FST SERIES
Submersible Turbine Pumps
Installation, Operation, and Maintenance Manual
# Table of Contents

4  ............... INTRODUCTION
4  ............... SAFETY CONSIDERATIONS
5  ............... PUMP IDENTIFICATION
5  ................ MANUFACTURER
5  ................ TYPE OF PUMP
5  ................ DATE OF MANUFACTURE
5  ................ INSTALLATION, OPERATION & MAINTENANCE MANUAL IDENTIFICATION
6  ............... GENERAL INSTRUCTIONS
6  ............... HANDLING AND TRANSPORT
6  ................ METHOD OF TRANSPORT
6  ................ STORAGE
7  ............... INSTALLATION & ALIGNMENT
7  ................ PREPARATION
8  ............... RECEIVING THE PUMP
8  ............... ELECTRICAL

CONSIDERATIONS
9  ................ PROVIDING A PROPER POWER SUPPLY
9  ................ SELECTING AND INSTALLING A PROPER MOTOR CONTROL SYSTEM
9  ................ SELECTING THE PROPER DROP CABLE
9  ................ MAKING THE SPLICE BETWEEN THE MOTOR LEADS AND THE DROP CABLE
9  ................ PROPERLY GROUNDING THE UNIT
9  ................ SELECTING AND INSTALLING AUXILIARY EQUIPMENT
10  ................ PRE-INSTALLATION MOTOR AND DROP CABLE CHECKS AND
10  ................ MOTOR SERVICING
10  ................ ATTACHING THE MOTOR TO THE PUMP
10  ................ TESTING BEFORE SPLICING DROP CABLE TO MOTOR LEADS
10  ................ MOTOR TESTS
10  ................ DROP CABLE TESTS
10  ................ SPLICING DROP CABLE TO MOTOR LEADS
10  ................ TESTING AFTER SPLICING DROP CABLE TO MOTOR LEADS
11  ............... INSTALLING THE PUMP
13  ................ ROUTINE OPERATION AND MAINTENANCE
13  ................ ROUTINE INSPECTIONS
13  ................ ROUTINE TESTING
14  ................ PERFORMANCE TESTING
18  ................ ELECTRICAL TESTS
18  ................ MEASURING INSULATION RESISTANCE (GROUND TEST)
20  ................ MEASURING RESISTANCE BETWEEN LEADS (MOTOR WINDING RESISTANCE)
22  ............... ASSEMBLY OF PUMP AND
23  ................ UPTHRUSt ADJUSTMENT
23  ................ PUMPS WITH 4” AND 6” MOTORS
24  ................ PUMPS WITH 8” MOTORS
24  ................ PUMPS WITH 6”, 8”, 10”, 12”, 14” AND 16” MOTORS (OPEN BEARING STYLE)
24  ................ RECOMMENDED SPARE PARTS
26  ............... SUBMERSIBLE TURBINE BOWL ASSEMBLY
INTRODUCTION

The pumps covered in this manual, when installed correctly, will last for many years in service. In order to gain the most from this equipment, this manual should be read thoroughly and followed during all stages of installation and operation.

SAFETY CONSIDERATIONS

FST submersible turbine pumps have been designed and manufactured for safe operation. In order to ensure safe operation, it is very important that this manual be read in its entirety prior to installing or operating the system. Franklin Electric shall not be liable for physical injury, damage or delays caused by a failure to observe the instructions for installation, operation and maintenance contained in this manual.

Remember that every pump has the potential to be dangerous because of the following factors:

- Parts are rotating at high speeds
- High pressures may be present
- High temperatures may be present
- Highly corrosive and/or toxic chemicals may be present

Paying constant attention to safety is always extremely important. However, there are often situations that require special attention. These situations are indicated throughout this book by the following symbols:

![DANGER]

DANGER - Immediate hazards which WILL result in severe personal injury or death.

![WARNING]

WARNING - Hazards or unsafe practices which COULD result in severe personal injury or death.

![CAUTION]

CAUTION - Hazards or unsafe practices which COULD result in minor personal injury or product or property damage.

Maximum Lifting Speed: 15 feet/second.

If in a climate where the fluid in the system could freeze, never leave liquid in the pump. Drain the system completely. During winter months and cold weather, the liquid could freeze and damage the system components. Always remember to drain the casing assemblies complete.

Do not run the equipment dry or start the pump without the proper prime (flooded system). Significant damage can occur to the unit if even run for a short time period without a fully filled casing assembly.

Never operate the pump(s) for more than a short interval with the discharge valve closed. The length of the interval depends on several factors including the nature of the fluid pumped and it’s temperature. Contact Technical Support for additional information if required.

Excessive pump noise or vibration may indicate a dangerous operating condition. The pump(s) must be shutdown immediately.

Do not operate the pump and/or the system for an extended period of time below the recommended minimum flow.

It is absolutely essential that the rotation of the motor be checked before starting any pump in the system. Incorrect rotation of the pump for even a short period of time can cause severe damage to the pumping assembly.

If the liquid is hazardous, take all necessary precautions to avoid damage and injury before emptying the pump casing.

Residual liquid may be found in the pump casing, suction and discharge manifolds. Take the necessary precautions if the liquid is hazardous, flammable, corrosive, poisonous, infected, etc.

Always lockout power to the driver before performing pump maintenance.

Never operate the pump without the coupling guard (if supplied) and all other safety devices correctly installed.

Do not apply heat to disassemble the pump or to remove the impeller. Entrapped liquid could cause an explosion.

If any external leaks are found while pumping hazardous product, immediately stop operations and repair.
PUMP IDENTIFICATION

MANUFACTURER

Franklin Electric
125 Morrison Drive
Rossville, TN 38066
United States of America

TYPE OF PUMP

FST submersible turbine pump is a vertical turbine, multi stage, Francis impeller design centrifugal pump.

DATE OF MANUFACTURE

The date of manufacture is indicated on the pump data plate.

All pumps are identified by serial number, model number and size. This information is stamped on a stainless steel identification plate which is permanently attached to the pump. Do not remove this plate as it will be impossible to identify the pump without it. Refer to the pump information in this manual for specific information.

NAMEPLATE INFORMATION

MODEL: Model designation of pump (8FKC-4)
SERIAL NUMBER: Serial Number of pump unit (issued by Production Control)
STAGES: Number of stages within pump
GPM: Rated capacity of pump
TDH: Rated Total Dynamic Head of pump
RPM: Speed of pump
HP: HP of pump
IMPELLER: Impeller model of pump
DISCHARGE (IN): Discharge size of pump in inches
SUCTION (IN): Suction size of pump in inches

WARRANTY

This product is covered by a Limited Warranty for a period of 12 months from the date of original purchase by the consumer. For complete warranty information, refer to www.franklinwater.com; or, contact Technical Support for a printed copy.

