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Environmental Policy and Technology Project

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Operation and Maintenance Manual
Kosaman and Berdykol Wellfields

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For the New Independent States of the former Soviet Union
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SECTION 1
Wellfield Equipment

1.1 PUMPING

This section describes pumping equipment installed at Kosaman and Berdykol wellfields in 1995 and 1996. The submersible pumping systems are composed of the following:

- Electric Motor
- Submersible Pump
- Sand Separator (15 systems)
- Electric/Safety Cable
- Control Panel
- Flowmeter

1.2 ELECTRIC MOTOR

Three sizes of electric motors were purchased for the well field rehabilitation project: 10, 25, and 50 horsepower. All the motors are designed to run at 2900 revolutions per minute (rpm) on a 380 Volt, 50 Hertz, 3 phase power supply. Table 1 summarizes the number and type of electric motors purchased for the wellfield rehabilitation project.

Table 1. Electric Motors

Horsepower (HP)	Kilowatts (kW)	Number Purchased
10	7.5	5
25	18.6	23
50	37.3	4*

*3 in 1995, 1 in 1996

There are four motor leads for the electrical connection, one for each of the three phases and one ground wire. The ground wire is not connected to the surface ground but is grounded to the earth via groundwater.

1.3 SUBMERSIBLE PUMP

Four sizes of submersible turbine pumps were purchased for the Wellfield Rehabilitation Project: 9.5, 18.9, 22 and 31.1 L/s. The flow rates produced once the pumps are installed vary and depend on the total dynamic head (THD) exerted on the pump. The closer the actual flow rates are to the design flow rate, the greater is the efficiency of the pump, which results in lower energy costs.

Table 2 summarizes the number and type of pumps purchased, the optimum TDH, and the operational range of the pumps. Section 4.0 contains performance curves and other manufacturer specifications for the submersible turbine pumps.

Table 2. Submersible Turbine Pumps

Optimum Flow (L/s)	Optimum TDH (meters)	Operational TDH Range (meters)	Operational Flow Range (L/s)	Number Purchased
9.5	44	34-49	6-10.3	5
18.9	110	84-137	11-24	3*
22	60	42-69	14-26	23
31.5	62	51-67	30-44	1

*Purchased in 1995

The flow rate of the pump should fall within the operational flow range of the pump for maximum efficiency. The TDH of the submersible pumps purchased in 1995 are higher than those purchased for the 1996 rehabilitation program.

1.4 SAND SEPARATOR

Sand separators are designed to remove sand through centrifugal action from groundwater before it reaches the pump intake. This significantly extends the life of the pump by reducing abrasion from sand. Removed sand is discharged to the bottom of the well. The well does not fill up with sand because sand stops entering the well after a period of time (see Section 4.0 for more details on this). A total of 15 sand separators of two types were purchased. Type G is for flow rates greater than 325 gpm (21 L/s) and type F is for flow rates less than 325 gpm (21 L/s). Table 3 summarizes the number of each type purchased, the acceptable flow range, and the outer diameter of each. Section 4.0 contains manufacturers specifications and other details.

Table 3. Sand Separators

Type	Flow Range (l/s)	Outside Diameter (mm)	Number Purchased
F	9.5-21	168.4	5
G	21-41	219.2	10

The sand separators are attached to a pump enclosure shell. Since the pump and motor are installed inside the shell, it is of larger diameter than the separators. The shell serves two purposes: to prevent sand laden water from entering the pump and to allow a sufficient amount of cooling water to pass by the motor.

1.5 ELECTRIC/SAFETY CABLE

Since there is a variety of motor sizes, there is a variety of electric cable sizes. Despite differences in size or gauge, all the cables are made of three strands of copper wires enclosed in a flat rubber insulating shell and are specifically designed for submersible pump applications. Table 4 lists the US standard size of copper wire used for each type of motor and the minimum diameter of the wire in millimeters.

Table 4. Electric Cable

Motor Size HP (kW)	Minimum Diameter, Copper Wire (mm)	Gauge of Cable (US AWG Standard)
10 (7.5)	2.6	10
25 (18.6)	3.3	8
50 (37.3)	5.2	4

If the copper wire needs to be replaced by aluminum wire, please account for differences in conductivity of copper and aluminum. It is critical that the proper splice equipment be used to connect the cable and the motor leads. Splicing should be done by experienced personnel with the proper equipment. Each pumping system installed during the full-scale wellfield rehabilitation project has a steel safety cable attaching the pump or sand separator to the wellhead at the surface. Do not remove or unattach the safety cable from the wellhead. This cable will prevent the pump from falling to the bottom of the well in the vent there is a failure in the riser pipe assembly.

1.6 CONTROL PANEL

The control panels contain many devices designed to protect the pumping systems from damage. The power monitor protects the motor from overvoltage, undervoltage, phase loss, phase reversal, and phase unbalance. The frequency monitor protects the motor from frequencies above and below acceptable limits. A lightning arrestor, which is mounted on the outside of the panel, protects the motor from being damaged by voltage surges caused by lightning. The motor starter contains overload protection that will shut off the motor if the amperes exceeds a set limit. The pump is protected by water level shutoff switches that are triggered by the water level dropping below or rising above predetermined level.

Table 5 summarizes the settings of the various protection devices contained in the control panels (Controlled Systems) purchased for the rehabilitation project.

Table 5. Control Panel Motor/Pump Protection Settings

Item	Range	Settings
Power Monitor	Overvoltage 350-450 Volts Undervoltage 300-400 Volts	418 Volts 342 Volts
Frequency Monitor	High 45-1023 Hertz Low 45-1023 Hertz	52 Hertz 48 Hertz
Overload Protection	10 Horsepower 25 Horsepower 50 Horsepower	16.3 Amperes 40 Amperes 80 Amperes
Water Level Shut-off (distance above pump intake)	150 gpm 350 gpm 500 gpm	32 feet (9.8 m) 60 feet (18.3 m) 69 feet (21 m)
Water Level Restart (distance above pump intake)	150 gpm 350 gpm 500 gpm	36 feet (11 m) 64 feet (19.5 m) 73 feet (22.2 m)

NOTE: Do not change the settings of these protective devices. Doing so may result in failure of the pumping system. The Control panels purchased for the pilot rehabilitation project (Asco/Delta) should only be used with the pumps/motors purchased in 1995 (8 inch, 3 stage Goulds pumps, 50 horsepower motors).

SECTION 2
Wellfield Operation

This section describes how the Kosaman and Berdykol wellfields should be operated. The two main factors that must be considered are well drawdown and pump idle time.

2.1 WELL DRAWDOWN

The most efficient way to operate the wellfield is to meet the demand with the smallest possible drawdown in the operating wells. Minimizing the drawdown means less energy is required to lift the water to the surface. To minimize drawdowns, pumping wells should be spaced as far apart as practically possible. For example, if ten wells are needed at Kosaman, every third well should be pumped rather than pumping ten neighboring wells. In the central portion of the Kosaman wellfield there are three wells (Wells No. 19, 22, 23) with relatively high drawdowns. As a result, special attention must be paid as to what wells can be pumped. To prevent automatic shutdowns due to excessive drawdown, follow these guidelines:

- Do not pump Wells No. 22 and 23 at the same time
- Do not pump Wells No. 18 and 21 when Well No. 19 is pumping

2.2 PUMP IDLE TIME

Pumps are designed for continuous operation. Damage to a pump and motor may occur if it is allowed to remain inactive for a long period of time. Well efficiency can also be adversely affected by long periods of inactivity. Therefore, it is important to operate every pump on a monthly basis so that no pump remains inactive for longer than 30 days.

SECTION 3
Equipment Maintenance/Removal/Installation

This section describes equipment maintenance procedures and instructions for the removal and installation of submersible pumping systems.

3.1 MAINTENANCE

Submersible pumping systems require little maintenance other than operating them periodically, as mentioned in Section 2.

The control panels require no maintenance, but should be well protected from rain, snow and dust. Therefore, the top openings on the pump houses should be kept well covered at all times and the doors of the pump houses should be shut and locked at all times.

The flowmeters require little maintenance. After a long period of inactivity, the grease in the bearings of the propeller may become hard. If the flowmeter fails to operate, it may be necessary to remove the flowmeter and hand loosen the propeller before reinstalling (See manufacturer's instructions in Section 4.0 for more details).

The wells may need maintenance if the capacity of the well begins to decline. If pumping water levels are reaching the water-level shutoff probe without adjacent wells pumping, then the well may need rehabilitation. The first step is to chlorinate the well. This is done by dissolving 4 kg of calcium hypochlorite in water and then dumping it into the well through the opening on the wellhead. Allow to sit for 2 days and then pump for 1 day. Be extremely careful when working with chlorine. Excessive exposure can be very harmful, even fatal. If chlorination is not successful, it may be necessary to redevelop the well using acid based chemicals. Instructions for the use of such chemicals is included in Section 4.0.

NOTE: Acid based chemicals are extremely hazardous and should only be used by experienced personnel with proper equipment.

3.2 PUMP/MOTOR REMOVAL INSTRUCTIONS

If a pumping system needs to be removed, some basic instructions are provided below. Please consult Section 4.0 for additional information on installation and removal of pumping equipment.

1. Turn the power off on the pump control panel and tag it.
2. Turn the circuit breaker on the transformer control panel off and tag it.
3. Disconnect high-voltage power switch on the transformer.
4. Disconnect the submersible pump cable and water level probe wires (orange and blue wires) at the wellhead.
5. Close the gate valves on the wellhead assembly.
6. Disconnect the flange connections on the wellhead elbow/cross.

7. Remove the wellhead elbow/cross and riser pipe from the well. When removing the riser pipe, be very careful not to damage the submersible pump cable, wires for the water level probes, and safety cable.
8. As the cables and wires are removed, coil them neatly off to the side, away from the work area. This keep the work area safe and prevent the cables and wires from getting entangled.
9. Once the pump has been pulled out, it may be necessary to have a cutting torch or welding unit available to separate the various parts of the pump assembly.
10. If the electrical connection must be severed, cut the protective rubber coat off the spliced wires and cut the three wires from the motor as close to the splice as possible.
11. Inspect the pump and motor of obvious signs of damage or wear.
13. If there are problems with the pumping system, see Section 4.0, Manufacturers Information.

3.3 PUMP INSTALLATION INSTRUCTIONS

Detailed pump installation instructions are provided by the manufacturer of the pump and are contained in Section 4.0. The instructions listed below supplement those contained in Section 4.0.

1. Chlorinate the well with 4 lb. (2 kg) calcium hypochlorite or equivalent.
2. Attach motor to pump.

<u>For Systems With No Sand Separator</u>

1. Attach check valve to pump discharge, using a pipe nipple. Be sure the check valve is oriented correctly (the spring on the valve should be pointing towards the pump and the flat side of the valve should be facing upward, towards the ground surface).
2. Attach a flanged connection to the check valve.
3. Weld a short piece of wire connecting the flanged connection to the check valve, the check valve to the nipple, and the nipple to the pump. This wire will ensure that the assembly does not come unscrewed.
4. Splice motor leads (black, red and yellow wires) to electric cable, matching like colored wires. Use copper tube connectors, crimped tightly to the wires and heat shrink or equivalent splicing method (See Section 4.0 for more detailed information on splicing methods).
5. Install wire screen over pump intake and place cable guard over spliced cable.
6. Wrap safety cable tightly around the pump, under the electric cable, and fasten with three clamps.

<u>For Systems With a Sand Separator</u>

1. Remove the screws attaching the riser assembly to the shell.
2. Attach a check valve to the threaded connection at the top of the riser assembly and then attach a flanged connection to the check valve.
3. Attach the pump to the bottom threaded connection of the riser assembly.
4. Weld a short piece of wire connecting the flanged connection to the check valve, the check valve to the riser assembly, and the riser assembly to the pump. This wire will ensure that the assembly does not come unscrewed.
5. Thread electric cable through the hole in plate on riser assembly before splicing.

6. Splice motor leads (black, red and yellow wires) to electric cable, matching like colored wires. Use copper tube connectors, crimped tightly to the wires and heat shrink or equivalent splicing method (See Section 4.0 for more detailed information on splicing methods).
7. Replace wire screen over pump intake and place cable guard over spliced cable.
8. Install the sand separator (the smaller diameter pipe) in the well with the threaded connection above the top of the casing.
9. Screw empty pump/motor shell onto the sand separator. Make sure the separator is secure so it does not fall into the well as the shell is screwed on.
10. Once the shell is screwed on, weld a short piece of wire connecting the shell to the separator.
11. Place the pump/riser assembly into the shell and secure with the screws.
12. Wrap some rubber and tape around the electric cable where it goes into the hole in the riser assembly. It is important to plug this hole so the water cannot bypass the separator.
13. Attach safety cable to the loop on the shell using three clamps.

Basic Instructions Continued

- When connecting flanges, use all bolt holes and properly sized bolts. Failure to do so increases the likelihood of pumping system dropped into the well.
- Fasten electric cable above and below each flanged connection and in the middle of each section of pipe. Place the cable within the cut-out in the flanges and keep it aligned with this cut-out during installation.
- Fasten the safety cable with tape at each flanged connection. Be sure to wrap the tape under the electric cable so in the vent the pump falls, the safety cable will not damage of severe the electric cable. Place the safety cable within the cut-out in the flanges to prevent damage to the cable during installation.
- At the proper depth, attach the water level shut-off/restart probes to the riser pipe.

The following table indicates the distance above the pump intake the probes need to be set for each type of pumping system.

Pump Capacity (l/s)	Water Level Shut-Off Probe feet (meters) above pump intake	Water Level Restart Probe feet (meters) above pump intake
9.5	10.3	11.6
22	18.3	19.5
31.5	22	23.2

SECTION 4
Manufacturers Information

4.1 J-Line Pump Drawing

4.2 Owner's Manual

4.3 Installation and Operation Instructions

4.4 Submersible Turbine Pump Specifications

4.5 Turbine Pump Performance Curves

4.6 Heat Shrink Kits

4.7 Lakos Pump Protection Separator

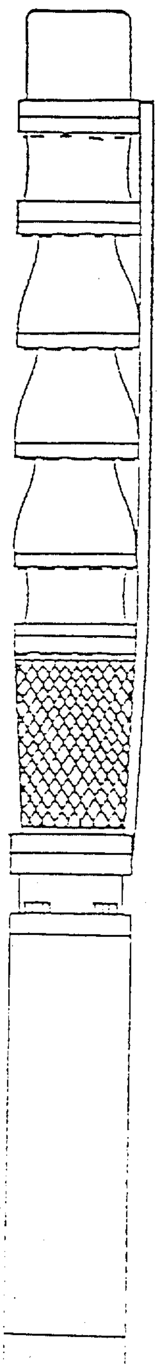
4.8 Weld-On Saddle Flowmeter

4.9 McCrometer Flowmeter Installation

4.10 Acid Redevelopment Procedures

J-LINE
TURBINE PUMPS
FORMERLY JACUZZI

OWNER'S MANUAL
INSTALLATION INSTRUCTIONS
Submersible Turbine Pumps



PLEASE READ THIS MANUAL BEFORE INSTALLING THE PUMP

INSPECTION

Examine equipment at time of receipt. Check that power cable is not cut or damaged, and that all equipment is correct for the particular installation. Handle pump and cable carefully and do not load other material on top of them. This is very important because of the precise alignment of the assembly and the vulnerability of the cable.

GENERAL DESCRIPTION

The pump unit comprises a vertical turbine pump assembly direct-coupled to a submersible electric motor. The connecting bracket accommodates the coupling between pump and motor shafts and serves also as the pump intake.

The pump unit is suspended in the well by the riser pipe, and power is taken down from the well head to the motor by a submersible cable secured at intervals to the riser pipe.

Please, read the maker's separate instruction manual for the motor, and keep it for future reference.

SUITABILITY OF WELL

Water from an undeveloped well often contain an excessive amount of sand, dirt, and abrasive which can damage the pump. Consequently, INSTALL THE PUMP IN A WELL WHICH HAS ALREADY BEEN PROPERLY DEVELOPED with a test pump.

Relate the capacity and setting of the pump to the yield of the well. Proper selection will prevent harmful shock loads on the bearings, which would occur with the intermittent entry of air and water if the water level were drawn down to the pump intake.

Check that the well is large enough to allow installation of the pump at the required depth. Keep the pump at least five feet from the bottom, particularly where there is a history of sand in the well. Do not install the pump below the lowest perforations in the well casing, unless the well size permits the installation of a shroud over the unit to ensure an adequate flow of water over the motor for cooling purposes.

Refer to the factory for recommendations if the pump is to be installed other than vertically as in a well.

CHECK VALVES

If the pump setting exceeds 100 feet, install a check valve at the first joint in the riser pipe above the pump. Always use an additional check valve at the surface if the pump is part of a pressure system, or if the pressure head exceeds 500 feet. If the setting exceeds 500 feet, install a third check valve (non-slam type) in the riser pipe at two-thirds of the setting above the pump.