Phone: (901) 850-5115
Fax: (901) 850-5119

FIGURE 1 – Pump Data Plate (Discharge Head & Bell Tag)
GENERAL INSTRUCTIONS

The pump and motor unit must be examined upon arrival to ascertain any damage caused during shipment. If damaged immediately notify the carrier and/or the sender. Check that the goods correspond exactly to the description on the shipping documents and report any differences as soon as possible to the sender. Always quote the pump type and serial number stamped on the data plate.

The pumps must be used only for applications for which the manufacturers have specified:

- The construction materials
- The operating conditions (flow, pressure, temperature, etc.)
- The field of application

In case of doubt, contact Technical Support.

Upon receipt of the pump, a visual check should be made to determine if any damage has been incurred during transit or shipment. The main areas to diligently inspect are:

- Broken or cracked bowl assembly, including the motor bracket, motor, discharge head and discharge flanges
- Bent or damaged shafts
- Broken motor end bells, bent lifting eye bolts or damaged conduit boxes on the driver
- Missing parts

Parts and/or accessories are sometimes wrapped individually or fastened to the equipment. Coupling hubs are shipped in separate boxes (sometimes housed under the coupling guard). If any damage or loss has been incurred, promptly contact Technical Support and the freight company that delivered the equipment.

HANDLING AND TRANSPORT

METHOD OF TRANSPORT

The pump must be transported in the horizontal position.

INSTALLATION

During installation and maintenance, all components must be handled and transported securely by using suitable slings. Handling must be carried out by specialized personnel to avoid damage to the pump and persons. The lifting rings attached to various components should be used exclusively to lift the components for which they have been supplied.

CAUTION

Maximum lifting speed: 15 feet/second

It is important to exercise extreme care in handling and installing all parts. Certain items are precision machined for proper alignment and, if dropped, banged, sprung or mistreated in any way, misalignment and malfunction will result. Other components, such as the electrical cable, may be vulnerable to gouging or scuffing. Parts which are too heavy to be lifted from the transporting car or truck should be skidded slowly and carefully to the ground to prevent damage. Never unload by dropping parts directly from the carrier to the ground and never use shipping crates for skids.

If the bowl assembly is strapped to an I-beam for support, do not remove the bowl assembly from the I-beam support until the bowl assembly is in the vertical orientation.

If job site conditions permit, you may be able to install directly from the truck that delivered the pump. If not, move the components to the installation area and lay them out in a clean and protected space convenient to the work location. Column pipe sections should be placed on suitable timbers to keep them out of the dirt, arranged so that the coupling ends point toward the wellhead. The bowl/motor assembly should be left on the skids until lifted for installation. The power cable and motor leads must receive special protection to avoid damage to the jacket or insulation.

If installation cannot begin within a few days after delivery, segregate and identify all components of the shipment so they won’t be confused with other equipment arriving to the job site.

READ and FOLLOW the storage instructions carefully because care of the pump during this period before installation can be as important as maintenance after operation has begun.

Check all parts against the packing list to make sure nothing is missing. It is much better to find out now than during the installation. Report any discrepancies immediately to Technical Support.
STORAGE

SHORT-TERM STORAGE
Normal packaging is designed to protect the pump during shipment and for dry, indoor storage for up to two months or less. If the pump is not to be installed or operated soon after delivery, store the unit in a clean, dry place, having slow changes in environmental conditions. Steps should be taken to protect the pump against moisture, dirt and foreign particulate intrusion. The procedure followed for this short-term storage is summarized below:

Standard Protection for Shipment:

a. Loose unmounted items, including, but not limited to, oilers, packing, coupling spacers, stilts and mechanical seals are packaged in a water proof plastic bag and placed under the coupling guard.

b. Inner surfaces of the bearing housing, shaft (area through bearing housing) and bearings are coated with Cortec VCI-329 rust inhibitor or equal.

c. Regreasable bearings are packed with grease (Exxon Mobile Polyrax EM).

d. After a performance test, if required, the pump is checked for drainage (some residual water may remain in the bowl assembly). Then, internal surfaces of ferrous casings, covers, flange faces and the impeller surface are sprayed with Calgon Vestal Labs RP-743m, or equal. Exposed shafts are taped with Polywrap.

e. Flange faces are protected with plastic covers secured with plastic drive bolts. 3/16 in (7.8 mm) steel or 1/4 in (6.3 mm) wood covers with rubber gaskets, steel bolts and nuts are available at extra cost.

f. All assemblies are bolted to a wood skid which confines the assembly within the perimeter of the skid.

g. Assemblies with special paint are protected with a plastic wrap.

h. All assemblies having external piping (seal flush and cooling water plans), etc. are packaged and braced to withstand normal handling during shipment. In some cases components may be disassembled for shipment. The pump must be stored in a covered, dry location.

It is recommended that the following procedure is taken:

1. Ensure that the suction and discharge flanges are covered and secured with cardboard, plastic or wood to prevent foreign objects from entering the pump.

2. If the pump is to be stored outdoors with no overhead covering, cover the unit with a tarp or other suitable covering.

LONG-TERM STORAGE

Long-term storage is defined as more than two months, but less than 12 months. The recommended procedure for long-term storage of pumps is given below. These procedures are in addition to the short-term procedure above.

Solid wood skids are utilized. Holes are drilled in the skid to accommodate the anchor bolt holes in the base plate, or the casing and bearing housing feet holes on assemblies less base plate. Tackwrap sheeting is then placed on top of the skid and the pump assembly is placed on top of the Tackwrap. Metal bolts with washers and rubber bushings are inserted through the skid, the Tackwrap and the assembly from the bottom of the skid and are then secured with hex nuts. When the nuts are “snugged” down to the top of the base plate or casing and bearing housing feet, the rubber bushing is expanded, sealing the hole from the atmosphere. Desiccant bags are placed on the Tackwrap. The Tackwrap is drawn up around the assembly and hermetically (heat) sealed across the top. The assembly is completely sealed from the atmosphere and the desiccant will absorb any entrapped moisture. A solid wood box is then used to cover the assembly to provide protection from the elements and handling. This packaging will provide protection up to twelve months without damage to mechanical seals, bearings, lip seals, etc. due to humidity, salt laden air, dust, etc. After unpacking, protection will be the responsibility of the user. Addition of oil to the bearing housing will remove the inhibitor. If units are to be idle for extended periods after addition of lubricants, inhibitor oils and greases should be used.

Every three months, the shaft should be rotated approximately 10 revolutions.

INSTALLATION & ALIGNMENT

PREPARATION

Before installing the pump, clean the discharge flange thoroughly. Remove any protective coatings that may be on the shaft.

If the pump is coming from Short-Term or Long-Term storage and has been prepared for storage in the manner above, remove all grease and/or oil from the bearings. The bearings should be flushed with an appropriate fluid to remove any contamination prior to placing the pump into service.
The height of the equipment must be sufficient to accommodate the longest component to be installed.

Equipment for removal of the pump after it has been in operation must be capable of lifting the above weight plus the weight of the water in the column pipe (if applicable).

RECEIVING THE PUMP

Immediately upon receipt, check that the number of boxes and pieces received is the same as shown on the freight bills. Check for shipping damage. Note any shortages or damages on the carrier’s copy of the freight bill prior to signing. Report these damages or shortages to Technical Support or your local factory representative immediately.

If facilities are not available for lifting the materials off the carrier’s vehicle, use skids for unloading rather than allowing the parts to drop to the ground. Even though a pump is made up of heavy steel parts, it is a piece of machinery and it is essential that its parts be handled with care. It is extremely easy to damage shafting, threaded parts, and mating surfaces of parts which must fit together. Even a minor bend in one piece of shafting can cause a pump to vibrate excessively; thus shortening the life of the pump drastically.

ELECTRICAL CONSIDERATIONS

A major portion of the work associated with a submersible pump is the electrical consideration. It is not the intent of this manual to provide detailed instructions for the electrical work. The services of a competent power electrician or electrical contractor will be required. All work must be done in accordance with applicable codes, the pump motor manual, instructions for other equipment that is part of the installation and sound electrical practices. The electrical work performed will include but not be limited to the following:

FIGURE 2 – Submersible Turbine Installation
PROVIDING A PROPER POWER SUPPLY

The power supply must have an adequate capacity (KVA) and must be of the proper voltage, phase and frequency to match the motor requirements. Three phase systems should have a full three phase supply utilizing three individual transformers or one three phase transformer. Open delta or wye systems using only two transformers must be de-rated. Such installations are also more likely to suffer from phase unbalance problems. Unbalanced voltage on three phase power sources will cause unbalanced motor currents. Motor current unbalances in excess of 5% can be expected to cause excessive heating in the motor, resulting in poor motor performance, nuisance overload tripping, and premature failure of the motor. If the power company cannot guarantee less than 5 percent unbalance, the use of the next larger size motor and the next larger size cable is recommended. Contact Technical Support for further information. The warranty can be voided by the use of an improper power supply.

SELECTING AND INSTALLING A PROPER MOTOR CONTROL SYSTEM

The motor control system must be sized to accommodate the pump motor. The control system should protect the motor from damage from abnormal conditions such as low voltage, high voltage, overload, excessive current unbalance, phase loss, overheating, lightening, etc. Single phase 3-wire motors require a special submersible motor control box. A standard magnetic starter with special extra-quick overload relays can be used for three phase motors; however, a control which is designed specially for submersible pumps is recommended. Overload protection and fuse requirements are given in the pump motor manual. The warranty can be voided by the use of an improper control system.

SELECTING THE PROPER DROP CABLE

Submersible pump drop cable is a special waterproof, heavily insulated cable made especially for this use. The cable size is based on the motor horsepower and voltage, and the distance from the motor to the control panel. Cable size selection charts are given in the motor manual. Failure to use the proper size and type cable can void the warranty.

MAKING THE SPLICE BETWEEN THE MOTOR LEADS AND THE DROP CABLE

A water-tight splice must be made to connect the drop cable to the motor leads. See PRE-INSTALLATION MOTOR AND DROP CABLE CHECKS AND PREPARATION on page 10.

PROPERLY GROUNDING THE UNIT

All units must be grounded in accordance with applicable codes.

Failure to ground the unit properly can result in serious or fatal shock.

MAKING AND EVALUATING ELECTRICAL TESTS. Installation, trouble-

shooting, and maintenance of a submersible pump will require performing and evaluating electrical tests such as resistance, continuity, voltage, current, current unbalance, etc. Some of these tests are described in ELECTRICAL TESTS on page 18. The use of electrical testing as a troubleshooting tool can very often quickly identify the problem and prevent the unnecessary time and expense of pulling the pump.

SELECTING AND INSTALLING AUXILIARY EQUIPMENT

A low water level switch is recommended and can be supplied as an option from Franklin Electric. The installation will also most likely require auxiliary equipment such as flow switches, pressure switches, level switches, time switches, etc. The need for this equipment must be evaluated based on the requirements of each installation and the proper equipment must be selected and installed.

Since most submersible pump service problems are electrical, it is imperative that the electrical work be done properly using high quality materials if the pump is to provide the long, trouble-free life for which it is designed.
PRE-INSTALLATION MOTOR AND DROP CABLE CHECKS AND PREPARATION

CAUTION

Do not use motor leads to lift or handle the motor. The motor leads are easily damaged. They should be protected and handled with care at all times.

The following tests can usually be done in the shop provided the motor leads and drop cable are protected and handled carefully during transportation to the installation site.

DANGER

Ground the unit when testing. Failure to ground the unit properly can result in serious or fatal shock. Also, the high starting torque of the motor will cause it to “kick” when power is applied. The unit should be restrained sufficiently to prevent damage to the equipment or personal injury.

MOTOR SERVICING

Consult the motor manual and perform any pre-installation servicing that is required. Some motors may require filling with oil or water.

ATTACHING THE MOTOR TO THE PUMP

If the pump motor has not already been attached to the pump, attach it per the instructions given in INSTALLING THE PUMP on page 11. For longer units, it may be more practical to assemble the pump to the motor in the vertical position at the installation site.

TESTING BEFORE SPLICING DROP CABLE TO MOTOR LEADS

Perform the following tests before making the splice between the motor leads and the drop cable. Instructions for performing resistance tests and evaluating the results are given in ELECTRICAL TESTS on page 18.

MOTOR TESTS

Measure the resistance between each motor lead and ground with the motor submerged in water. See ELECTRICAL TESTS on page 18.

- Measure the resistance of the motor windings. See Section ELECTRICAL TESTS on page 18.
- Record the values for future reference.
- If possible, give the motor/pump unit a short (approx. 1 minute) running test in a tank of water. If a tank is not available, “bump” the motor (do not exceed 2 seconds) to check that it will run.

DROP CABLE TESTS

- Measure the resistance between the cable conductors and ground with the cable submerged in water. See ELECTRICAL TESTS on page 18.

SPICING DROP CABLE TO MOTOR LEADS

A waterproof splice must be made to connect the drop cable to the motor leads. A properly made splice will last the life of the pump. An improperly made splice will become a service problem. Make the splice per instructions supplied with the drop cable or per instructions in the pump motor manual. The splice should be located above the pump bowl. See FIGURE 3. It should be as compact as possible. A compact splice is less likely to be damaged as the pump is being lowered into the well.

TESTING AFTER SPLICING DROP CABLE TO MOTOR LEADS

Perform the following tests after making the splice, but before lowering the pump into the well.