POWER CABLE

Employ a competent electrician to splice the motor leads to the cable by one of the following methods. Splicing kits are shown in Catalog Section 246.

METHOD I - TAPED SPLICE

1. Remove ten inches from the outer jackets of jacketed cables. Be careful not to damage the insulation of the individual conductors.

2. Trim the motor leads so that the yellow wire is three inches shorter and the black wire three inches longer than the red one.

3. Trim the wires of the cable so that the yellow wire is three inches longer and the black wire three inches shorter than the red one.

4. Strip one-half inch of insulation from the end of each wire and scrape the metal clean.

5. Join like-colored wires with connectors, secure the connectors with staking pliers and fill each connector with solder to insure mechanical and electrical joints.

6. Bind each connection with approved self-bonding rubber tape, with the first layer extending one inch over the insulation, and the second layer extending one inch beyond the first.

7. Apply two layers of plastic insulating tape, each extending one inch beyond the previous one.

8. Bind the three conductors together with one layer of approved self-bonding rubber tape, and two layers of approved electrical tape, all extending over the outer sheath if a jacketed cable is used.

METHOD 2 - MOLDED SPLICE

Read the instructions enclosed with the splicing kit. Because of the speed at which it sets, do not mix the resin before completing the preparation of the splice.

CAUTION

TAKE GREAT CARE TO PREVENT DAMAGE TO THE CABLE DURING INSTALLATION.

When the cable is supplied on a reel, support the reel on a piece of pipe laid across a pair of sturdy saw horses. Locate the reel about six feet from the well so that the cable unwinds from the top.

Prevent the cable from scraping on the well casing.

Avoid pinching the cable either in the pipe clamps, or between the riser pipe and the well casing.

Should the cable get damaged, either cut out the defective length and splice the ends as described previously, or repair the damage in the following manner.

REPAIR

Although cuts and abrasions may not puncture the cable insulation, repair them in the following manner:

1. Use a solvent, such a paint thinner or gasoline to clean the cable in the region of damage. Roughen the surface of the insulation with sandpaper, or by scraping it with a knife.

2. Apply a coating of rubber cement (Goodyear Pliobond, 3M Scotchcote, or equal) to the prepared surface, and let it dry for half hour.

3. Cut off a length of 3/4 inch wide vinyl plastic electrical tape about one inch longer than the cut or abrasion, and lay it smoothly over the damage. Start binding the cable with the same tape one inch in front of the damage, lapping each wrap halfway over the previous one, until the binding extends one inch beyond the damage. Wind the tape smoothly without wrinkles and avoid stretching it unduly. Add three more layers in a similar manner each extending 1/2 inch beyond that beneath. Apply a coating of rubber cement over the repair as an additional bond and to improve the resistance to oil and solvents.

ELECTRICAL INSTALLATION

Employ a competent electrician to do the wiring in accordance with the local electrical code. Conventional overhead or underground installation is satisfactory for the electrical power transmission to the well head.

Check that the power supply corresponds with that shown on the nameplates of the motor and control box. Note that every installation requires a fused disconnect switch or circuit breaker.

A SINGLE-PHASE unit includes a control box incorporating overload relays, but requires a magnetic starter for automatic operation.

A THREE-PHASE unit requires a magnetic starter with three-leg protection having QUICK-TRIP AMBIENT-COMPENSATED overload relays.

NOTE THAT THE GUARANTEE IS VOID IF INCORRECT OVERLOAD RELAYS ARE USED.

Mount the control equipment vertically on a post or wall, and protect it from direct sunlight and extremes of temperature. Make the connections to the control equipment in accordance with the wiring diagram to avoid damage to the motor.

PRELIMINARY ELECTRICAL TEST WITH PUMP ABOVE GROUND

After splicing the motor leads to the cable, use a 500-volt megohm meter (megger) to test the insulation. Connect the ground lead of the instrument to the motor frame, and the line lead to the ends of the cable conductors. Turn the crank of the megger for five to ten seconds, and check that the needle shows a value of at least 50 megohms. Remove the megger and wet down the motor leads and power cable with a hose or bucket. Reconnect the megger and check the resistance again. Should the value be appreciably less than before, it indicates damaged insulation. Locate the damage either by visual inspection or by checking the resistance as successive sections of the cable are immersed in water. If the cable is new, it is probable unnecessary to check its entire length, but check it thoroughly from just above the splice down to the motor.

Check the rotation of the pump unit before installing it in the well. Connect the cable temporarily to the control equipment. Hold the pump shell and apply the power momentarily by snapping the line switch quickly on and off. If the rotation is correct, the reaction of the shell will be clock-wise when viewed from the pump discharge (that is, the pump shaft will be seen to rotate counterclockwise if there is no check valve to obstruct the view).

Correct the rotation of a three-phase motor by interchanging any two motor leads at the starter. Refer to the maker's instruction manual for reversing the rotation of a single-phase motor. Disconnect the cable from the control equipment before installing the pump, but mark the leads and terminals for correct re-connection later.

LIGHTNING ARRESTERS

Install lightning arresters to protect the submersible motor against the effects of electrical storms. Although they will not give protection against direct strikes, they will ground the surges caused in transmission lines by surrounding storms.

One arrester is sufficient for a single-phase unit, but two are necessary for a three-phase unit. Install them in accordance with the maker's separate instructions, either in the control box on some single-phase systems, or in the supply line immediately ahead of the control equipment. Pay particular attention to the ground connection. DO NOT USE A GROUND ROD. Use the best ground on the premises, which is usually the metal riser pipe from the pump or other metal water pipe. Obtain the correct size of ground connector for the pipe from an electrical supply house, and make the connection between the arrester and the connector with #10 (or heavier) stranded copper wire. Bare and insulated wire is suitable.

Where there is an insulation joint (such as a piece of rubber hose) in the pipe from the well, be sure that the ground connection is made on the well side of the joint.

INSTALLATION OF PUMP, RISER PIPE AND CABLE

TAKE GREAT CARE TO PREVENT DAMAGE TO THE CABLE DURING INSTALLATION.

When the cable is supplied on a reel, support the reel on a piece of pipe laid across a pair of sturdy saw horses. Locate the reel about six feet from the well so that the cable unwinds from the top.

Prevent the cable from scraping on the well casing.

Avoid pinching the cable either in the pipe clamps, or between the riser pipe and the well casing.

Should the cable get damaged, either cut out the defective length and splice the ends, or repair the damage, as described in the section on POWER CABLE.

Thread the first length of riser pipe into the pump discharge and raise the pump and pipe into a vertical position over the well. Be careful neither to drag the pump along the ground, nor let it strike other objects.

Lower the pump about 10 feet into the well, and fasten the cable to the riser pipe to prevent tangling and damage. Use electrical tape for light cable and stainless steel bands for heavy cable. Continue to add lengths in the same manner until the required pump setting is reached. Secure the cable to the riser pipe at regular intervals with tape or bands.

Use an ohmmeter or megger to make continuity and insulation checks on the cable at intervals of 10 to 20 feet as the pump is lowered. This will locate any fault in the cable.

Place the sanitary well, seal, surface plate, or other adapter on the last length of riser pipe, and pass the submersible cable through the opening provided. Then attach the discharge tee or elbow to the riser pipe. Lower the riser pipe to its final position and tighten the well seal or other device to support the installation in the well.

INITIAL START-UP AND PERFORMANCE CHECK

Make final continuity and insulation (50 megohms or higher) checks before connecting the cable to the control equipment. Check that the supply voltage is within 10% of the motor rating. It is preferable for the supply voltage to be on the high side. Check all phases of a three-phase supply.

Check the pump and well performance before making the final connection to the discharge system.

1. Install a pressure gauge and gate valve on the end of the pipe. Close the gate valve.

2. Start the pump, and check the pressure developed against the close valve. If this pressure is substantially less than expected (do not forget to allow for the depth to water level), the pump may be running backward. To change the rotation, refer to the section on PRELIMINARY ELECTRICAL TESTS WITH PUMP ABOVE GROUND.

3. Open the gate valve to give a low flow until you are certain that the well will not yield sand. Open the gate valve gradually to give full flow.

4. Use a hook-on ammeter to read the current, which should approximate the full-load current given on the motor nameplate, but must not exceed the Service Factor rating of the motor. The Service Factor varies with the make and the horsepower of the motor. Consult the factory if insufficient information is given about Service Factor performance.

Check that the currents in the individual phases of a three-phase system are approximately equal. Where there is considerable difference between them, change all three connections at the starter as shown below (so that rotation remains the same) to obtain the most consistent readings.

STARTER	L 1	L 2	L 3
CABLE (1)	Black	Yellow	Red
(2)	Red	Black	Yellow
(3)	Yellow	Red	Black

Then subtract the average of the readings from the highest. The difference, expressed as a percentage of the average, must not exceed 10%. Note that the highest reading must not exceed the maximum permissible for the motor.

Example:	Phase 1	54.0 amp	
	Phase 2	55.0 amp	Average: 56.3 amp
	Phase 3	60.0 amp	

$$\% \text{ unbalance} = \frac{60.0 - 56.3}{56.3} \times 100$$

$$= \frac{3.7 \times 100}{56.3} = 6.6\%$$

Should the unbalance exceed 10%, ask the power company to improve the voltage balance between the incoming lines.

5. Use a voltmeter to check the voltage at the starter while the pump is running. The average must be within 10% of the motor rating, and the maximum variation of any phase of a three-phase system from the average should not exceed 1%. The effect of an unbalanced supply voltage causes a current unbalance and increased losses in the motor far out of proportion to the voltage unbalance.

6. Continue to run the pump until the draw-down of the water in the well becomes stable.

Should the water level drop to the pump intake to admit air, use one or more of the following methods to protect the installation.

(a) Install additional riser pipe to place pump lower in well, if possible.

(b) Use a cock or similar valve in the discharge line to throttle the pump output to suit the yield of the well.

(c) Install a FLOATLESS LIQUID LEVEL CONTROL.

(d) Use a pressure switch with low water protection or a separate low-water cutout switch. Neither of these devices give as reliable protection as a floatless liquid level control, and both require careful application.

(e) Replace the pump with a smaller unit to avoid over-pumping the well.

CAUTION

NEVER RUN THE PUMP UNLESS IT IS COMPLETELY SUBMERGED IN WATER, otherwise damage can occur to both pump and motor. In addition, air drawn into the pump can cause an air lock.

RELIEF VALVE

Always install a relief valve if the pump is capable of developing pressures in the discharge system greater than the pressure ratings of individual components. The relief valve must be large enough to handle the pump output at the relief pressure.

PERIODIC CHECK-UP

The most reliable indications of the condition of a submersible pump are:

(a) The current drawn by the motor;

(b) The insulation resistance of the installation below ground.

As the pump wears, the motor current increases, until eventually the overloads trip to protect the motor. While this automatic protection looks after an emergency situation, proper care of a submersible installation should include periodic check-ups to avoid interruptions in the water supply. Use a megger to check the insulation resistance every six months. Record the insulation and the running current for future reference. When the insulation resistance falls below 10 megohms, check it frequently for further deterioration, and pull the pump when the resistance falls to 1/2 megohm.

When pulling the pump, either coil the cable on a reel, or raise it from the ground to dry. Check the insulation again when the cable and splices are dry. If the insulation value between the line and motor casing increases to 50 megohms or more, isolate the fault in the cable or the splice and make the necessary repairs. However, if the insulation reading remains low, disconnect the motor from the cable and check the motor separately. Should the motor be defective, check the pump end for wear, and obtain a replacement for either the motor alone, or the complete pump unit, as necessary.

TROUBLESHOOTING

1. PUMP FAILS TO START.

(a) Electrical trouble - call dealer or electrician.

(b) Sand lock in pump - call dealer.

(c) Static water level below top electrode of liquid level control due to seasonal variation.

2. PUMP FAILS TO DELIVER WATER.

(a) Overload tripped.

(b) Air lock in pump.

(c) Clogged intake screen.

(d) Insufficient well yield.

3. OVERLOADS TRIP.

(a) Worn pump, or pump bound by sand.

(b) Electrical trouble - call dealer or electrician.

4. PUMP GIVES REDUCED OUTPUT.

(a) Insufficient well yield.

(b) Worn pump.

(c) Clogged intake screen.

(d) Low voltage.

(e) Incorrect rotation (three-phase only).

5. PUMP CYCLES TOO FREQUENTLY.

(a) Excessive pressure drop between pressure switch and tank.

(b) "Cut-in" pressure at tank too high.

(c) "Cut-out" pressure at tank too low.

(d) Waterlogged pressured tank.

6. PRESSURE SWITCH CYCLES RAPIDLY WHEN PUMP STARTS.

(a) Pressure switch too far from pressure tank.

INSTALLATION RECORD

Record the following details at the time of installation and retain for future reference:

Purchased From: ____________________

Install By: ____________________

Date of Installation: ____________________

Catalog Figure Number: ____________________

Motor Make: ____________________ Motor Serial Number: ____________________

Motor HP: __________ Volts: __________ Phase: __________ Cycle: __________

Maximum Allowable Current: (Amps) ____________________

Well: Inside Diameter: (Inches) ____________________ Depth: (Feet) ____________________

Standing Water Level: (Feet below ground) ____________________

Depth to Lowest Perforation: (Feet below ground) ____________________

Riser Pipe: Size: (Inches) ____________________ Length: (Feet) ____________________

(Refer to section on RISER PIPE).

Power Cable: Size: ____________________ Length: (Feet) ____________________

Distance Between Well and Point of Discharge: ____________________

Discharge Operating Conditions: ____________________

____

____

Installation and Operation Instructions

STAINLESS STEEL SUBMERSIBLE PUMPS

Your Grundfos Submersible Pump is of the utmost quality. Combined with proper installation, your Grundfos pump will give you many years of reliable service.

To ensure the proper installation of the pump, carefully read the complete manual before attempting to install the pump.

SECTION 1.

Shipment Inspection

Examine the components carefully to make sure no damage has occurred to the pump-end, motor, cable or control box during shipment.

This Grundfos Submersible Pump should remain in its shipping carton until it is ready to be installed. The carton is specially designed to protect it from damage. During unpacking and prior to installation, **make sure that the pump is not dropped or mishandled.**

The motor is equipped with an electrical cable. **Under no circumstance should the cable be used to support the weight of the pump.**

You will find a loose data plate wired to the pump. It should be securely mounted at the well or attached to the control box.

SECTION 2.

Pre-Installation Checklist

Before beginning installation, the following checks should be made. They are all critical for the proper installation of this submersible pump.

☑ **A. CONDITION OF THE WELL**
If the pump is to be installed in a new well, the well should be fully developed and bailed or blown free of cuttings and sand. The stainless steel construction of the Grundfos submersible make it resistant to abrasion; however, no pump, made of any material, can forever withstand the destructive wear that occurs when constantly pumping sandy water.

If this pump is used to replace an oil-filled submersible or oil-lubricated line-shaft turbine in an existing well, **the well must be blown or bailed clear of oil.**

Determine the maximum depth of the well, and the draw-down level at the pump's maximum capacity. Pump selection and setting depth should be based on this data.

The inside diameter of the well casing should be checked to ensure that it is not smaller than the size of the pump and motor.

☑ **B. CONDITION OF THE WATER**
Submersible pumps are designed for pumping clear and cold water that is free of air and gases. Decreased pump performance and life expectancy can occur if the water is not cold and clear or contains air and gases.

Maximum water temperature should not exceed 102°F. Special consideration must be given to the pump and motor if it is to be used to pump water above 102°F.

The Grundfos stainless steel submersible is highly resistant to the normal corrosive environment found in some water wells. If water well tests determine the water has an excessive or unusual corrosive quality, or exceeds 102°F, contact your Grundfos representative for information concerning specially designed pumps for these applications.

☑ **C. INSTALLATION DEPTH**
A check should be made to ensure that the installation depth of the pump will always be at least three feet below the maximum draw-down level of the well. For flow rates exceeding 100 gpm, the NPSH may have to be considered. Refer to NPSH curves in the technical brochure.

The bottom of the motor should never be installed lower than the top of the well screen or within five feet of the well bottom.

If the pump is to be installed in a lake, pond, tank or large diameter well, the water velocity passing over the motor must be sufficient to ensure proper motor cooling. The minimum recommended water flow rates which ensure proper cooling are listed in Table A.

☑ **D. ELECTRICAL SUPPLY**
The motor voltage, phase and frequency indicated on the motor nameplate should be checked against the actual electrical supply.

SECTION 3.

Wire Cable Type

wire cable used between the pump and control box or [illegible]el should be approved for submersible pump applications. The conductor may be solid or stranded. The cable may consist of individually insulated conductors twisted together, insulated conductors molded side by side in one flat cable or insulated conductors with a round overall jacket.