- Check that the splice is waterproof by immersing it in a container of water for approximately one hour and then taking resistance readings between each cable conductor and the water. See ELECTRICAL TESTS on page 18.
- Measure the total resistance of the complete drop cable and motor circuit to insure that a good splice was made. Record the values for future reference. See ELECTRICAL TESTS on page 18.
INSTALLING THE PUMP

CAUTION

The pump motor will exert a torque that will tend to unscrew threaded column pipe connections. For this reason, threaded column joints must be tightened to a torque of at least 10 ft.-lbs. per rated HP of the motor (example, 500 ft.-lbs. for a 50 HP motor). If the pump installation rig cannot produce this amount of torque, it will be necessary to weld each joint or use some other method to keep the joints from unscrewing.

If a check valve is to be used and it is not already installed, install the check valve on the pump. See FIGURE 3. Clean the threads and apply thread sealant. Check that the arrow on the check valve is pointed in the direction of flow. Check that the valve disc or pop- pet is not stuck in the open or closed position. Tighten the valve securely. See Caution above.

The method of installing the pump, motor, and bottom piece of column will vary depending on the size and length of these components:

• For smaller units, the bottom section of column can be screwed into the pump and the entire pump/motor/column assembly handled as one piece.

• For larger units, it may be more practical to install the pump/motor assembly and the bottom piece of column pipe separately. A special elevator or clamp may be required to hold the pump/motor assembly in place while the first piece of column is being screwed into the pump discharge.

• For very large units or extremely long units where the pump and motor have not been assembled, it may be desirable to lift the pump and motor separately and assemble the motor to the pump in the vertical position. See ASSEMBLY OF PUMP AND MOTOR on page 10. This method requires a special elevator or clamp to hold the motor in place while the pump is being connected and a special elevator or clamp to hold the pump/motor assembly in place while the first piece of column is being installed. Eyebolts or some other means of lifting the motor will also be required.

Rig the first piece of equipment for lifting, hoist it into the vertical position, and position it over the well. Do not allow the equipment to drag along the ground as it is lifted. Special care must be taken when lifting long pumps or pump/motor assemblies, since they may sag excessively in the middle when raised at one end and permanently deform the unit. The shipping skid should remain attached during uprighting of very long units.

Check that all of the steps below have been completed:

• Assemble pump and motor. See page 10.

• Install the bottom piece of column in the pump discharge. Do not lower the unit into the well at this time.

• Complete PRE-INSTALLATION MOTOR AND DROP CABLE CHECKS AND PREPARATION on page 10. (testing before splicing cable).

• Complete PRE-INSTALLATION MOTOR AND DROP CABLE CHECKS AND PREPARATION on page 10. (cable splicing).

• Complete PRE-INSTALLATION MOTOR AND DROP CABLE CHECKS AND PREPARATION on page 10. (testing after splicing cable).

Temporarily connect the drop cable to the electric panel and start the pump for not more than 2 seconds to check that it will run.

DANGER

Ground the unit when testing. Failure to ground the unit properly can result in serious or fatal shock. Also the high starting torque of the motor will cause it to “kick” when power is applied. The unit should be restrained sufficiently to prevent equipment damage or personal injury.

On 3-phase units, check for proper rotation during this test. If the unit kicks clockwise (when viewed from above), the rotation is correct and the wires should be tagged so that they can be reconnected to the same terminals in the panel. If the unit kicks counterclockwise, interchange any two of the three wires before tagging them. DISCONNECT THE CABLE FROM THE PANEL.

Install a cable clamp on each side of the cable splice. See FIGURE 3. Be careful not to damage the cable. If an air line is to be installed, route it beside the cable, making sure that it is not pinched by the clamps. If there is any danger that the splice will rub against the well casing during installation, it should be protected by thick rubber chafing pads or by a steel shield. Check that the grounding system is in place.
Failure to ground the unit can result in serious or fatal shock. Refer to electrical code requirements.

Slowly lower the unit into the well (or sump) adding joints of column pipe as the unit is lowered. Tighten each joint securely. See note above. Remove slack from the drop cable and attach a cable clamp approximately every 10 feet. For units with large heavy drop cable, additional cable support can be obtained by installing a clamp immediately above each pipe coupling. Line up the cable on one side of the pump and maintain as much clearance as possible on that side when lowering the pump.

Be extremely careful not to scrape or damage the drop cable, drop cable splice or grounding system when lowering the pump.

Hold the drop cable up away from the well casing as the pump is being lowered. Never force the pump into the casing.

After the last piece of column pipe has been installed, install the discharge elbow. Install a cable clamp between the last column pipe coupling and the discharge elbow surface plate. Route the drop cable and grounding system thru the large threaded hole in the surface plate. Route the air line (if used) thru one of the smaller threaded holes in the surface plate. All of these holes are threaded with standard NPT pipe threads. If a gasket is required between the discharge elbow and its mounting surface, the gasket should be placed on the foundation prior to installing the discharge elbow.

After the discharge elbow has been properly tightened, carefully rotate the entire unit in the well until the discharge flange is facing in the desired direction. Push the unit to one side of the well, providing the maximum clearance for the drop cable when rotating the unit.

Slowly lower the discharge elbow onto its mounting surface. BE CAREFUL NOT TO DAMAGE THE GROUNDING SYSTEM OR PINCH THE DROP CABLE BETWEEN THE SURFACE PLATE AND THE WELL CASING. If a gasket or other sealing device is used, be sure that it is aligned properly and that it is not damaged. Install the discharge elbow mounting bolts.

Before connecting the drop cable to the control panel:

- Take a resistance reading between the drop cable conductors and ground to assure that the insulation on the cable or splice was not damaged during installation. See ELECTRICAL TESTS on page 18.

- Measure the resistance of the drop cable and motor circuit. See ELECTRICAL TESTS on page 22. Compare these readings with those taken in PRE-INSTALLATION MOTOR AND DROP CABLE CHECKS AND PREPARATION on page 10 to assure that the splice is still intact.

Make the electrical connection between the drop cable and the control panel. It may be desirable to use a terminal box at the discharge to simplify the electrical work required when the pump is pulled. See FIGURE 3. Be sure that the unit is grounded properly.

Be sure to connect the leads as they were marked previously in the procedure.

**STARTING THE PUMP**

Initial start-up and testing may require starting and stopping the pump several times. BE SURE TO ALLOW ADEQUATE COOLING OFF PERIOD BETWEEN STARTS. Consult the motor manual. If no information is given, a good rule-of-thumb is to allow a minimum of 15 minutes between starts.

For initial start-up allow the water to be pumped out onto the ground. A throttle valve in the discharge line is recommended. Position the throttle valve approximately one-fourth open for start-up of the pump. This will prevent surging the well or the pump during start-up.