The conductor insulation should be type RW, RUW, TW, TWU or equivalent and must be suitable for use with submersible pumps. An equivalent Canadian Standards Association certified wire may also be used. See Table D for recommended sizes of cable lengths.

SECTION 4.

Splicing the Motor Cable

A good cable splice is critical to proper operation of the submersible pump and must be done with extreme care.

If the splice is carefully made, it will work as well as any other portion of the cable, and will be completely watertight.

Grundfos recommends using a heat shrink splice kit. The splice should be made in accordance with the kit manufacture's instructions. Typically a heat shrink splice can be made as follows:

1. Examine the motor cable and the drop cable carefully for damage.

2. Cut the motor leads off in a staggered manner. Cut the ends of the drop cable so that the ends match up with the motor leads (See Figure 4-A). On single-phase motors, **be sure to match the colors.**

3. Strip back and trim off ½ inch of insulation from each [illegible]d, making sure to scrape the wire bare to obtain a good connection. Be careful not to damage the copper conductor when stripping off the insulation.

4. Slide the heat shrink tubing on to each lead. Insert a properly sized "Sta-kon" type connector on each lead, making sure that lead colors are matched. Using a "Sta-kon" crimping pliers, indent the lugs (Figure 4-B). Be sure to squeeze hard on the pliers, particularly when using large cable.

5. Center the heat shrink tubing over the connector. Using a propane torch, lighter, or electric heat gun, uniformly heat the tubing starting first in the center working toward the ends (Figure 4-C).

6. Continue to apply the heat to the tubing using care not to let the flame directly contact the tubing. When the tubing shrinks and the sealant flows from the ends of the tubing, the splice is complete (Figure 4-D).

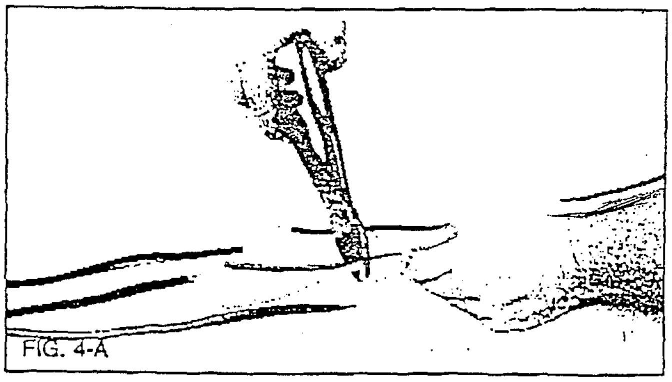


FIG. 4-A

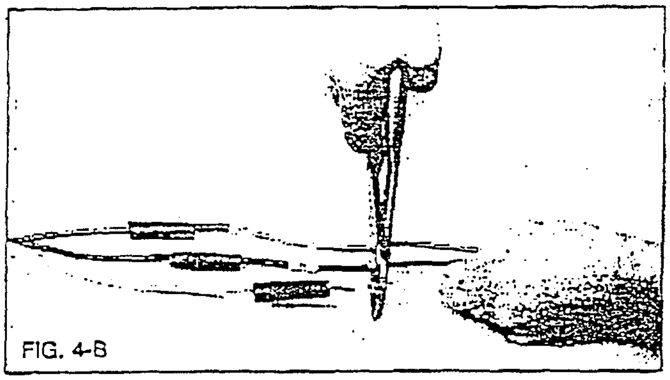


FIG. 4-B

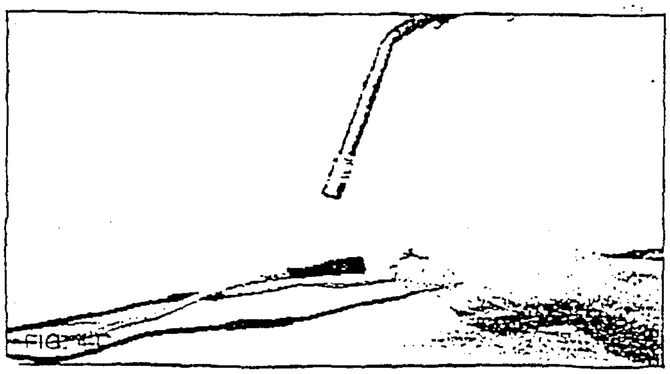


FIG. 4-C

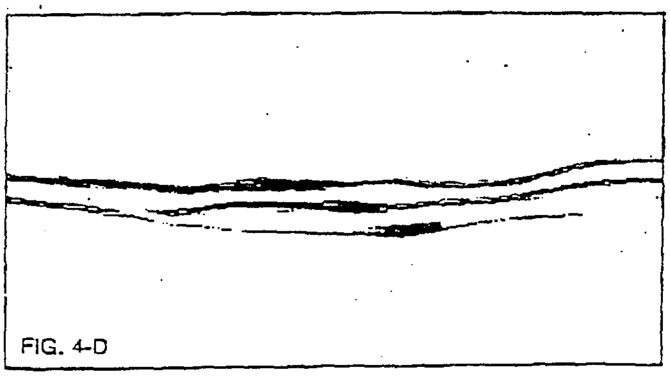


FIG. 4-D

SECTION 5.

Installation

The riser pipe or hose should be properly sized and selected based on estimated flow rates and friction-loss factors.

A back-up wrench should be used when the riser pipe is attached to the pump. The pump should be gripped only by the flats on the top of the discharge chamber. **The body of the pump, cable guard or motor should not be gripped under any circumstance.**

If Steel Riser Pipe is Used:

We recommend that steel riser pipes always be used with the larger submersibles. An approved pipe thread compound should be used on all joints. Make sure the joints are adequately tightened in order to resist the tendency of the motor to loosen the joints when stopping and starting.

When tightened, the first section of the riser pipe must not come in contact with the check valve retainer in the discharge chamber of the pump.

After the first section of the riser pipe has been attached to the pump, the lifting cable or elevator should be clamped to the pipe. **Do not clamp the pump.** When raising the pump and riser section, be careful not to place bending stress on the pump by picking it up by the pump-end only.

Make sure that the electrical cables are not cut or damaged in any way when the pump is being lowered in the well.

The drop cable should be secured to the riser pipe at frequent intervals to prevent sagging, looping or possible cable damage. Nylon cable clips or waterproof tape may be used. The cable splice should be protected by securing it with clips or tape just above and below the splice.

If Plastic or Flexible Riser Pipe is Used:

It is recommended that plastic type riser pipe be used **only** with the smaller domestic submersibles. The pipe manufacturer or representative should be contacted to insure the pipe type and physical characteristics are suitable for this use. Use the correct joint compound recommended by the pipe manufacturer. In addition to making sure that joints are securely fastened, the use of a torque arrester is recommended when using plastic pipe.

Do not connect the first plastic or flexible riser section directly to the pump. Always attach a metallic nipple or adapter into the discharge chamber of the pump. When tightened, the threaded end of the nipple or adapter must not come in contact with the check valve retainer in the discharge chamber of the pump.

The drop cable should be secured to the riser pipe at frequent intervals to prevent sagging, looping and possible cable damage. Nylon cable clips or waterproof tape may be used. The cable splice should be protected by securing it with clips or tape just above each joint.

IMPORTANT- Plastic and flexible pipe tend to stretch under load. This stretching must be taken into account when securing the cable to the riser pipe. Leave 3 to 4 inches of slack between clips or taped points to allow for this stretching. This tendency for plastic and flexible pipe to stretch will also affect the calculation of the pump setting depth. As a general rule, you can estimate that plastic pipe will stretch to approximately 2% of its length. For example, if you installed 200 feet of plastic riser pipe, the pump may actually be down 204 feet. If the depth setting is critical, check with the manufacturer of the pipe to determine how to compensate for pipe stretch.

When plastic riser pipe is used, it is recommended that a safety cable be attached to the pump to lower and raise it. The discharge piece of a Grundfos 4 inch submersible is designed to accommodate this cable (Figure 5-A).

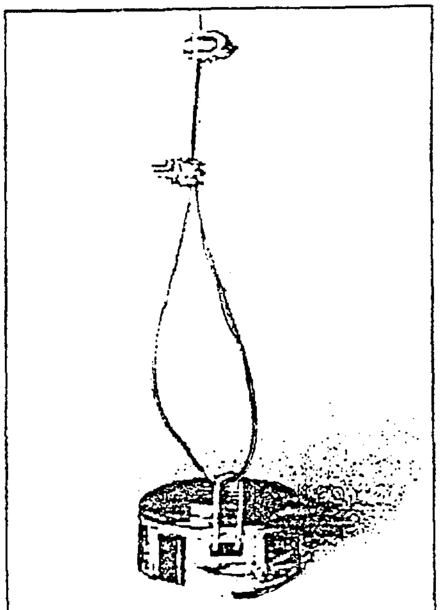


FIG. 5-A

Check valves:

A check valve should always be installed at the surface of the well. In addition, for installations deeper than 200 feet, check valves should be installed at no more than 200 foot intervals.

Protect the well from contamination:

To protect against surface water entering the well and contaminating the water source, the well should be finished off above grade, and a locally approved well seal or pitless adapter unit utilized.

SECTION 6.

Electrical

WARNING: To reduce the risk of electric shock during operation of this pump requires the provision of acceptable grounding. If the means of connection to the supply connected box is other than grounded metal conduit, ground the pump back to the service by connecting a copper conductor, at least the size ' the circuit supplying the pump, to the grounding screw provided within the wiring compartment.

All electrical work should be performed by a qualified electrician in accordance with the latest edition of the National Electrical Code, local codes and regulations.

Verification of the electrical supply should be made to ensure the voltage, phase and frequency match that of the motor. Motor voltage, phase, frequency and full-load current information can be found on the nameplate attached to the motor. Motor electrical data can be found in Table E.

If voltage variations are larger than ± 10%, do not operate the pump.

Direct on-line starting is used due to the extremely fast run-up time of the motor (0.1 second maximum), and the low moment of inertia of the pump and motor. Direct on-line starting current (locked rotor amp) is between 4 and 6.5 times the full-load current. If direct on-line starting is not acceptable and reduced starting current is required, an auto-transformer or resistant starters should be used for 5 to 30 HP motors (depending on cable length). For motors over 30 HP, use auto-transformer starters.

Engine-Driven Generators

.ne submersible pump is going to be operated using an engine driven generator, we suggest the manufacturer of the generator be contacted to ensure the proper generator is selected and used. See Table B for generator sizing guide.

If power is going to be supplied through transformers, Table C outlines the minimum KVA rating and capacity required for satisfactory pump operation.

Control Box/Panel Wiring

1. *Single-Phase Motors:*

Single-phase motors must be connected as indicated in the motor control box. A typical single-phase wiring diagram using a Grundfos control box is shown (Figure 6-A).

2. *Three-Phase Motors:*

Three-phase motors must be used with the proper size and type of motor starter to ensure the motor is protected against damage from low voltage, phase failure, current unbalance and overload current. A properly sized starter with ambient-compensated extra quick-trip overloads must be used to give the best possible motor winding protection. **Each of the three motor legs must be protected with overloads.** The thermal overloads must trip in less than 10 seconds at locked rotor (starting) current. For starter and overload protection guide, see Table H. A three-phase motor wiring diagram is illustrated below (See Figure 6-B).

Pumps should NEVER be started to check rotation unless the pump is totally submerged. Severe damage may be caused to the pump and motor if they are run dry.

Single-Phase Wiring Diagram
for GRUNDFOS Control Boxes

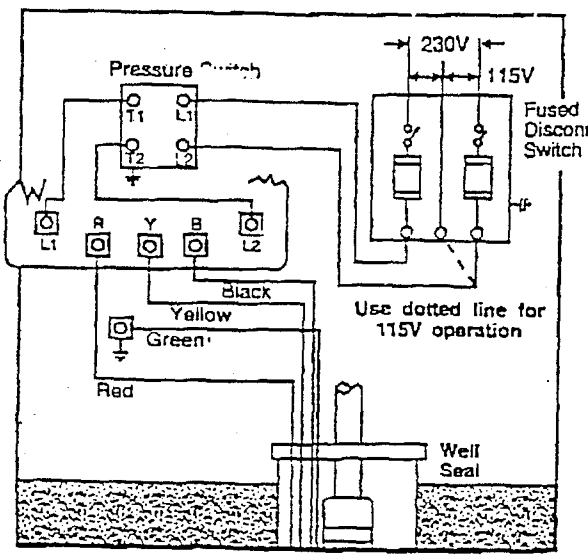


Figure 6-A

Three-Phase Wiring Diagram
for GRUNDFOS and FRANKLIN Motors

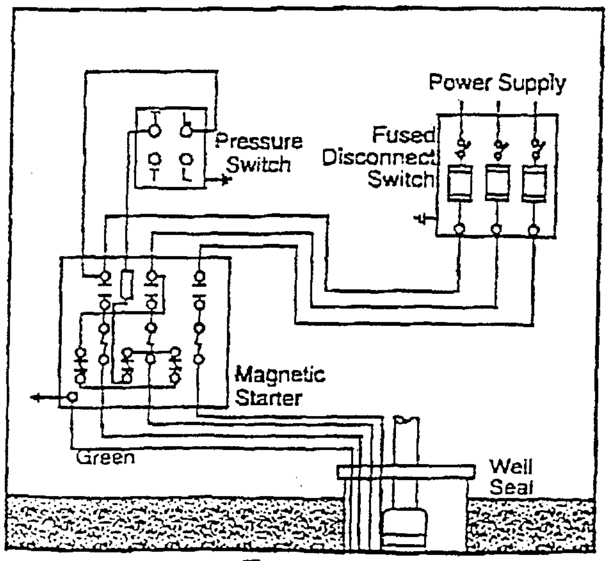


Figure 6-B

High Voltage Surge Arresters

A high voltage surge arrester should be used to protect the motor against lightning and switching surges. Lightning voltage surges in power lines are caused when lightning strikes somewhere in the area. Switching surges are caused by the opening and closing of switches on the main high-voltage distribution power lines.

The correct voltage-rated surge arrester should be installed on the supply (line) side of the control box (Figure 6-C and 6-D). The arrester must be grounded in accordance with the National Electrical Code and local codes and regulations.

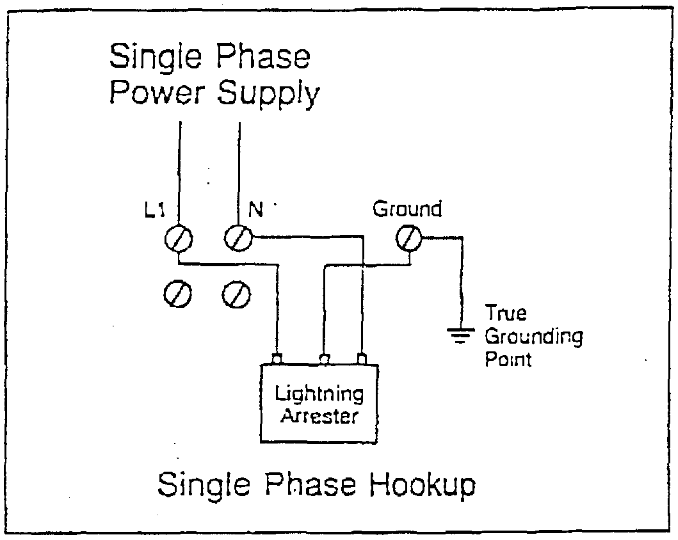


Figure 6-C

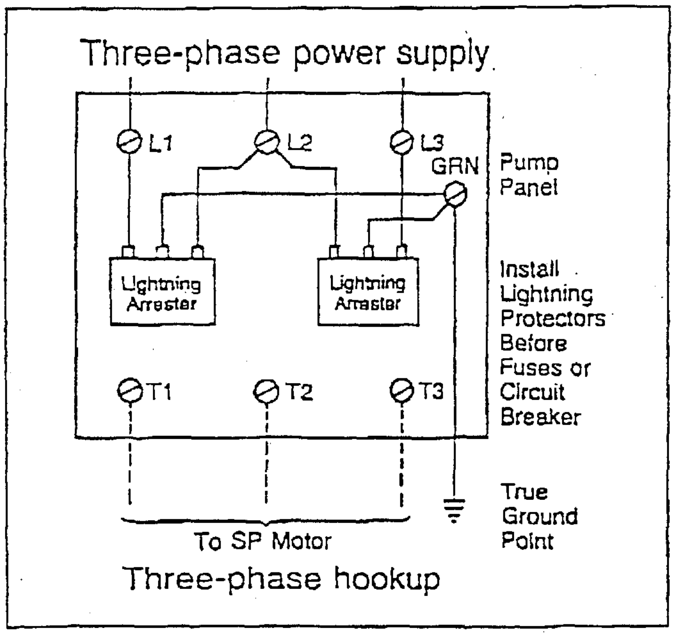


Figure 6-D

The warranty on all three-phase submersible motors is VOID if:

1. The motor is operated with single-phase power through a phase converter.
2. Three-leg ambient compensated extra quick-trip overload protectors are not used.
3. Three-phase current unbalance is not checked and recorded. (See START-UP Section 7 for Instructions.)
4. High voltage surge arresters are not installed.

Control Box/Panel Grounding

The control box or panel shall be permanently grounded in accordance with the National Electrical Code and local codes or regulations. The ground wire should be a bare copper conductor at least the same size as the drop cable wire size. The ground wire should be run as short a distance as possible and be securely fastened to a true grounding point.

True grounding points are considered to be: a grounding rod driven into the water strata, steel well casing submerged into the water lower than the pump setting level, and steel discharge pipes without insulating couplings. If plastic discharge pipe and well casing are used or if a grounding wire is required by local codes, a properly sized bare copper wire should be connected to a stud on the motor and run to the control panel. Do not ground to a gas supply line. Connect the grounding wire to the ground point first and then to the terminal in the control box or panel.

Wiring Checks and Installation

Before making the final surface wiring connection of the drop cable to the control box or panel, it is a good practice to check the insulation resistance to ensure that the cable and splice are good. Measurements for a new installation must be at least 2,000,000 ohm. Do not start the pump if the measurement is less than this.

If it is higher than 2,000,000 ohm, the drop cable should then be run through the well seal by means of a conduit connector in such a way as to eliminate any possibility of foreign matter entering the well casing. Conduit should always be used from the pump to the control box or panel to protect the drop cable (See Figure 6-E). Finish wiring and verify that all electrical connections are made in accordance with the wiring diagram. Check to ensure the control box or panel and high voltage surge arrester have been grounded.

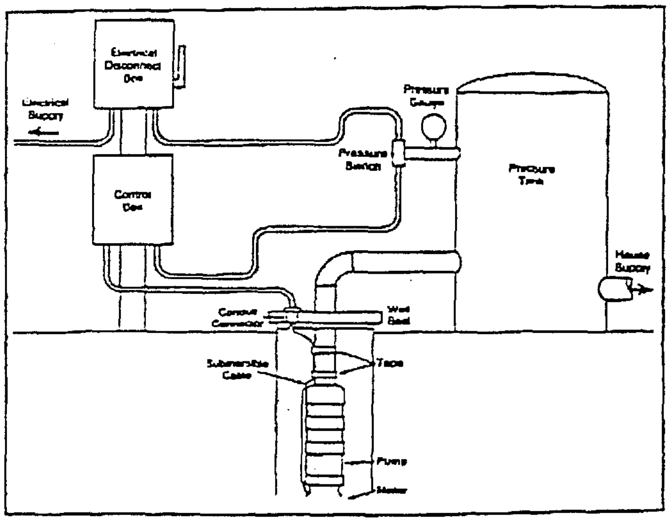


Figure 6-E

SECTION 7.

Start-Up

.he pump has been set into the well and the wiring onnections have been made, the following procedures should e performed:

A. Attach a temporary horizontal length of pipe with installed gate valve to the riser pipe.

B. Adjust the gate valve one-third of the way open.

C. On three-phase units, check direction of rotation and current unbalance according to the instructions below.

For single-phase units proceed directly to "Developing the Well".

D. Under no circumstances should the pump be operated for any prolonged period of time with the discharge valve closed. This can result in motor and pump damage due to overheating. A properly sized relief valve should be installed at the well head to prevent the pump from running against a closed valve.

Three-Phase Motors

1. Check the direction of rotation

Three-phase motors can run in either direction depending n how they are connected to the power supply. When the three cable leads are first connected to the power supply there is a 50% chance that the motor will run in the proper irection. **To make sure the motor is running in the proper irection, carefully follow the procedures below:**

A. Start the pump and check the water quantity and pressure developed.

B. Stop the pump and interchange any two leads.

C. Start the pump and again check the water quantity and pressure.

D. Compare the results observed. The wire connection which gave the highest pressure and largest water quantity is the correct connection.

. Check for current unbalance

Current unbalance causes the motor to have reduced starting torque, overload tripping, excessive vibration and poor performance which can result in early motor failure. It is very mportant that current unbalance be checked in all three-hase systems. **Current unbalance between the legs should not exceed 5% under normal operating conditions.**

The supply power service should be verfied to see if it is a wo or three transformer system. If two transformers are present, the system is an "open" delta or wye. If three transformers are present, the system is true three-phase.

lake sure the transformer ratings in kilovolt amps (KVA) is ufficient for the motor load. See Table C.

The percentage of current unbalance can be calculated by using the following formulas and procedures:

$$\text{Average current} = \frac{\text{Total of current values measured on each leg}}{3}$$

$$\%\ \text{Current unbalance} = \frac{\text{Greatest amp difference from the average}}{\text{average current}} \times 100$$

To determine the percentage of current unbalance:

A. Measure and record current readings in amps for each leg (hookup 1). Disconnect power.

B. Shift or roll the motor leads from left to right so the drop cable lead that was on terminal 1 is now on 2, lead on 2 is now on 3, and lead on 3 is now on 1 (hookup 2). Rolling the motor leads in this manner will not reverse the motor rotation. Start the pump, measure and record current reading on each leg. Disconnect power.

C. Again shift drop cable leads from left to right so the lead on terminal 1 goes to 2, 2 to 3 and 3 to 1 (hookup 3). Start pump, measure and record current reading on each leg. Disconnect power.

D. Add the values for each hookup.

E. Divide the total by 3 to obtain the average.

F. Compare each single leg reading from the average to obtain the greatest amp difference from the average.

G. Divide this difference by the average to obtain the precentage of unbalance

Use the wiring hookup which provides the lowest percentage of unbalance. (See Table F for a specific example of correcting for three-phase power unbalance.)

Developing the Well

After proper rotation and current unbalance have been checked, start the pump and let it operate until the water runs clear of sand, silt and other impurities.

Slowly open the valve in small increments as the water clears until the desired flow rate is reached. Do not operate the pump beyond its maximum flow rating. **The pump should not be stopped until the water runs clear.**

If the water is clean and clear when the pump is first started, the valve should still be **slowly opened until the desired flow rate is reached.** As the valve is being opened, the drawdown should be checked to ensure the pump is always submerged. **The dynamic water level should always be more than 3 feet above the inlet strainer of the pump.**

Disconnect the temporary piping arrangements and complete the final piping connections.

Under no circumstances should the pump be operated for any prolonged period of time with the discharge valve closed. This can result in motor and pump damage due to overheating. A properly sized relief valve should be installed at the well head to prevent the pump from running against a closed valve.

Start the pump and test the system. Check and record the voltage and current draw on each motor lead.

Operation

1. The pump and system should be periodically checked for water quantity, pressure, drawdown, periods of cycling and operation of controls.

2. If the pump fails to operate, or there is a loss of performance, refer to Troubleshooting, Section 8.

SECTION 8.

Troubleshooting

The majority of problems that develop with submersible pumps are electrical, and most of these problems can be corrected without pulling the pump from the well. The following chart covers most of the submersible service work. As with any troubleshooting procedure, start with the simplest solution first; always make all the above-ground checks before pulling the pump from the well.

Usually only two instruments are needed – a combination voltmeter/ammeter, and an ohmmeter. These are relatively inexpensive and can be obtained from most water systems suppliers.

WHEN WORKING WITH ELECTRICAL CIRCUITS, USE CAUTION TO AVOID ELECTRICAL SHOCK. It is recommended that rubber gloves and boots be worn and that care is taken to have metal control boxes and motors grounded to power supply ground or steel drop pipe or casing extending into the well. WARNING: Submersible motors are intended for operation in a well. When not operated in a well, failure to connect motor frame to power supply ground may result in serious electrical shock.

Preliminary Tests

SUPPLY VOLTAGE

How to Measure

By means of a voltmeter, which has been set to the proper scale, measure the voltage at the control box or starter.

On single-phase units, measure between line and neutral.

On three-phase units measure between the legs (phases.)

What it Means

When the motor is under load, the voltage should be within ± 10% of the nameplate voltage. Larger voltage variation may cause winding damage.

Large variations in the voltage indicate a poor electrical supply and the pump should not be operated until these variations have been corrected.

If the voltage constantly remains high or low, the motor should be changed to the correct supply voltage.

CURRENT MEASUREMENT

How to Measure

By use of an ammeter, set on the proper scale, measure the current on each power lead at the control box or starter. See Electrical Data, Table E, for motor amp draw information.

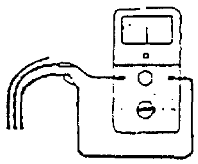
Current should be measured when the pump is operating at a constant discharge pressure with the motor fully loaded.

What it Means

If the amp draw exceeds the listed service factor amps (SFA) or if the current unbalance is greater than 5% between each leg on three-phase units, check for the following:

1. Burnt contacts on motor starter.
2. Loose terminals in starter or control box or possible cable defect. Check winding and insulation resistances
3. Supply voltage too high or low.
4. Motor windings are shorted.
5. Pump is damaged, causing a motor overload.

WINDING RESISTANCE



How to Measure

Turn off power and disconnect the drop cable leads in the control box or starter. Using an ohmmeter, set the scale selectors to Rx1 for values under 10 ohms and and Rx10 for values over 10 ohms.

Zero-adjust the meter and measure the resistance between leads. Record the values.

Motor resistance values can be found in Electrical Data, Table E. Cable resistance values are in Table G.

What it Means

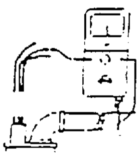
If all the ohm values are normal, and the cable colors correct, the windings are not damaged.

If any one ohm value is less than normal, the motor may be shorted.

If any one ohm value is greater than normal, there is a poor cable connection or joint. The windings or cable may also be open.

If some of the ohm values are greater than normal and some less, the drop cable leads are mixed. To verify lead colors, see resistance values in Electrical Data, Table E.

INSULATION RESISTANCE



How to Measure

Turn off power and disconnect the drop cable leads in the control box or starter. Using an ohm or mega ohmmeter, set the scale selector to Rx100K and zero-adjust the meter.

Measure the resistance between the lead and ground (discharge pipe or well casing, if steel).

What it Means

For ohm values, refer to table below. Motors of all HP, voltage, phase and cycle duties have the same value of insulation resistance.

OHM VALUE	MEGAOHM VALUE	CONDITION OF MOTOR AND LEADS
		Motor not yet installed:
2,000,000 (or more)	2.0	New Motor.
1,000,000 (or more)	1.0	Used motor which can be reinstalled in the well.
		Motor in well (Ohm readings are for drop cable plus motor):
500,000 - 1,000,000	0.5 - 1.0	A motor in reasonably good condition.
20,000 - 500,000	0.02 - 0.5	A motor which may have been damaged by lightning or with damaged leads. Do not pull the pump for this reason.
10,000 - 20,000	0.01 - 0.02	A motor which definitely has been damaged or with damaged cable. The pump should be pulled and repairs made to the cable or the motor replaced. The motor will still operate, but probably not for long.
less than 10,000	0 - 0.01	A motor which has failed or with completely destroyed cable insulation. The pump must be pulled and the cable repaired or the motor replaced. The motor will not run in this condition.

Troubleshooting Chart

FAULT	POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
A. Pump Does Not Run	1. No power at pump panel.	Check for voltage at panel.	If no voltage at panel, check feeder panel for tripped circuits.
	2. Fuses are blown or circuit breakers are tripped.	Remove fuses and check for continuity with ohmmeter.	Replace blown fuses or reset circuit breaker. If new fuses blow or circuit breaker trips, the electrical installation and motor must be checked.
	3. Motor starter overloads are burnt or have tripped out (three-phase only).	Check for voltage on line and load side of starter.	Replace burnt heaters or reset. Inspect starter for other damage. If heater trips again, check the supply voltage and starter holding coil.
	4. Starter does not energize (three-phase only).	Energize control circuit and check for voltage at the holding coil.	If no voltage, check control circuit. If voltage, check holding coil for shorts. Replace bad coil.
	5. Defective controls.	Check all safety and pressure switches for operation. Inspect contacts in control devices.	Replace worn or defective parts.
	6. Motor and/or cable are defective.	Turn off power. Disconnect motor leads from control box. Measure the lead-to-lead resistances with the ohmmeter (Rx1). Measure lead-to-ground values with ohmmeter (Rx100K). Record measured values.	If open motor winding or ground is found, remove pump and recheck values at the surface. Repair or replace motor or cable.
	7. Defective capacitor (single-phase only).	Turn off the power, then discharge capacitor. Check with an ohmmeter (Rx100K). When meter is connected, the needle should jump forward and slowly drift back.	If there is no needle movement, replace the capacitor.

Troubleshooting Chart (continued)

FAULT	POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
B. Pump Runs But Does Not Deliver Water	1. Groundwater level in well is too low or well is collapsed.	Check well draw-down. Water level should be at least 3 ft. above pump inlet during operation.	If not, lower pump if possible, or throttle discharge valve and install water level control.
	2. Integral pump check valve is blocked.	Install pressure gauge, start pump, gradually close the discharge valve and read pressure at shut-off. After taking reading, open valve to its previous position. Convert PSI to feet (For water: PSI x 2.31 ft/PSI = ______ ft.), and add this to the total vertical distance from the pressure gauge to the water level in the well while the pump is running. Refer to the specific pump curve for the shut-off head for that pump model. If the measured head is close to the curve, pump is probably OK.	If not close to the pump curve, remove pump and inspect discharge section. Remove blockage, repair valve and valve seat if necessary. Check for other damage. Rinse out pump and re-install.
	3. Inlet strainer is clogged.	Same as B.2 above.	If not close to the pump curve, remove pump and inspect. Clean strainer, inspect integral check valve for blockage, rinse out pump and reinstall.
	4. Pump is damaged.	Same as B.2 above.	If damaged, repair as necessary. Rinse out pump and re-install.
C. Pump Runs But at Reduced Capacity	1. Wrong rotation (three-phase only).	Check for proper electrical connection in control panel.	Correct wiring and change leads as required.
	2. Draw-down is larger than anticipated.	Check draw-down during pump operation.	Lower pump if possible. If not, throttle discharge valve and install water level control.
	3. Discharge piping or valve leaking.	Examine system for leaks.	Repair leaks.
	4. Pump strainer or check valve are clogged.	Same as B.2 above.	If not close to the pump curve, remove pump and inspect. Clean strainer, inspect integral check valve for blockage, rinse out pump and reinstall.
	5. Pump worn.	Same as B.2 above.	If not close to pump curve, remove pump and inspect.
D. Pump Cycles Too Much	1. Pressure switch is not properly adjusted or is defective.	Check pressure setting on switch and operation. Check voltage across closed contacts.	Re-adjust switch or replace if defective.
	2. Level control is not properly set or is defective.	Check setting and operation.	Re-adjust setting (refer to manufacturer data.) Replace if defective.
	3. Insufficient air charging or leaking tank or piping.	Pump air into tank or diaphram chamber. Check diaphram for leak. Check tank and piping for leaks with soap and water solution. Check air to water volume.	Repair or replace damaged component.
	4. Plugged snifter valve or bleed orifice.	Examine valve and orifice for dirt or corrosion.	Clean and/or replace if defective.
	5. Tank is too small.	Check tank size. Tank volume should be approximately 10 gallons for each gpm of pump capacity.	If tank is too small, replace with proper size tank.

FAULT	POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
E. Fuses Blow or Circuit Breakers Trip	1. High or low voltage.	Check voltage at pump panel. If not within ±10%, check wire size and length of run to pump panel.	If wire size is correct, contact power company. If not, correct and/or replace as necessary.
	2. Three-phase current unbalance.	Check current draw on each lead. Unbalance must be within ±5%.	If current unbalance is not within ±5%, contact power company.
	3. Control box wiring and components (single-phase only).	Check that control box parts match the parts list. Check to see that wiring matches wiring diagram. Check for loose or broken wires or terminals.	Correct as required.
	4. Defective capacitor (single-phase only).	Turn off power and discharge capacitor. Check using an ohmmeter (Rx100K). When the meter is connected, the needle should jump forward and slowly drift back.	If no meter movement, replace the capacitor.
	5. Starting relay (Franklin single-phase motors only)	Check resistance of relay coil with an ohmmeter (Rx1000K). Check contacts for wear.	Replace defective relay.

SECTION 9. Technical Data

Table A
Minimum Water Flow Requirements for Submersible Pump Motors

MOTOR DIAMETER	CASING OR SLEEVE I.D. IN INCHES	MIN. FLOW PAST THE MOTOR (GPM)
4"	4	1.2
	5	7
	6	13
	7	21
	8	30
6"	6	10
	7	28
	8	45
	10	85
	12	140
	14	198
	16	275
8"	8	10
	10	55
	12	110
	14	180
	16	255
10"	10	30
	12	85
	14	145
	16	220
	18	305

NOTES:
1. A flow inducer or sleeve must be used if the water enters the well above the motor or if there is insufficient water flow past the motor.
2. The minimum recommended water velocity over 4" motors is 0.25 feet per second.
3. The minimum recommended water velocity over 6, 8, and 10" motors is 0.5 feet per second.