If the pump has been in the well for several days before the start-up, check the resistance between the cable conductor and ground to assure that water has not penetrated the splice or the cable insulation. See ELECTRICAL TESTS on page 18.

Clamp the tongs of a clamp-on type ammeter around one power lead to the pump. Set the ammeter on the maximum scale. After the motor starts, it can be reset to a lower scale as desired. Refer to the motor manual and determine the normal operating amps for the installed motor.

Start the pump and observe and record the current readings on each conductor of the power lead. If the current exceeds the normal value determined in the motor manual, stop the pump immediately. A high current reading indicates that something is wrong. Among the potential problems are:

- Incorrect pump rotation (3 phase only)
- Improper voltage
- Sand locked pump
- Improper cable size or leak in cable
- Mechanical damage

In any case, the problem must be corrected before the pump can be operated.
On three phase units if water does not appear within one minute (deeper settings may require approximately one half minute per 100 ft. setting) the motor may be running backwards. Stop the pump and interchange any two of the three cable connections. If there is any doubt about the proper rotation, run the motor in one direction and then the other. The rotation that gives the highest pressure and flow is always the correct one.

Check the voltage. The voltage when the pump is running should be within 5% of the pump motor nameplate voltage.

Open the throttle valve. If a flow meter is available, open the throttle valve to rated flow of the pump. If sand appears in the water, throttle the pump at approximately 80% of full flow until the sand clears. If excessive noise develops, pressure fluctuates, or water appears foamy white, the pump is probably cavitating and the flow should be throttled until the noise diminishes, the pressure remains steady, and the water is clear.

On three phase units check for current unbalance. Details of the current unbalance test are given in ELECTRICAL TESTS on page 18. THE MAXIMUM ALLOWABLE CURRENT UNBALANCE IS 5%. If the current unbalance exceeds 5% after rolling the leads and connecting them for the lowest unbalance, the pump should be stopped and corrective action taken. Current unbalance in excess of 5% can be expected to cause excessive heating in the motor and premature failure. Operation with a current unbalance in excess of 5% will void the warranty.

After the unit has been in operation for approximately one week, perform the routine tests listed in ROUTINE OPERATION AND MAINTENANCE on page 13.

ROUTINE OPERATION AND MAINTENANCE

A submersible pump, properly installed in a clean well, will run for a long period of time with a minimum of attention. However, conditions are not always ideal and can change for the worse in the course of time. Submersible pumps usually run unattended and automatic control devices are used to stop and start the unit and to protect it from abnormal conditions such as overloads, line faults, etc. It is important that these automatic devices be adjusted properly and maintained in good working condition. Failure of an automatic control can easily cause the failure of a pump that is in excellent condition. Unfortunately these protective devices may not protect the installation against all of the hazards that may be encountered.

In order to assure that potential problems are identified and corrected as soon as possible, a program for regular inspection and testing of the unit should be established. The frequency of inspection and testing will vary depending on the complexity of the controls, the consequences of a failure, the cost of making the inspections and tests, the age and condition of the unit, the results of previous inspections and tests, and the operating philosophy of the owner.

ROUTINE INSPECTIONS

On a periodic basis, the unit should be given a quick inspection. The inspection should include the following:

- Check for any obviously abnormal conditions such as gross leakage or gross damage.
- Check that the unit is not making excessive noise. Check the electric panel for alarms, blown fuses, etc.
- Check the electrical system for signs of overheating or other abnormal conditions.

Any problems noted should be carefully investigated and corrected immediately.

ROUTINE TESTING

The following tests should be performed on a periodic basis and at any time the pump is started up after a prolonged shutdown. All test readings should be recorded so that they can be used for comparison. Gradual changes can indicate a gradual deterioration. Large changes can indicate rapid deterioration with a potential for sudden failure in the near future.

- Check the resistance between the drop cable conductor and ground. See FIGURE 5.
- Measure the resistance of the drop cable and motor windings. See ELECTRICAL TESTS on page 18.
- Measure the voltage and the current. Compare the readings with previous readings. If either the voltage or the current has changed substantially, check the current unbalance. See ELECTRICAL TESTS on page 18. Excessive current is an indication of a problem somewhere in the system which should be corrected immediately.
- Measure the water level in the well. A drop in the water level may indicate over pumping of the well or clogging of the well screen which can result in damage to the well, pump, and the motor. Be sure that the pump is always under the water. Lowering the pump by installing additional column pipe should be considered if the pump suction is submerged 5 feet or less when pumping.
PERFORMANCE TESTING

Performance testing of the pump consists of measuring and recording the following:

- Discharge pressure (feet) (feet = psi x 2.31 for water)
- Pumping level (feet) (distance from the center of the discharge pressure gage to the water level when pumping)
- Flow (gallons per minute)
- Input power (kilowatts)
- Line voltage on all phases (volts)
- Current in all three phases (amps)

The above information should be taken at four operating points: shutoff, slightly less than rated flow, rated flow and slightly greater than rated flow.

Do not operate the pump at shutoff for more than 30 seconds as this can cause the motor to overheat and burnout.

Record the above information and retain it for comparison with previous or subsequent performance tests.

The following formulas will be helpful in evaluating the readings taken.

\[
\text{Pump Output HP (Water Horsepower)} = \frac{Q \times W \times SG}{3960}
\]

Where:
- \( Q \) = flow in gallons/minute
- \( H \) = total head in feet
- \( SG \) = Specific Gravity

\[
\text{Power Input HP} = \text{KW input} \times 1.34
\]

\[
\text{Wire-to-Water Efficiency} = \frac{\text{Pump Output HP}}{\text{Pump Input HP}}
\]

The pump output horsepower is a measure of pump performance. Over the lifetime of the pump the output horsepower will decrease due to wear. By comparing output horsepower readings taken over a period of time the rate and degree of wear of the pump can be determined. Note that both head (pressure) and flow are included in the pump output horsepower formula. Be careful not to try to draw conclusions about the pump’s performance by considering pressure alone or flow alone. For example, consider what happens if the pumping level in the well changes. The pump output horsepower will remain essentially the same and the flow will change. This change in flow could be misinterpreted as a change in pump performance.

The wire-to-water efficiency is a measure of how well the pump and motor unit are utilizing the power consumed.

TROUBLESHOOTING

When properly installed and operating in non-abrasive, non-corrosive water a pump is a relatively long lived piece of machinery, requiring a minimum of attention. However, machinery is subject to wear. The most common causes of improper operation are given below.