Table B
Guide for Engine-Driven Generators in Submersible Pump Applications

	MINIMUM KILOWATT RATING OF GENERATOR FOR THREE-WIRE SUBMERSIBLE PUMP MOTORS	
MOTOR HP FOR SINGLE OR THREE PHASE UNITS	EXTERNALLY REGULATED GENERATOR	INTERNALLY REGULATED GENERATOR
0.33 HP	1.5 KW	1.2 KW
0.50	2.0	1.5
0.75	3.0	2.0
1.0	4.0	2.5
1.5	5.0	3.0
2.0	7.5	4.0
3.0	10.0	5.0
5.0	15.0	7.5
7.5	20.0	10.0
10.0	30.0	15.0
15.0	40.0	20.0
20.0	60.0	25.0
25.0	75.0	30.0
30.0	100.0	40.0
40.0	100.0	50.0
50.0	150.0	60.0
60.0	175.0	75.0
75.0	250.0	100.0
100.0	300.0	150.0
125.0	375.0	175.0
150.0	450.0	200.0
200.0	600.0	275.0

NOTES:
1. Table is based on typical 80°C rise continuous duty generators with 35% maximum voltage dip during start-up of single-phase and three-phase motors.
2. Contact the manufacturer of the generator to assure the unit has adequate capacity to run the submersible motor.
3. If the generator rating is in KVA instead of kilowatts, multiply the above ratings by 1.25 to obtain KVA.

Table C

Transformer Capacity Required for Three-Phase Submersible Pump Motors

THREE-PHASE MOTOR HP	MINIMUM TOTAL KVA REQUIRED*	MINIMUM KVA RATING FOR EACH TRANSFORMER: 2 TRANSFORMERS OPEN DELTA OR WYE	MINIMUM KVA RATING FOR EACH TRANSFORMER: 3 TRANSFORMERS DELTA OR WYE
1.5	3	2	1
2	4	2	1½
3	5	3	2
5	7½	5	3
7.5	10	7½	5
10	15	10	5
15	20	15	7½
20	25	15	10
25	30	20	10
30	40	25	15
40	50	30	20
50	60	35	20
60	75	40	25
75	90	50	30
100	120	65	40
125	150	85	50
150	175	100	60
200	230	130	75

* Pump motor KVA requirements only, and does not include allowances for other loads.

Table D

Submersible Pump Cable Selection Chart (60 Hz)

The following tables list the recommended copper cable sizes and various cable lengths for submersible pump motors.

These tables comply with the 1978 edition of the National Electric Table 310-16, Column 2 for 75°C wire. The ampacity (current carrying properties of a conductor) have been divided by 1.25 per the N.E.C., Article 430-22, for motor branch circuits based on motor amps at rated horsepower.

To assure adequate starting torque, the maximum cable lengths are calculated to maintain 95% of the service entrance voltage at the motor when the motor is running at maximum nameplate amps. Cable sizes larger than specified may always be used and will reduce power usage.

The use of cables smaller than the recommended sizes will void the warranty. Smaller cable sizes will cause reduced starting torque and poor motor operation.

SINGLE-PHASE MOTOR MAXIMUM CABLE LENGTH

(Motor to service entrance) (2)

MOTOR RATING		COPPER WIRE SIZE												
VOLTS	HP	14	12	10	8	6	4	2	0	00	000	0000	250	300
115	⅓	130	210	340	540	840	1300	1960	2910					
	½	100	160	250	390	620	960	1460	2160					
230	⅓	550	880	1390	2190	3400	5250	7960						
	½	400	650	1020	1610	2510	3880	5880						
	¾	300	480	760	1200	1870	2890	4370	6470					
	1	250	400	630	990	1540	2380	3610	5380	6520				
	1½	190	310	480	770	1200	1870	2850	4280	5240				
	2	150	250	390	620	970	1530	2360	3820	4480				
	3	120	190	300	470	750	1190	1850	2890	3810				
	5			180	280	450	710	1110	1740	2170				
	7½				200	310	490	750	1140	1410				
	10					250	390	600	930	1160				

CAUTION: Use of wire size smaller than listed will void warranty.

FOOTNOTES:

1. If aluminum conductor is used, multiply lengths by 0.5. Maximum allowable length of aluminum is considerably shorter than copper wire of same size.
2. The portion of the total cable which is between the service entrance and a 3Ø motor starter should not exceed 25% of the total maximum length to assure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
3. Cables #14 to #0000 are AWG sizes, and 250 to 300 are MCM sizes.

THREE-PHASE MOTOR MAXIMUM CABLE LENGTH

(Motor to service entrance) (2)

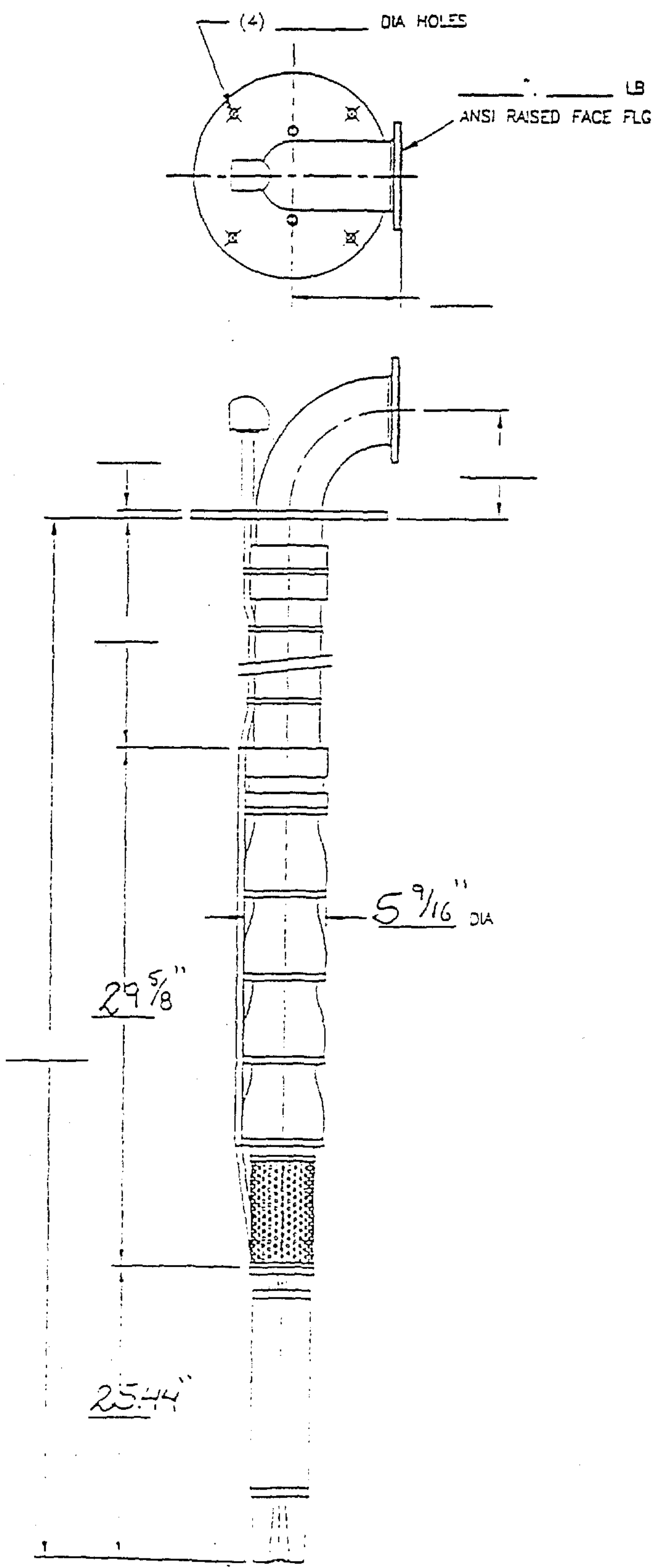
MOTOR RATING		COPPER WIRE SIZE												
VOLTS	HP	14	12	10	8	6	4	2	0	00	000	0000	250	300
208	1½	310	500	790	1260									
	2	240	390	610	970	1520								
	3	180	290	470	740	1160	1810							
	5		170	280	440	690	1080	1660						
	7½			200	310	490	770	1180	1770					
	10				230	370	570	880	1330	1640				
	15					250	390	600	910	1110	1340			
	20						300	460	700	860	1050	1270		
	25							370	570	700	840	1030	1170	
	30							310	470	580	700	850	970	1110
230	1½	360	580	920	1450									
	2	280	450	700	1110	1740								
	3	210	340	540	860	1340	2080							
	5		200	320	510	800	1240	1900						
	7½			230	360	570	890	1350	2030					
	10				270	420	660	1010	1520	1870				
	15					290	450	690	1040	1260	1540			
	20						350	530	810	990	1200	1450		
	25						280	430	650	800	970	1170	1340	
	30							350	540	660	800	970	1110	1270
460	1½	1700												
	2	1300	2070											
	3	1000	1600	2520										
	5	590	950	1500	2360									
	7½	420	680	1070	1690	2840								
	10	310	500	790	1250	1960	3050							
	15			540	850	1340	2090	3200						
	20			410	850	1030	1610	2470	3730					
	25				530	830	1300	1990	3010	3700				
	30				430	680	1070	1640	2490	3060	3700			
	40						790	1210	1830	2250	2710	3290		
	50						640	980	1480	1810	2190	2850	3010	
	60							830	1250	1540	1850	2240	2540	2890
	75								1030	1260	1520	1850	2100	2400
	100									940	1130	1380	1560	1790
	125											1080	1220	1390
	150												1050	1190
	200												1080	1300
	250													1080
575	1½	2620												
	2	2030												
	3	1580	2530											
	5	920	1480	2330										
	7½	660	1060	1680	2650									
	10	490	780	1240	1950									
	15		530	850	1340	2090								
	20			650	1030	1610	2520							
	25			520	830	1300	2030	3110						
	30				680	1070	1670	2560	3880					
	40					790	1240	1900	2860	3510				
	50						1000	1540	2310	2840	3420			
	60						850	1300	1960	2400	2890	3500		
	75							1060	1600	1970	2380	2890	3290	
	100								1190	1460	1770	2150	2440	2790

CAUTION: Use of wire size smaller than listed will void warranty.

FOOTNOTES:

1. If aluminum conductor is used, multiply lengths by 0.5. Maximum allowable length of aluminum is considerably shorter than copper wire of same size.
2. The portion of the total cable which is between the service entrance and a 3Ø motor starter should not exceed 25% of the total maximum length to assure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
3. Cables #14 to #0000 are AWG sizes, and 250 to 300 are MCM sizes.

J-LINE® SUBMERSIBLE TURBINE PUMP



MATERIAL OF CONSTRUCTION	
Bowl Cast Iron	Impeller Bronze
Bowl Shaft 416 S.S.	Shaft Coupling S.S.
Bowl Bearings Bronze	Bowl W/R
Strainer S.S.	Impeller W/R

PUMP		
Type Submersible	Model 6JCHB4	
GPM 150	TDH 130	
Depth Gauge:	Required:	Not Required:
Air Line:	Required:	Not Required:

MOTOR	
HP 10 HP	RPM 2900
Phase 3	Hertz 50
Voltage 380	

CABLE	
Size 10/3	Length 250 Feet
Type Flt Jkt. Sub. Cable	

DISCHARGE ELBOW	
Base Plate	Bolt Holes: 4 -
Diameter Bolt Circle:________ Bolt Holes:______________	R.F. 150# ASA Discharge Flange Diameter Flange:______________

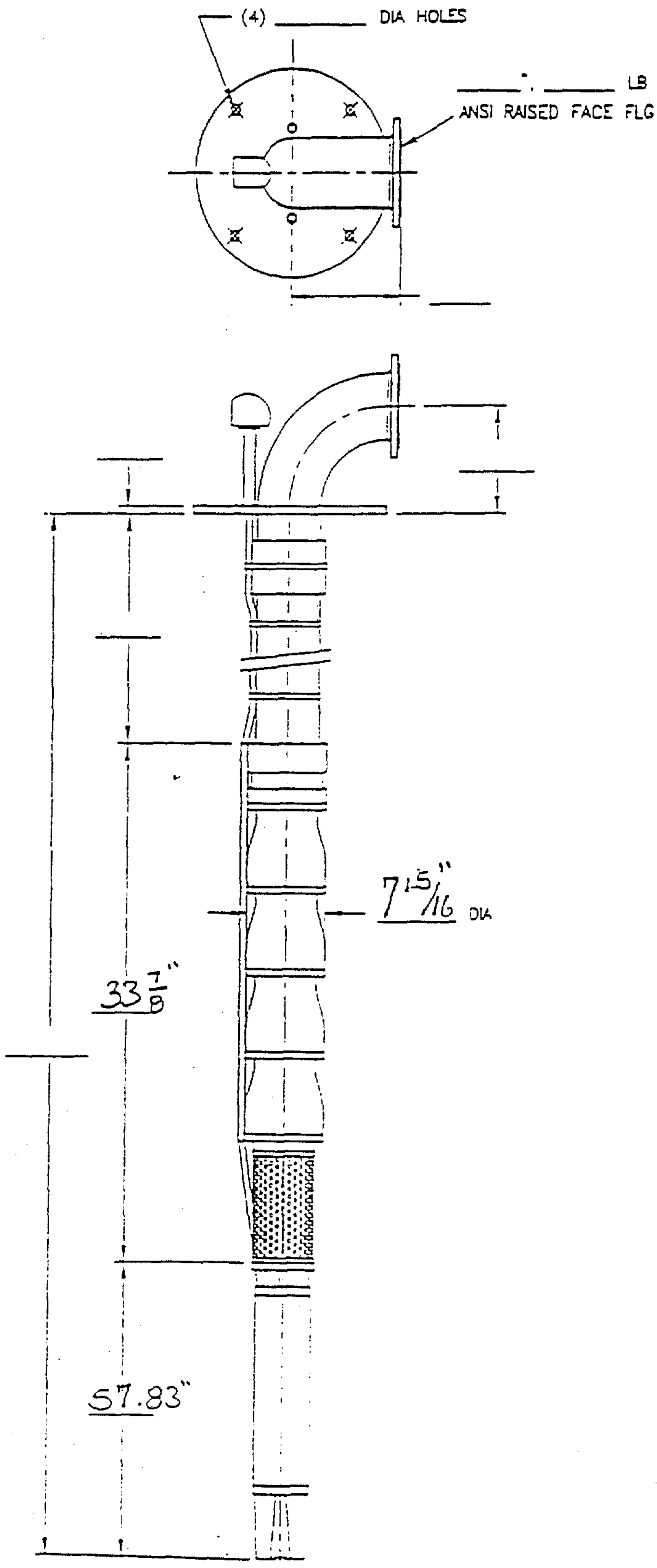
JUNCTION BOX	
Required:	Not Required:

RISER reccomended	
Pipe Size 4"	Section Length 21 Feet

OTHER SPECIFICATIONS	
Drawing No.	Serial No.
Fluid	Spec.Gravity
Viscosity	Temperature
PH	No.Units Required

Customer International Tecnologies		
Address 14 Bloomingdale Court		
City Rockville	ST Md.	ZIP 20852
Tel. (301) 984-3254	Fax. (301) 984-3922	
Rec.		
Supplier J-Line Pump Co.		
Salesman Gustavo Uzcategui		

J-LINE® SUBMERSIBLE TURBINE PUMP



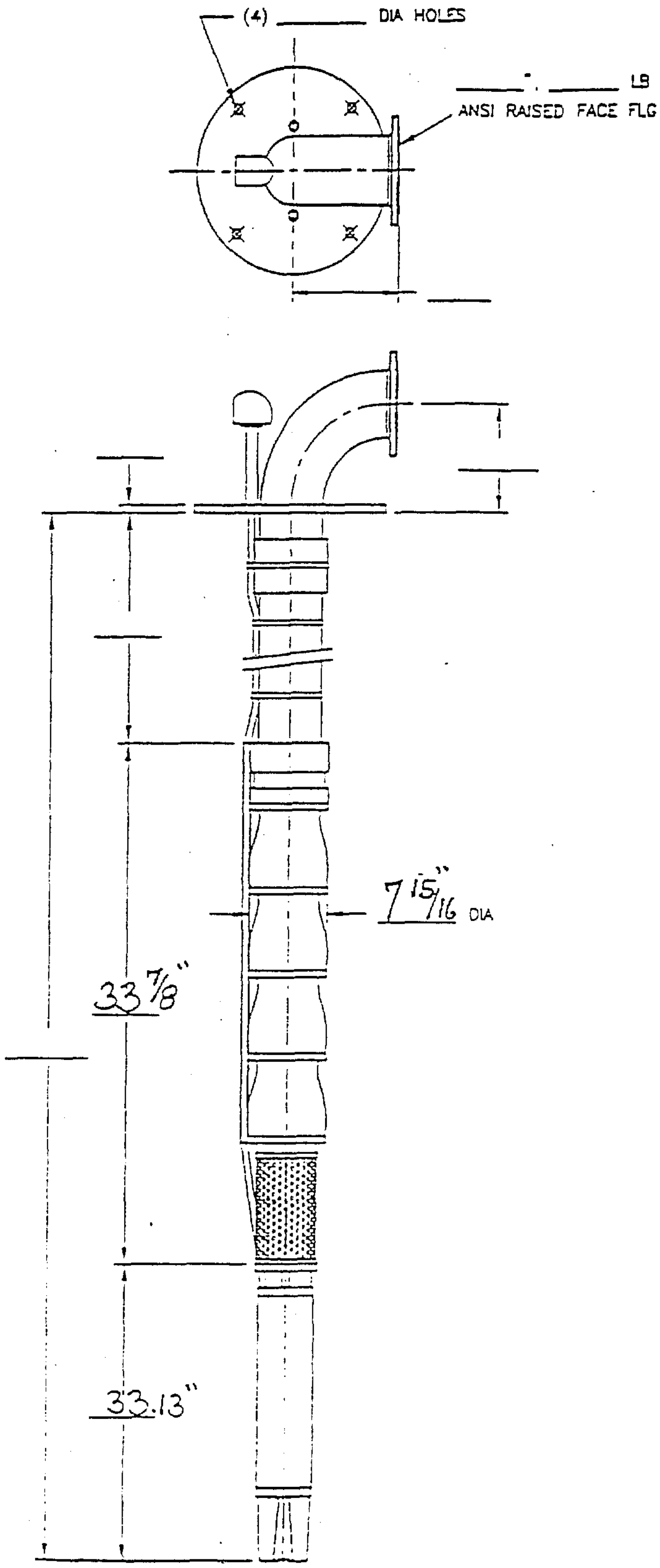
MATERIAL OF CONSTRUCTION	
Bowl Cast Iron	Impeller Bronze
Bowl Shaft 416 S.S.	Shaft Coupling S.S.
Bowl Bearings Bronze	Bowl W/R
Strainer S.S.	Impeller W/R
PUMP	
Type Submersible	Model 8EHCZ3
GPM 500	TDH 215
Depth Gauge: Required:	Not Required:
Air Line: Required:	Not Required:
MOTOR	
HP 50	RPM 2900
Phase 3	Hertz 50
Voltage 380	
CABLE	
Size 4/3	Length 250 Feet
Type Flat Jkt. Cable	
DISCHARGE ELBOW	
Base Plate 6"	Bolt Holes: 4 -
Diameter Bolt Circle:____ Bolt Holes:____	R.F. 150# ASA Discharge Flange Diameter Flange:____
JUNCTION BOX	
Required:	Not Required:
RISER recomended	
Pipe Size 6"	Section Length 20 Feet
OTHER SPECIFICATIONS	
Drawing No.	Serial No.
Fluid	Spec. Gravity
Viscosity	Temperature
PH	No. Units Required

Customer	International Tecnologies
Address	14 Bloomingdale Court
City	Rockville ST Md. ZIP 20852
Tel.	(301) 984-3254 Fax. (301) 984-3922
Rep.	
Supplier	J-Line Pump Co.
Salesman	Gustavo Urzcategui

Impeller Trim ≈ 6.053

J-LINE®

SUBMERSIBLE TURBINE PUMP



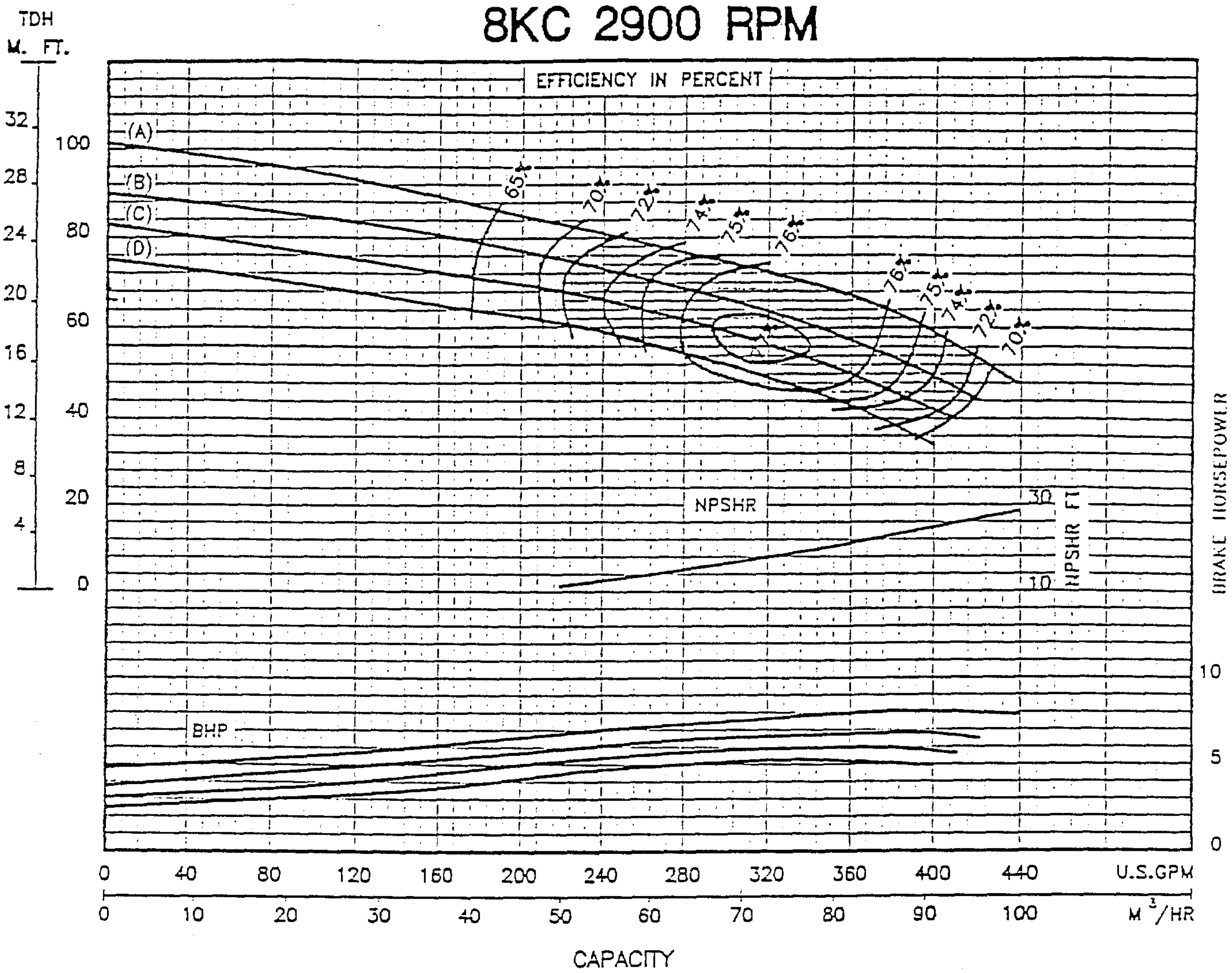
MATERIAL OF CONSTRUCTION	
Bowl Cast Iron	Impeller Bronze
Bowl Shaft 416 S.S.	Shaft Coupling S.S.
Bowl Bearings Bronze	Bowl W/R
Strainer S.S.	Impeller W/R
PUMP	
Type Submersible	Model 8KCB3
GPM 350	TDH 180
Depth Gauge: Required:	Not Required:
Air Line: Required:	Not Required:
MOTOR	
HP 25	RPM 2900
Phase 3	Hertz 50
Voltage 380	
CABLE	
Size 8/3	Length 250 Feet
Type Flat JKt. SubCable	
DISCHARGE ELBOW	
Base Plate	Bolt Holes: 4 -
Diameter Bolt Circle:_______ Bolt Holes:_______	R.F. 150# ASA Discharge Flange Diameter Flange:_______
JUNCTION BOX	
Required:	Not Required:
RISER recomended	
Pipe Size 6"	Section Length 20 Feet
OTHER SPECIFICATIONS	
Drawing No.	Serial No.
Fluid	Spec.Gravity
Viscosity	Temperature
PH	No.Units Required

Customer	International Technologies
Address	14 Bloomingdale Court
City	Rockville ST Md. ZIP 20852
Tel.	(301) 984-3254 Fax. (301) 984-3922
Rep.	
Supplier	J-Line Pump Co.
Salesman	Gustavo Uzcategui

TURBINE PUMP CURVE

JULY 1995

8KC 2900 RPM



IMPELLER DATA		
Impeller Number	3680	TRIM: (A) 6.313" X 18"
Material	BRONZE	(B) 6.000" X 18"
Type	CLOSED	(C) 5.750" X 18"
Thrust Factor	K=3.93	(D) 5.500" X 18"
Eye Area	5.72 sq. in.	Minimum submergence above eye of bottom impeller: 16 in.
Weight	5.50 lb.	

EFFICIENCY CORRECTION					
Number of Bowls	1	2	3		
Change as follows	-4	-2	0		

Change in efficiency may affect both head and horsepower.

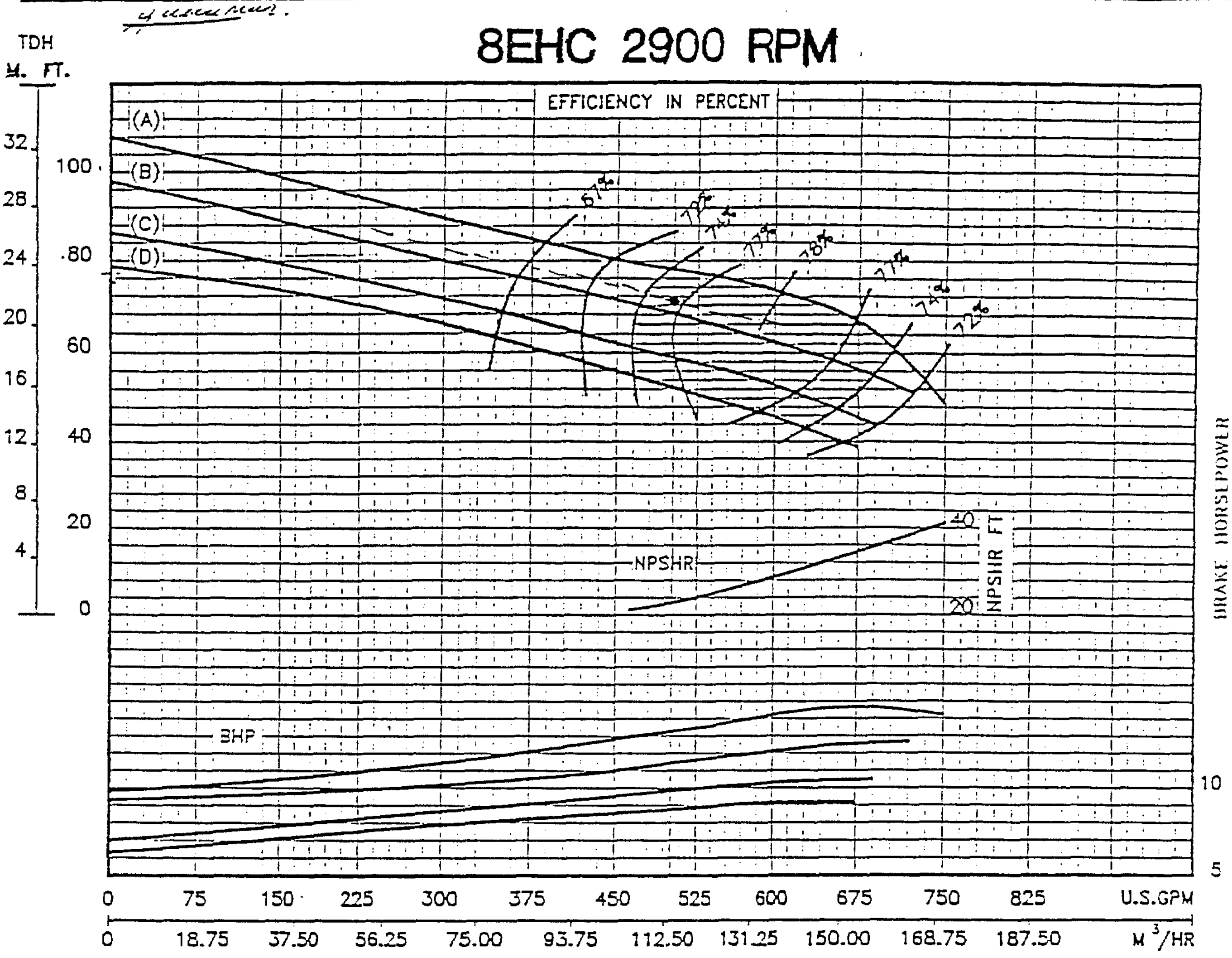
BOWL DATA		
Bowl Number	3591 C.I./ENAM.	
Bowl Dia.	7.938"max 7.500"min	
Max. No. Stages	14	
One Stage Weight	130	lb
Add'l Stage Weight	30	lb
Std. Shaft Dia.	1.000	in
Std. Lateral	0.438	in
Discharge Size	5 – 6	in
Suction Size	5 – 6	in
Max Sphere Size	0.375	in
Max Operation P.S.I.	692 (special)	

Performance based on pumping clear, fresh water at a temperature not over 85° F., and free of gas, air or abrasives, and with bowls properly adjusted and submerged.

TURBINE PUMP CURVE

JULY 1995

8EHC 2900 RPM



IMPELLER DATA			
Impeller Number	2978	TRIM:	(A) 6.313" X 29.5"
Material	BRONZE		(B) 6.000" X 29.5"
Type	CLOSED		(C) 5.750" X 29.5"
Thrust Factor	K=5.40		(D) 5.500" X 29.5"
Eye Area	8.33 sq. in.		Minimum submergence above eye of bottom impeller: 19 in.
Weight	5.00 lb.		

EFFICIENCY CORRECTION				
Number of Bowls	1	2	3	4
Change as follows	−3	−2	−1	0

Change in efficiency may affect both head and horsepower.

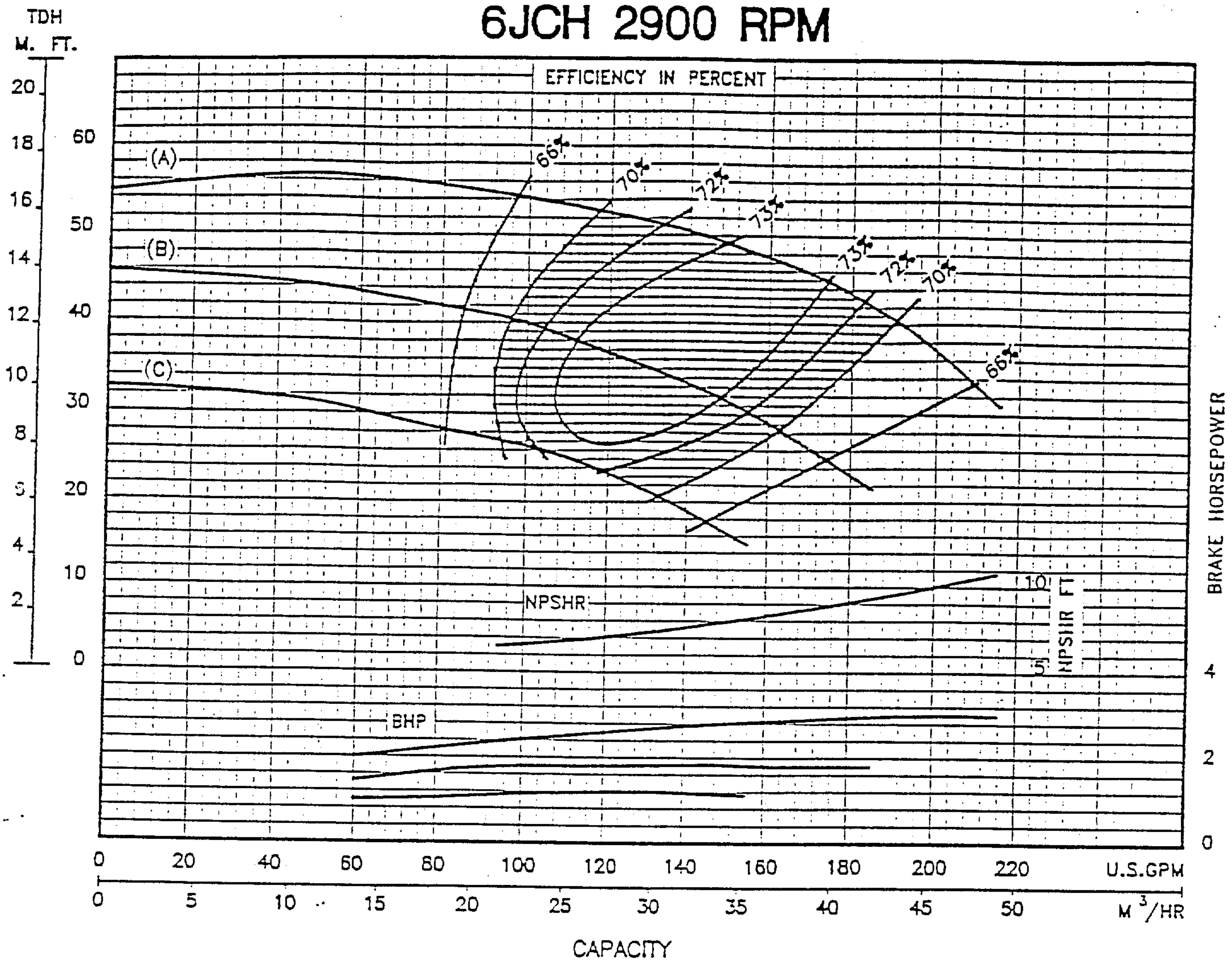
BOWL DATA		
Bowl Number	2883 C.I./ENAM.	
Bowl Dia.	7.938"max	7.500"min
Max. No. Stages	7	
One Stage Weight	130	lb
Add'l Stage Weight	30	lb
Std. Shaft Dia.	1.000	in
Std. Lateral	0.375	in
Discharge Size	5 – 6	in
Suction Size	5 – 6	in
Max. Sphere Size	0.625	in
Max Operation P.S.I.	692 (special)	

Performance based on pumping clear, fresh water at a temperature not over 85° F., and free of gas, air or abrasives, and with bowls properly adjusted and submerged.