These include problems created by wear and other adverse conditions. Note that most of these problems require removal of the pump from the well in order to correct the problem. Contact Technical Support or your representative for this type of service.
<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>No liquid delivered</th>
<th>Not enough liquid delivered</th>
<th>Not enough discharge pressure</th>
<th>Loss of liquid after starting</th>
<th>Pump operating for a short time, then stops</th>
<th>Pump is pulling high horsepower</th>
<th>Driver running hot</th>
<th>Excessive vibration</th>
<th>Cavitation noise from pump</th>
<th>Pump bearings running hot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suction lift too high</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discharge head too high</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotational speed too low</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incorrect direction of rotation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impeller plugged/impeller partially blocked by debris</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air leak in discharge line</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insufficient Net Positive Suction Pressure Available (NPSHA)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Damaged impeller</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Defective packing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inlet pipe not submerged enough</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impeller diameter too small</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obstruction in water passageways</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entrained air or gas in liquid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discharge head lower than previously thought</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific gravity of liquid higher than previously thought</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viscosity of liquid higher than previously thought</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bent or damaged shaft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bearings worn</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Misalignment of pump and driver</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Defect in driver</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage and/or frequency lower than previously thought</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotor assembly binding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotational speed too high</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROBLEM</td>
<td>POSSIBLE CAUSE</td>
<td>RECOMMENDED REMEDY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>----------------</td>
<td>-------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem #1&lt;br&gt;Pump not reaching design flow rate.</td>
<td><strong>1.1</strong> Insufficient NPSH. (Noise may not be present)&lt;br&gt;<strong>1.2</strong> System head greater than anticipated.&lt;br&gt;<strong>1.3</strong> Entrained air.&lt;br&gt;<strong>1.4</strong> Entrained gas from process.&lt;br&gt;<strong>1.5</strong> Speed too low.&lt;br&gt;<strong>1.6</strong> Direction of rotation wrong.&lt;br&gt;<strong>1.7</strong> Impeller too small.&lt;br&gt;<strong>1.8</strong> Impeller clearance too large.&lt;br&gt;<strong>1.9</strong> Plugged impeller, suction line or casing which may be due to large solids.&lt;br&gt;<strong>1.10</strong> Wet end parts (bowl, impeller) worn, corroded or missing.</td>
<td>Recalculate NPSH available. It must be greater than the NPSH required by pump at desired flow. If not, redesign suction piping, holding number of elbows and number of planes to a minimum to avoid adverse flow rotation as it approaches the impeller.&lt;br&gt;Reduce system head by increasing pipe size and/or reducing number of fittings. Increase impeller diameter. <strong>NOTE:</strong> Increasing impeller diameter may require use of a larger motor.&lt;br&gt;Air leak from atmosphere on suction side. 1. Check suction line gaskets and threads for tightness. 2. If vortex formation is observed in suction tank, install vortex breaker. 3. Check for minimum submergence.&lt;br&gt;Process generated gases may require larger pumps.&lt;br&gt;Check motor speed against design speed.&lt;br&gt;After confirming wrong rotation, reverse any two of three leads on a three phase motor. The pump should be disassembled and inspected before it is restarted.&lt;br&gt;Replace with proper diameter impeller. <strong>NOTE:</strong> Increasing impeller diameter may require use of a larger motor.&lt;br&gt;Replace impeller and/or case wear rings.&lt;br&gt;1. Reduce length of suction when possible. 2. Reduce solids in the process fluid when possible. 3. Consider larger pump.&lt;br&gt;Replace part or parts.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem #2.0&lt;br&gt;Pump not reaching design head (TDH).</td>
<td><strong>2.1</strong> Refer to possible causes under Problem #1.0.</td>
<td>Refer to remedies listed under Problem #1.0 and #3.0.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROBLEM</td>
<td>POSSIBLE CAUSE</td>
<td>RECOMMENDED REMEDY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>----------------</td>
<td>--------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Problem #3.0  
No discharge or flow | 3.1 Not properly primed. | Repeat priming operation, recheck instructions. If pump has run dry, disassemble and inspect the pump before operation. |
|  | 3.2 Direction of rotation wrong. | After confirming wrong rotation, reverse any two of three leads on a three phase motor. The pump should be disassembled and inspected before operation. |
|  | 3.3 Plugged impeller, suction line or casing which may be due to a fibrous product or large solids. | Refer to recommended remedy under Problem #1.0, Item #1.9. |
|  | 3.4 Damaged pump shaft, impeller. | Replace damaged parts. |
| Problem #4.0  
Pump operates for short period, then loses prime. | 4.1 Insufficient NPSH<sub>A</sub>. | Refer to recommended remedy under Problem #1.0, Item #1.1. |
|  | 4.2 Entrained air. | Air leak from atmosphere on suction side. Refer to recommended remedy under Problem #1.0, Item #1.1. |
| Problem #5.0  
Excessive noise from wet end. | 5.1 Cavitation - insufficient NPSH available. | Refer to recommended remedy under Problem #1.0, Item #1.1. |
|  | 5.2 Abnormal fluid rotation due to complex suction piping. | Redesign suction piping, holder number of elbows and number of planes to a minimum to avoid adverse fluid rotation as it approaches the impeller. |
|  | 5.3 Impeller rubbing. | 1. Replace impeller and/or case wear rings. 2. Check outboard bearing assembly for axial end play. |
| Problem #6.0  
Pump will not run. | 6.1 No power to control box. | Refer to ELECTRICAL TESTS |
|  | 6.2 Motor protection device tripped. | Refer to ELECTRICAL TESTS |
|  | 6.3 Blown fuse. | Refer to ELECTRICAL TESTS |
|  | 6.4 Open circuit in cable, splice or motor winding. | Refer to ELECTRICAL TESTS |
|  | 6.5 Control box malfunction. | Refer to ELECTRICAL TESTS |
### Problem #7.0
**Overload Protector Trips**

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>POSSIBLE CAUSE</th>
<th>RECOMMENDED REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1</td>
<td>Incorrect control box.</td>
<td>Replace with correct control box.</td>
</tr>
<tr>
<td>7.2</td>
<td>Incorrect, loose or corroded electrical connections.</td>
<td>Replace defective item. Refer to ELECTRICAL TESTS.</td>
</tr>
<tr>
<td>7.3</td>
<td>Incorrect voltage.</td>
<td>Correct line voltage.</td>
</tr>
</tbody>
</table>

### ELECTRICAL TESTS

#### MEASURING INSULATION RESISTANCE (GROUND TEST)

The condition of the insulation around a conductor can be determined by measuring the electrical resistance between the conductor and ground. This measurement can be made with a meggar or an ohmmeter. The value is stated in ohms or megohms (ohms x 1,000,000). High ohm values indicate good insulation.

The basic procedure for measuring insulation resistance is given below:

1. Turn off all power and disconnect the leads to be tested from the electrical panel.

   **WARNING**

   Failure to turn off the power will damage the meter and can cause serious or fatal shocks.

   Failure to disconnect the leads can result in false readings.

   Set the meter selector knob to RX 100K or RX 100,000. (Some meters may not have RX 100K in which case RX 10K or RX 10,000 scale can be used.) Clip the meter leads together and adjust the meter to zero.

   Unclip the leads and attach them. See FIGURE 4.

   Do not touch any bare wires or allow bare wires to come in contact with the ground or metal. False readings will result.

If the meter needle is at either extreme end of the scale, a more accurate reading can be obtained by switching the selector switch to another scale. Re-zero the meter each time the selector switch is moved.

The readings obtained from drop cables and motor leads should be within the range specified in FIGURE 5. Low readings indicate that the motor windings are grounded or that the cable or splice insulation is damaged. If low or marginal readings are obtained on a new installation the problem should be corrected before proceeding with the installation.

![FIGURE 4 – Measuring Insulation Resistance](image)

Insulation resistance does not vary with rating. All motors of all HP, voltage and phase rating have the same insulation resistance ranges.
<table>
<thead>
<tr>
<th>CONDITION OF MOTORS AND LEADS</th>
<th>OHMS</th>
<th>MEGOHMS</th>
<th>METER READING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>R x 100K or</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>R x 100,000 scale</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>R x 10K or</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>R x 10,000 scale</td>
</tr>
<tr>
<td>BENCH TESTS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* A new motor (without drop cable)</td>
<td>20,000,000+</td>
<td>20+</td>
<td>200+</td>
</tr>
<tr>
<td>* A used motor which can be reinstalled in the well</td>
<td>10,000,000+</td>
<td>10+</td>
<td>100+</td>
</tr>
<tr>
<td>* Cable splice after immersion for one hour in water</td>
<td>2,000,000+</td>
<td>2+</td>
<td>20+</td>
</tr>
<tr>
<td>WELL TESTS (ohm readings are for drop cable plus motor)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* A new motor or used motor in good condition.</td>
<td>2,000,000+ +</td>
<td>2+</td>
<td>20+</td>
</tr>
<tr>
<td>* A motor in reasonably good condition.</td>
<td>500,000-2,000,000</td>
<td>0.5-2.0</td>
<td>5-20</td>
</tr>
<tr>
<td>* A motor which may have been damaged by lightning or with damaged leads. Do not pull the pump for this reason.</td>
<td>20,000-500,000</td>
<td>0.02-0.5</td>
<td>0.2-5</td>
</tr>
<tr>
<td>* 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 not fail for this reason alone, but will probably not operate for long.</td>
<td>10,000-20,000</td>
<td>0.01-0.02</td>
<td>0.1-0.2</td>
</tr>
<tr>
<td>* A motor which has failed or with completely destroyed cable insulation. The pump must be pulled and the cable repaired or the motor replaced.</td>
<td>less than 10,000</td>
<td>0-0.01</td>
<td>0-0.1</td>
</tr>
</tbody>
</table>

+ Indicates that the reading should be the value shown or greater. Higher readings indicate better insulation.

FIGURE 5 – Nominal Insulation Resistance Values Between All Legs & Ground
MEASURING RESISTANCE BETWEEN LEADS
(MOTOR WINDING RESISTANCE)

The general condition of motor windings can be determined by measuring the resistance of the motor windings (i.e., the resistance between the motor leads) and comparing the measured resistance with values given in the motor manual. The resistance is measured with an ohm-meter and the value is stated in ohms.

The basic procedure for measuring motor winding resistance is given below.

**WARNING**

Turn off the power and disconnect the leads to be tested from the panel.

Failure to turn off the power will damage the meter and can cause serious or fatal shock.

Failure to disconnect the leads can result in false readings.

Set the meter selector knob to "Ax 1". Clip the meter leads together and adjust the meter to zero.

Unclip the leads and attach them. See FIGURE 6.

Resistance measured between the motor leads prior to splicing the drop cable to the motor leads should be within the motor winding resistance limits specified in the motor manual. Resistance measured between the drop cable leads after splicing the drop cable to the motor leads will indicate the resistance of the drop cable plus the motor windings. The motor winding resistance is obtained by the formula below. The calculated value should be within the limits specified in the motor manual.

Motor winding resistance reading measured at drop cable from FIGURE 6.

A higher winding resistance than shown in the motor manual indicates a possible burned (open) winding, an open cable, a loose connection, or the wrong motor (different HP or voltage than readings being referenced).

A considerably lower winding resistance than shown in the motor manual indicates a possible shorted (burned together) winding or the wrong motor.

Unequal resistance between the windings on a three-phase motor indicates a burned winding or a faulty connection.

The values below are for copper conductors. If aluminum conductor drop cable is used, the resistance will be higher for each foot of cable of the same size. To determine the actual resistance of aluminum drop cable, divide the ohm readings from this chart by 0.61. This chart shows total resistance of cable from control box to motor and back.

![Ohm Meter](Image)

FIGURE 6 – Measuring Winding Resistance

C. CURRENT UNBALANCE TEST

For three-phase units, THE CURRENT UNBALANCE BETWEEN LEGS OF THE POWER SUPPLY SHOULD NOT EXCEED 5%. Current unbalance is determined by measuring the amperage in each of the three legs and then calculating the percent current unbalance using the formula below. This calculation must be performed using each of the three hookups shown.

THE HOOKUP THAT RESULTS IN THE LOWEST PERCENT CURRENT UNBALANCE SHOULD BE USED FOR THE FINAL CONNECTION OF THE POWER LEADS. This procedure is commonly known as "rolling the leads". To prevent changing the motor rotation, be careful to follow the hookups shown below very carefully. A worksheet and sample calculation are given. See FIGURE 7.
FIGURE 6 – Drop Cable Resistance
Since loads on a transformer bank may vary during the day, readings should be taken at least twice; once during the day at what would be considered the normal load period and once in the evening during the usual peak load period.

The leads should then be connected for the lowest percent current unbalance during the period that the pump will operate the most.

By observing where the highest current reading is for each leg of each of the hookups, the cause of the unbalance can be determined. If the high current leg is always on the same power leg L, this indicates that most of the unbalances from the power source. If the high current is always on the same motor lead T, this indicates that the motor or a poor connection is causing most of the unbalance.

\[
\text{Percent Current Unbalance} = \left(\frac{\text{max. current difference in any leg from average current}}{\text{average current}}\right) \times 100
\]

### Sample Calculation

<table>
<thead>
<tr>
<th>Hook Up</th>
<th>T1</th>
<th>L1</th>
<th>T2</th>
<th>L2</th>
<th>T3</th>
<th>L3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>51</td>
<td>150</td>
<td>50</td>
<td>46</td>
<td>53</td>
<td>150</td>
</tr>
<tr>
<td>2nd</td>
<td>51</td>
<td>150</td>
<td>50</td>
<td>46</td>
<td>53</td>
<td>150</td>
</tr>
<tr>
<td>3rd</td>
<td>51</td>
<td>150</td>
<td>50</td>
<td>46</td>
<td>53</td>
<td>150</td>
</tr>
</tbody>
</table>

- Measure current in each leg.
- Add leg currents to determine total current.
- Calculate average leg current.
- Determine max. difference of any one leg from the average.
- Calculate percent unbalance using formula above.