TURBINE PUMP CURVE

JULY 1995

6JCH 2900 RPM



IMPELLER DATA		
Impeller Number	6606	TRIM: (A) 4.688" X 20°
Material	BRONZE	(B) 4.250" X 20°
Type	CLOSED	(C) 3.750" X 20°
Thrust Factor	K=2.24	
Eye Area	3.65 sq. in.	Minimum submergence above eye of bottom impeller: 9 in.
Weight	2.38 lb.	

EFFICIENCY CORRECTION				
Number of Bowls	1	2	3	4
Change as follows	-4	-2	-1	0

Change in efficiency may affect both head and horsepower.

FLANGED BOWL DATA		
Bowl Number	6616 C.I./ENAM.	
Bowl Dia.	5.563"	
Max. No. Stages	37	
One Stage Weight	75	lb
Add'l Stage Weight	15	lb
Std. Shaft Dia.	1.000	in
Std. Lateral	0.500	in
Discharge Size	4	in
Suction Size	4	in
Max. Sphere Size	0.188	in
Max Operation P.S.I	360 (special)	

Performance based on pumping clear, fresh water at a temperature not over 85° F., and free of gas, air or abrasives, and with bowls properly adjusted and submerged.

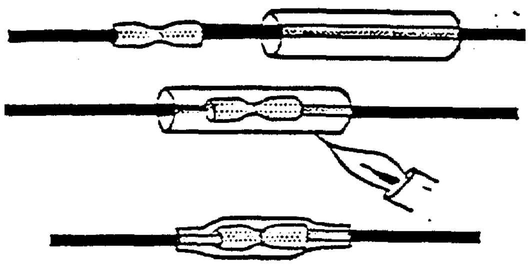
Heat Shrink Kits

Instructions

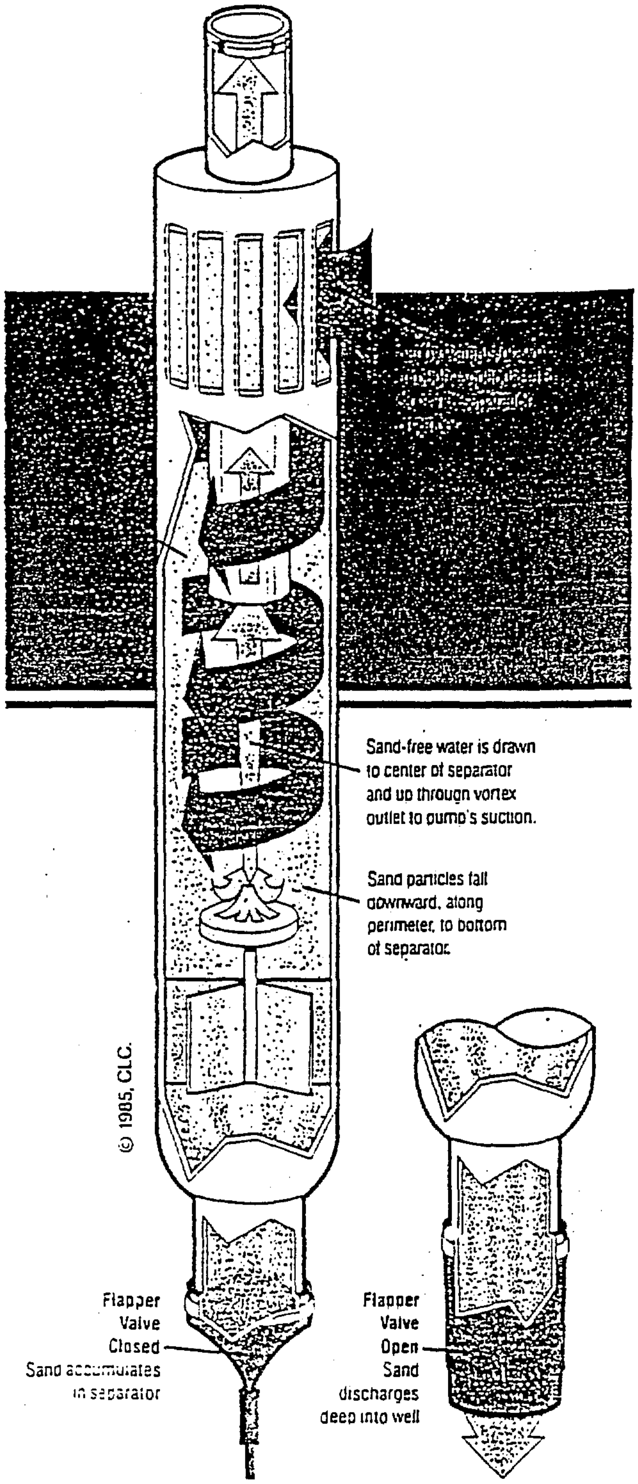
A heat source is required to complete splices. The heat source may be a propane or butane torch, lighter, or electric heat gun. For best results the wires must be clean.

Basic 2 and 3 Wire Splice Kits

1. Slip shrink tubing on each wire.
2. Crimp Butt Connectors on each stripped wire.
3. Center Tubing over Connector.
4. Heat the tubing beginning at the center and working toward the ends while keeping the heat source moving.
5. When the tubing shrinks to shape and the sealant flows from the ends, the splice is complete.



Lakos Pump Protection Separators

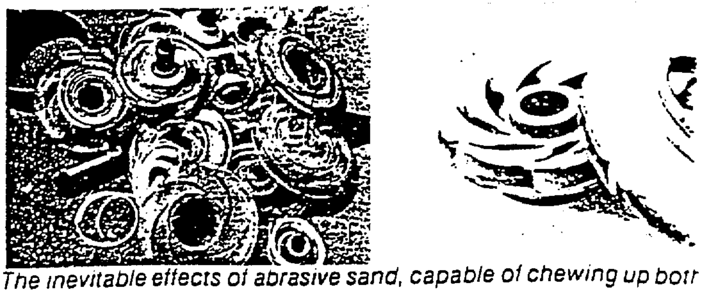


Flow Range:
100 - 3,180 U.S. gpm
(23 - 722 m³/hr.)

This series consists of 16 models, each engineered for a specific flow range and a minimum water well I.D. (see details, page 2). Proper model selection is critical — see page 5 for details. For lower (or higher) flow rates, ask about Lakos SUB-K Pump Protection Separators (or consult your Lakos representative).

I. Operation

Lakos Pump Protection Separators are designed for the specific purpose of removing sand from water at the suction side of turbine and submersible pumps. The sandy water is drawn through the inlet slots, thereby creating an accelerated circular flow within the separator. This action forces the sand to the perimeter of the separation chamber, where a loss of velocity allows the sand to gradually settle to the bottom of the unit and out the purge opening. Low pressure, caused by the centrifugal action (and the pump's suction), draws the now sand-free water to the vortex finder and through the separator's outlet to the pump's intake (see diagram, front cover).



The inevitable effects of abrasive sand, capable of chewing up botr and plastic pump imp

II. Installation Instructions

NOTE: See footnotes in "Required Data," page 5 for specific restrictions in well depth and drawdown water level.

1. Lakos Pump Protection Separators come in a variety of sizes and may be shipped in a number of ways. Most often, however, each unit is shipped complete, strapped onto a wooden skid. ***Before any installation, remove all labels, decals and shipping instructions from each unit to avoid plugging the inlet slots.***

2. Lakos Pump Protection Separators are designed to continuously flush separated particles back into the source water. Should this not be possible, sand removal to the surface or other remote site may be accomplished using an integral Lakos (periodic) Eductor System. See back cover for more information or ask your Lakos representative for details.

3. TURBINE MODELS ONLY - Lakos Turbine Separators are manufactured with a standard riser size (note chart on page 2). Should this riser not match the connection to your pump's bowl assembly, you'll need to arrange for the proper connection (i.e. reducer, etc.)

Lifting lugs are provided on the riser of all models size "E" through "KKA" for ease of installation. Once the separator has been eased into the well opening and secured at the lugs, carefully thread the bowl assembly to the separator's riser.

At this point, you may proceed with your customary routine for installing the pump.

4. SUBMERSIBLE MODELS ONLY - To make Lakos Pu... Protection Separators operate properly, the pump's er... intake must be directed first through the actual separator. T... achieve this with a submersible pump, we provide a *pump enclosure shell* (see diagrams, pages 2 and 4). The subme... sible pump is contained within this shell and then attachec directly to the separator itself. (See instructions on page 4 ... proper installation of the pump in the shell).

With the pump properly secured in the shell, the riser is nc attached directly to the column pipe. Be sure to arrange for difference in pipe size between column pipe and riser. Insta tion may now proceed as normal for submersible pumps.

5. Once installed, Lakos Pump Protection Separators require no routine maintenance. Systems with educt or other solids purging techniques should be operated according to your Lakos representative's instructions. Shoı you ever need to pull your pump, always take such an opportunity to inspect the separator and purge assembly.

6. Lakos Pump Protection Separators must be operatei according to the flow range per model designated in chart on page 2. Should your original flow rate vary significantly, note the instructions on page 4 for use of the adjust. flow collar on selected models.

These instructions are prepared specifically for installation of Lakos Separators in water wells. However, these units may also applied to other submerged uses. Consult your Lakos representative for details.

Where does the sand go?

Certainly the most common procedure for (and objection to) disposing of separated sand is to discharge that sand deep into the water well. It has always been . . . and always will be . . . a better alternative than grinding up a pump and destroying its efficiency. And, though the accumulation of sand in a well could, eventually, require evacuation (though it very seldom does), that cost is far less than the certainty of expensive pump repair (or replacement) and excessive energy costs through reduced efficiency.

But the sand most likely will never fill up the well. Extensive research conducted by Ohio University, under the direction of the National Water Well Association, unmasked the mystery of what a pump protection sand separator can really do to solve the problem of a sandy well. (*See Water Well Journal*, October 1985 issue.) Essentially, the study revealed that a pump protection separator actually helps create a state of "equilibrium," virtually eliminating the entry of additional sand into a well. Technically, it is described as such:

1. Sand is carried into a well by the velocity and efficiency c the incoming water.
2. The sand separator removes and discharges that sand b into the well until the well fills up to a certain level.
3. At that level, the flow pattern of the incoming water throu the ground formations and into the well is sufficiently distoı to reduce its actual incoming velocity and efficiency.
4. At such a reduced efficiency, the water is then no longer capable of carrying sand into the well.
5. The sand separator maintains that equilibrium by prever the pump from evacuating sand . . . which would otherwise encourage conditions in the well to draw in more sand.

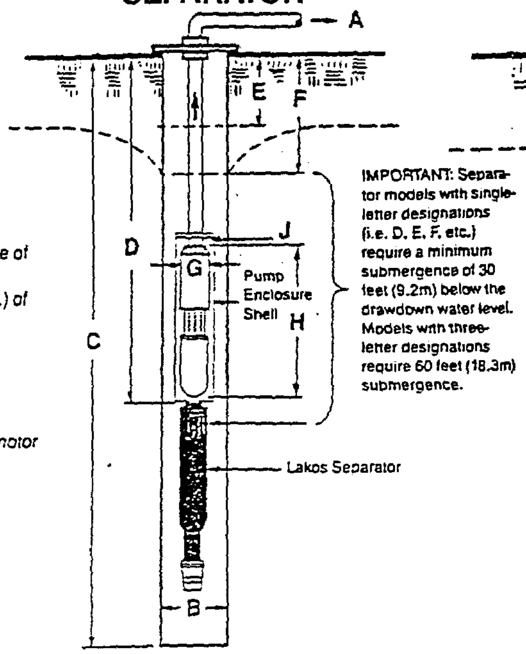
CONCLUSION: The separated sand from a Lakos Pump Protection Separator most often will **not** fill up the well ... a... may, instead, actually stop additional sand from even ente the well.

Installation Schematics

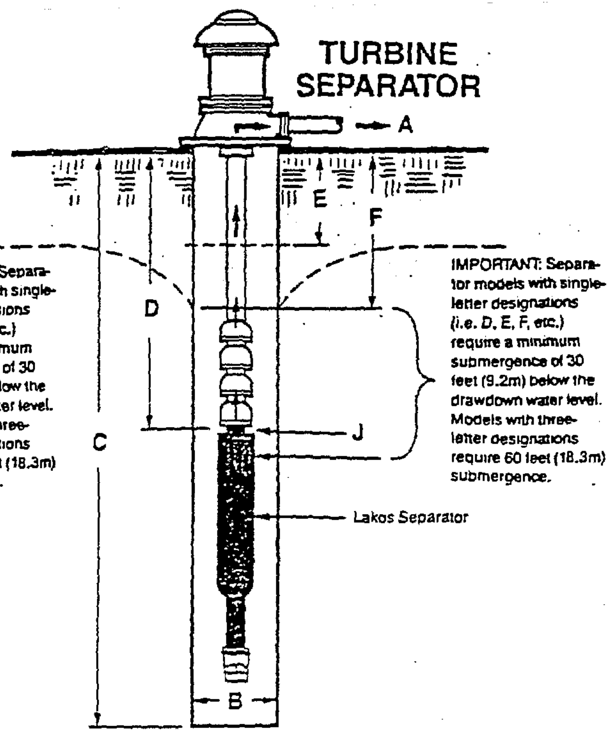
Required data for proper model selection:

A. Maximum & minimum flow rate of pump
B. Minimum inside diameter (I.D.) of well
C. Depth of well
D. Depth of pump setting
E. Static water level
F. Drawdown water level
G. Maximum diameter of pump/motor
H. Overall length of pump/motor
J. Pump's riser size (N.P.T.)

SUBMERSIBLE SEPARATOR



TURBINE SEPARATOR



General Specifications

The following data applies *only* to the basic turbine separator. Since the pump enclosure shell for a submersible separator is predicated on the actual pump's dimensions, standard specifications cannot be published. See worksheet.