The maximum allowable unbalance is 5%.

**FIGURE 7 – Load Datasheet**

If the current unbalance still exceeds 5% after rolling the leads and connecting them for the lowest unbalance, the pump should be stopped and corrective action taken. The power company should be contacted for assistance.

**ASSEMBLY OF PUMP AND MOTOR**

The size and length of the pump/motor assembly will determine whether the pump and motor can be assembled in the shop or must be assembled in the vertical position at the well site. Very large units or long units with many stages must be assembled at the well site.

Do not use the motor leads to lift or handle the motor. The motor leads are easily damaged. They should be protected and handled with care at all times.
Consult the motor manual and perform any pre-installation servicing of the motor that is required. Some motors will require filling with oil or water.

If the motor is to be assembled to the pump while in the shop, go to Step 3 below. If the motor is to be assembled at the well site, perform the ELECTRICAL TESTS on page 18 while the motor is still in the shop. Be careful to protect the motor leads during transportation of the motor to the well site.

Check that the pump shaft and motor shaft turn freely.

Clean the exposed portion of the pump shaft and motor shaft. Clean the flange faces and registers on the pump and motor mating flanges. Remove all burrs from these areas.

Install the key in the motor shaft. See FIGURE 8. Splined motor shafts do not use a key.

If the shaft coupling has set screws in motor shaft half of the coupling, loosen or remove these set screws.

Align the motor with the pump and slide the motor shaft into the shaft coupling on the pump. Be careful not to damage the shaft, the coupling, or the key. Orient the motor so that the motor leads are aligned with the notch provided in the pump mounting flange. Install and tighten the mounting bolts (or capscrews).

If the shaft coupling has set screws in the motor shaft half of the coupling, pull the coupling toward the motor until the shafts butt and then install and tighten the set screws on the motor end of the coupling.

Install a shield over the motor leads to prevent damaging the leads when lowering the pump into the well. A channel shaped metal shield held in place with 1/2" wide stainless steel “Band-It” straps is recommended. The shield should be installed as shown in FIGURE 8 with the lower end positioned immediately above the suction inlet, the upper end at the top of the discharge case (or check valve) and straps located as shown.

Test the completed pump/motor assembly per the ELECTRICAL TESTS on page 18. Ignore this step if the pump was assembled at the well site.

FIGURE 8 – Typical Pump/Motor Assembly

UPTHRUST ADJUSTMENT

PUMPS WITH 4” AND 6” MOTORS

The impeller up-thrust has been preset to mount the pump end to the motor. The total amount of upward axial movement must be 0.125 inches. To adjust, loosen the hex nut at the discharge end plug and then adjust the stud to obtain the proper up-thrust limit. Tighten the hex nut to lock into place. See FIGURE 9.
FIGURE 9 – Up-thrust Adjustment

PUMPS WITH 8” MOTORS

The impeller up-thrust must be checked and adjusted after motor installation. With the pump end mounted to the motor, the total amount of upward axial movement must be 0.125 inches. To adjust, loosen the hex nut at the discharge end plug and then adjust the stud to obtain the proper up-thrust limit. Tighten the hex nut to lock into place. See FIGURE 10.

FIGURE 10 – Up-thrust Adjustment

PUMPS WITH 6”, 8”, 10”, 12”, 14” AND 16” MOTORS (OPEN BEARING STYLE)

The impeller up-thrust must be checked and adjusted after motor installation. With the pump end mounted to the motor, the total amount of upward axial movement must be 0.125 inches. To adjust, loosen the hex nut at the discharge end plug and then adjust the stud to obtain the proper up-thrust limit. Tighten the hex nut to lock into place. Loosen the set screw in the thrust collar, obtain the proper up-thrust limit and re-tighten the set screws. See FIGURE 11.

FIGURE 11 – Up-thrust Adjustment

SPARE PARTS

RECOMMENDED SPARE PARTS

The decision on what spare parts to stock varies greatly depending on many factors such as the criticality of the application, the time required to buy and receive new spares, the erosive/corrosive nature of the application, and the cost of the spare part. Please refer to the Parts Catalog for more information.

HOW TO ORDER SPARE PARTS

Spare parts can be ordered from the local Franklin Electric Sales Engineer, or from the Distributor or Representative. The pump size and type can be found on the name plate on the discharge head or suction bell. See FIGURE 1. Please provide the item number, description, and alloy for the part(s) to be ordered.

To make parts ordering easy, a copy of the Parts Catalog can be obtained from the local Franklin Electric Sales Engineer, or from the Distributor or Representative.
SUBMERSIBLE TURBINE BOWL ASSEMBLY

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>006</td>
<td>SUCTION SCREEN</td>
<td>300 SS</td>
</tr>
<tr>
<td>136B</td>
<td>BOWL BEARING</td>
<td>BRONZE</td>
</tr>
<tr>
<td>136D</td>
<td>DISCHARGE CASE BEARING</td>
<td>BRONZE</td>
</tr>
<tr>
<td>136S</td>
<td>SUCTION CASE BEARING</td>
<td>BRONZE</td>
</tr>
<tr>
<td>179</td>
<td>BOWL</td>
<td>CAST IRON</td>
</tr>
<tr>
<td>225</td>
<td>IMPELLER COLLET</td>
<td>CARBON STEEL</td>
</tr>
<tr>
<td>256C</td>
<td>MOTOR COUPLING</td>
<td>416 SS</td>
</tr>
<tr>
<td>256D</td>
<td>UPTHrust DISC</td>
<td>300 SS</td>
</tr>
<tr>
<td>302</td>
<td>DISCHARGE CASE</td>
<td>DUCTILE IRON</td>
</tr>
<tr>
<td>364</td>
<td>BOWL O-RING</td>
<td>VITON</td>
</tr>
<tr>
<td>364L</td>
<td>LIP SEAL</td>
<td>RUBBER</td>
</tr>
<tr>
<td>444</td>
<td>IMPELLER</td>
<td>304 SS</td>
</tr>
<tr>
<td>616D</td>
<td>DISCHARGE CASE PLUG</td>
<td>CARBON STEEL</td>
</tr>
<tr>
<td>728B</td>
<td>BOWL SHAFT</td>
<td>416 SS</td>
</tr>
<tr>
<td>816</td>
<td>SUCTION CASE</td>
<td>CAST IRON</td>
</tr>
</tbody>
</table>

REFER TO FACTORY FOR OPTIONAL METALLURGY AND LEAD-TIMES
ALL PRICES ARE F.O.B ROSSVILLE, TN AND SUBJECT TO CHANGE WITHOUT NOTICE