MODEL	MINIMUM WELL I.D. in. / mm	FLOW RANGE U.S. gpm m³ / hr	OUTSIDE DIAMETER in. / mm	LENGTH WITH RISER in. / mm	RISER SIZE N.P.T.	WEIGHT lbs. / kg	MINIMUM WELL I.D. FOR EDUCTOR* in. / mm
D	6 152.4	100 - 175 23 - 40	4½ 114.3	83⅜ 2117.7	2½ - inch	72 32.7	10 254
E	7 177.8	125 - 250 29 - 57	5⁹⁄₁₆ 141.3	102 2590.8	3 - inch	114 51.7	10 254
F	8 203.2	150 - 325 34 - 74	6⅝ 168.3	115¼ 2927.4	4 - inch	195 88.5	11 280
GSA	9¾ 247.6	325 - 520 74 - 118	6⅝ 168.3	119 3022.6	6 - inch	295 133.8	12 305
GGA	9¾ 247.6	520 - 710 118 - 161	6⅝ 168.3	125 3175.0	6 - inch	307 139.3	12 305
G	10¾ 273.1	325 - 650 74 - 148	8⅝ 219.1	127½ 3238.5	6 - inch	285 129.3	13 330
HSA	12 304.8	600 - 910 136 - 207	8⅝ 219.1	136½ 3467.1	6 - inch	340 154.2	14 356
HHA	12 304.8	880 - 1375 200 - 312	8⅝ 219.1	140¾ 3575.1	8 - inch	355 161.0	14 356
H	13¼ 336.6	550 - 1110 125 - 252	10¾ 273.1	133 3378.2	8 - inch	345 56.5	15 381
ISA	13¼ 336.6	1290 - 1700 293 - 386	10¾ 273.1	145½ 3695.7	8 - inch	465 210.9	15 381
I	15¼ 387.4	825 - 1450 187 - 329	12¾ 323.8	149 3784.6	8 - inch	443 200.9	17 432
JSA	15¼ 387.4	1460 - 2040 332 - 463	12¾ 323.8	153 3886.2	10 - inch	518 234.9	18 457
J	17¼ 438.2	1010 - 1800 230 - 409	14 355.6	158 4013.2	10 - inch	525 238.1	18 457
KSA	17¼ 438.2	1780 - 2420 404 - 550	14 355.6	165 4191.0	10 - inch	628 284.9	20 508
K	19¼ 488.9	1640 - 2560 373 - 582	16 406.4	180 4572.0	10 - inch	670 303.9	20 508
KKA	19¼ 488.9	2520 - 3180 573 - 723	16 406.4	196 4978.4	12 - inch	715 324.3	20 508

Head Loss: Typically 9 - 14 feet (2.74 - 4.27 m)
Maximum Particle Size: ¼ - inch (6.3 mm)
Maximum Particle Concentration: 1,000 ppm

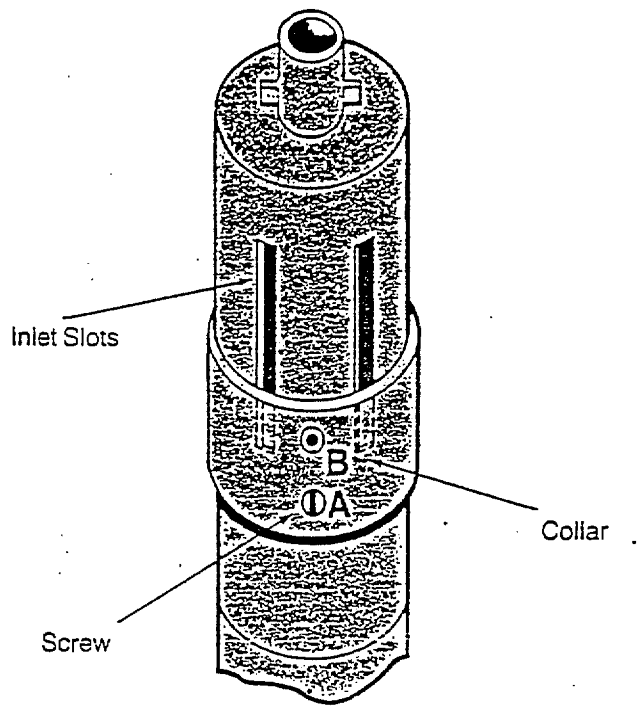
Minimum Clearance Below Separator's Purge Discharge: 30 feet (9.2 m)

* See back cover for more information on Eductor System.

Metrics in shaded bands

Flow Adjustment Collar

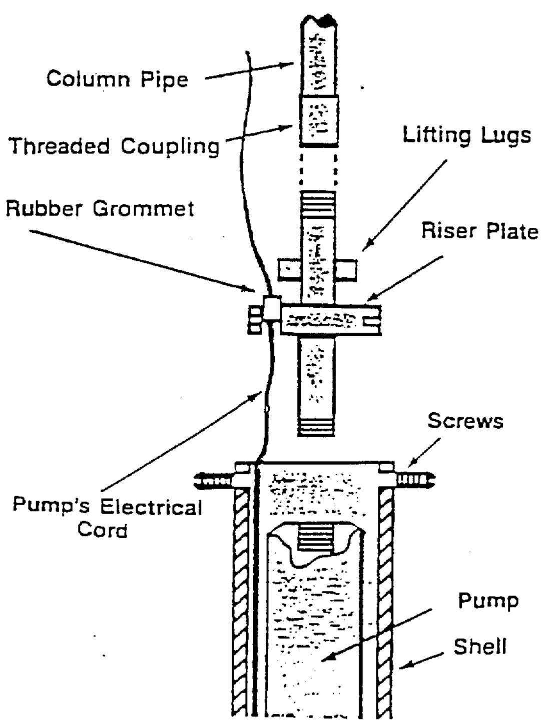
Standard on selected models, this manual adjustment allows you to "fine-tune" the performance of Lakos Pump Protection Separators. It is designed specifically for a significant variation in your pump's actual flow rate. Most often, this adjustment will be made at the factory according to the flow rate specified when ordering. Should a change of flow rate indicate an appropriate adjustment (according the chart at right) you may wish to make that adjustment at your earliest opportunity. To do so, simply remove the screws holding the collar in place and slide the collar to the proper position. Replace screws in proper insets.



Model	Flow Range (U.S. gpm • m³/hr.)	Position of Collar
E	125-200 27-45	Collar On
	200-250 45-57	Collar Off
F	150-210 34-48	A
	210-275 48-62	B
	275-325 62-74	Collar Off
G	325-425 74-97	A
	425-525 97-119	B
	525-650 119-148	Collar Off
H	550-675 125-153	A
	676-825 154-187	B
	826-1110 188-252	Collar Off
I	825-1050 187-238	A
	1050-1225 238-278	B
	1225-1450 278-329	Collar Off
J	1010-1275 230-290	A
	1275-1450 290-329	B
	1450-1800 329-409	Collar Off
K	1640-1890 373-429	A
	1890-2250 429-511	B
	2250-2560 511-582	Collar Off

Metrics shown in shaded bands.

Enclosing the Pump in the Shell



For Submersible Pump Protection Models Only

The pump enclosure shell is designed to make certain that all water entering the pump is first drawn through the separator. This, therefore, requires that the pump intake be properly shielded as described below.

1. Remove the riser assembly from the shell by removing the stainless steel set screws.
2. Attach the riser assembly to the pump's discharge.
3. Thread the pump's electrical cord through the opening in the riser plate. A rubber grommet is provided to establish a good seal.
4. Slide the pump into the shell and secure riser with the screws.
5. Gap between riser plate and shell should be sealed with a waterproof plastic sealant, putty or caulking compound to prevent water entry at this point.
6. Pump and shell assembly are now ready for installation. A pair of lifting lugs are provided to make hoisting and adding column pipe easy. Shell assembly should be attached directly to the separator unit. (See diagram, page 2).

McCrometer PRODUCT DATA

3255 WEST STETSON AVENUE, HEMET, CALIFORNIA 92545 PHONE: (909) 652-6811 TELEX: 676 343 FAX: (909) 652-3078 BULLETIN MW600

WELD-ON SADDLE FLOWMETER MODEL MW600

DESCRIPTION

Model MW600 Weld-On Saddle Meter is machined to the same radius as the tube on which it is to be installed to provide accurate alignment. The Model MW600 is manufactured to comply with applicable provisions of American Water Works Association Standard No. C704-92 for propeller-type flowmeters. As with all McCrometer propeller flowmeters, standard features include a magnetically coupled drive, instantaneous flowrate indicator and straight reading, six-digit totalizer.

Impellers are manufactured of high-impact plastic, capable of retaining their shape and accuracy over the life of the meter. Each impeller is individually calibrated at the factory to accommodate the use of any standard McCrometer register, and since no change gears are used, the MW600 can be field-serviced without the need for factory recalibration. Factory lubricated, stainless steel bearings are used to support the impeller shaft. The sealed bearing design limits the entry of materials and fluids into the bearing chamber providing maximum bearing protection.

The instantaneous flowrate indicator is standard and available in gallons per minute, cubic feet per second, liters per second and other units. The register is driven by a flexible steel cable encased within a protective vinyl liner. The register housing protects both the register and cable drive system from moisture while allowing clear reading of the flowrate indicator and totalizer.

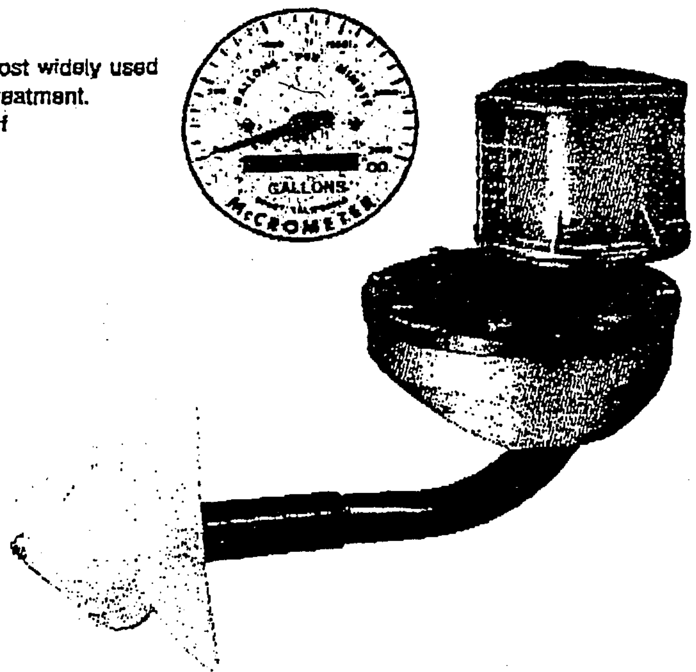
INSTALLATION

Standard installation is horizontal mount. If the meter is to be mounted in the vertical position, please advise the factory. A straight run of full pipe the length of five diameters ahead and one diameter behind the meter is the minimum normally recommended.

APPLICATIONS

The McCrometer propeller meter is the most widely used flowmeter for municipal and wastewater treatment applications as well as agricultural and turf irrigation measurement. Typical applications include:

- Water and wastewater management
- Center pivot systems
- Sprinkler irrigation systems
- Drip irrigation systems
- Golf course and park water management
- Gravity turnouts from underground pipelines
- Commercial nurseries



WELD-ON SADDLE METER MODEL MW600

SPECIFICATIONS

PERFORMANCE

ACCURACY/REPEATABILITY: ±2% of reading guaranteed throughout full range. ±1% over reduced range. Repeatability 0.25% or better.

RANGE: (see dimensions chart below).

HEAD LOSS: (see dimensions chart below).

MAXIMUM TEMPERATURE: (Standard Construction) 160°F constant.

PRESSURE RATING: 150 psi. Consult factory for higher rated version.

MATERIALS

SADDLE: Carbon steel.

BEARING ASSEMBLY: Impeller shaft is 316 stainless steel. Ball bearings are 440C stainless steel.

MAGNETS: Permanent type. Cast or sintered alnico..

BEARING HOUSING: Brass; stainless steel optional.

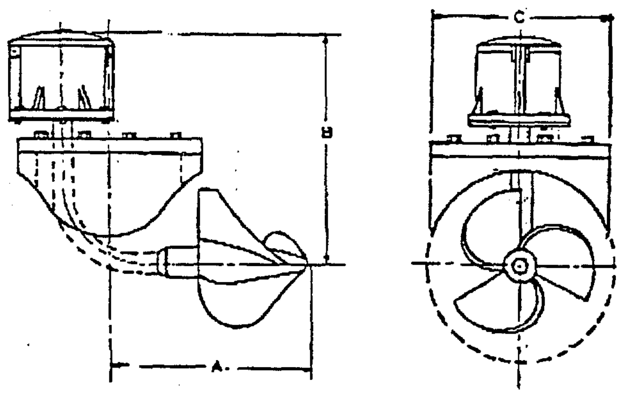
REGISTER: An instantaneous flowrate indicator and six-digit straight-reading totalizer are standard. The register is hermetically sealed within a die cast aluminum case. This protective housing includes a domed acrylic lens and hinged lens cover with locking hasp.

IMPELLER: Impellers are manufactured of high-impact plastic, retaining their shape and accuracy over the life of the meter. High temperature impeller is optional.

COATING: Fusion-bonded epoxy.

OPTIONS

- Weld-on saddle can be profiled to fit any outside diameter pipe dimensions
- Forward/reverse flow measurement
- Register extensions
- All stainless steel construction
- High temperature construction
- "Over Run" bearing assembly for higher than normal flowrates
- Electronic propeller meter available in all sizes of this model
- A complete line of flow recording/control instrumentation
- Certified calibration test results
- Stainless steel bearing housing



MW600	DIMENSIONS													
Meter Size (Inches)	4	6	8	10	12	14	16	18	20	24	30	36	42	48
Maximum Flow U.S. GPM	600	1200	1500	1800	2500	3000	4000	5000	6000	8500	12500	17000	25000	30000
Minimum Flow U.S. GPM	50	90	100	125	150	250	275	400	475	700	1200	1500	2000	2500
Approx. Head Loss in Inches at Max. Flow	23.0	17.0	6.75	3.75	2.75	2.00	1.75	1.50	1.25	1.00	.7	.5	.45	.3
Shipping Weight, lbs.	30	45	70	90	120	125	130	150	175	190	205	210	220	230
A (Inches)	11.37	12.87	12.87	12.12	12.12	12.12	12.12	15.00	15.00	15.00	15.00	15.00	15.00	15.00
B (Inches)	10.75	10.75	11.75	13.75	14.75	14.75	16.75	18.75	18.75	20.75	22.38	26.38	29.38	32.38
C* (Inches)	4 1/2	6 5/8	8 5/8	10 3/4	12 3/4	12 3/4	12 3/4	16	16	18	18	20	20	20

*Dimension C is O.D. of customer pipeline. On ordering, please specify I.D. and O.D. of pipeline in which meter is to be installed.

Larger flowmeters on special order

FOR MORE INFORMATION CONTACT:

KETEMA
McCROMETER DIVISION
3255 W. Stetson Ave.
Hemet, CA 92545
(909) 652-6811 / Telex: 676 343
Fax: (909) 652-3078

McCrometer Flowmeter Installation

Required tools:

- 3 open end ratchet wrenches with ½" and 9/16" openings (each wrench has both sizes)
- 3 open end ratchet wrenches with 1 3/8" and 15/16 openings
- 3 wire cutters
- 2 hammers
- 3 small wire brushes for cleaning threads
- 1 can light machine oil
- 3 small levels
- 3 half-round files

Installation instructions:

- Place saddle on discharge line at least 5 pipe diameters (2.5 feet) from the existing flowmeter housing.
- Place level on saddle and make sure it is centered and level on discharge pipe.
- Trace outline of inside of saddle on discharge pipe with a marking pen.
- Cut hole in discharge pipe corresponding to trace of saddle.
- File off any rough edges or burrs on the discharge pipe after hole is cut.
- Place saddle over hole and level once again.
- Tack weld saddle to hold it in place during welding. Remove level.
- Weld saddle on with 2 passes on the exterior and on the interior.
- After pipe and saddle cool, install flowmeter.
- Use light machine oil to lubricate bolts fastening meter to saddle.
- Use wire brush, cloth, or air to remove any metal shavings in threaded holes before inserting bolts.

The bearings are sealed, therefore sand production will have little effect on the flowmeters; however, they are lubricated with graphite, which can stiffen up after long periods inactivity. This means we will have to include a note in the O&M manual we produce for them that states that if flowmeter does not work after a pump has been inactive for a long period of time (2-3 months or more), the flowmeter should be removed and the propeller forcibly turned to loosen up the graphite lubricant. Once this is done, the flowmeter should be reinstalled.

Acid Redevelopment Procedures

These redevelopment procedures are based on the use of SWYCO S/C and SWYCO B/E.

Before placing acid in well, be sure all personnel are outside pump house, preferably even further away .The person installing the acid must be wearing a dust mask and safety goggles, not glasses.

Pour 250 lbs of SWYCO S/C into well.

Swab screen section of well for 15 minutes per 10 feet interval. This means that for 150 feet of screen, it will take approximately 4 hours to swab the screened interval one time.

Start swabbing from the top of the screen section and work downward.

After swabbing entire section 2 times, sample water from the well and check pH.

If pH is 2 to 3 then add 150 lbs of SWYCO B/E.

If pH is greater than 3, add 50 lbs of SWYCO S/C and swab screened section 1 time, then add 150 lbs of SWYCO B/E.

Swab screen section 2 times after SWYCO B/E is added.

During the procedure, the well will sit overnight with the chemicals in the well.

After pump is installed, pump water to waste for 4 hours.

Add 3.5 lbs of chlorine and let sit 24 hours before well is pumped.