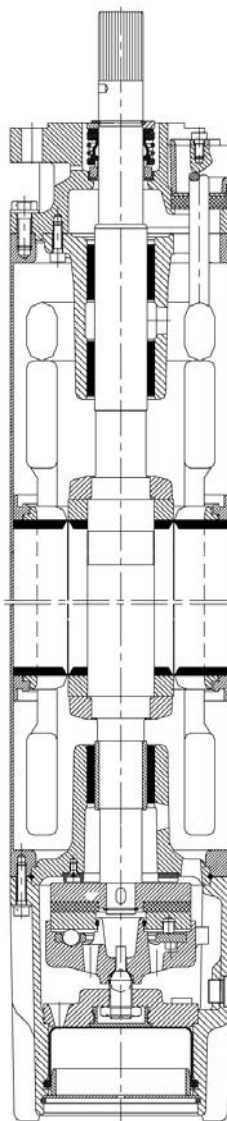


INSTALLATION, OPERATION &
MAINTENANCE MANUAL
FOR
SERIES 900
SUBMERSIBLE MOTORS
'E' & 'H' SERIES



15 MARCH 2006
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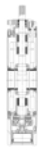
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SAFETY CONSIDERATIONS

The American-Marsh submersible turbine motor has 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 pump. American-Marsh Pumps 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 motor 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 - Immediate hazards which WILL result in severe personal injury or death.



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



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 casing could freeze, never leave liquid WITHOUT antifreeze in the motor. During winter months and cold weather, the liquid could freeze and damage the motor housing.

WATER SYSTEMS GROUP

Do not unpack the motor until it is ready to be installed. The packaging and crating is specifically designed to protect the motor during transport and storage.

Do not lift the motor by the motor lead. Damage to the lead and eventual failure of the motor can be caused.

Do not run the equipment dry or start the motor without the proper prime (motor flooded with required lubricant).

Never operate the motor 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 its temperature. Contact American-Marsh Engineering for additional support if required.

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

Do not start or stop the motor greater than the number specified in Figure 12.

It is absolutely essential that the rotation of the motor be checked before installation of the coupling spacer and starting the pump. Incorrect rotation of the pump for even a short period of time can cause severe damage.

Always lockout power to the driver before performing maintenance.

Never operate the pump without the coupling guard and all other safety devices correctly installed.

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

Submersible motors should not be installed in ponds, lakes or swimming pools due to possible electrical shock.



PUMP IDENTIFICATION

MANUFACTURER

American-Marsh Pumps
185 Progress Road
Collierville, TN 38017
United States of America

TYPE OF MOTOR

The American-Marsh submersible motors are available in 4 inch diameter E Series and 6 inch diameter H Series configurations.

E SERIES

The 4 inch diameter motors are hermetically sealed, encapsulated and water lubricated with a field replaceable motor lead. The stator windings are of enameled copper wire and mounted in a stainless steel shell. The interior of the stator is also protected by a stainless steel shell and the entire stator assembly is filled with resin. This resin, which completely fills in the void between these two stainless steel shells, dissipates heat quickly resulting in longer motor life. The remaining parts of the motor are pre-filled with de-ionized water

NAMEPLATE INFORMATION

MODEL 3M6-50-T4-H	HP 5	HZ 60
VOLTS 460	AMPS 7.5	KW 3.7
PHASE/WIRE 3P-3W	RPM 3450	SF 1.15
S.F. MAX AMPS 8.5	CONTINUOUS DUTY	
S.NO. XXXXXX		

FIGURE 1 – Pump Data Plate

MODEL	: Model number of the motor.
HP	: Rated HP of motor.
HZ	: Rated frequency of motor.
VOLTS	: Rated voltage of motor.
AMPS	: Rated amperage of motor.
KW	: Rated kilowatt of motor.
PHASE/WIRE	: Rated phase of motor and number of wires present on motor lead.
RPM	: Rated speed of motor in revolutions per minute.
S.F.	: Rated service factor of motor.
S.F. MAX. AMPS.	: Maximum amperage of motor while operating at 1.15 service factor.
CONTINUOUS DUTY	: Rating of motor.
S.NO.	: Serial number of motor.

providing cooling and lubrication of the rotor brushes and thrust bearing.

H SERIES

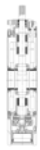
The 6 inch diameter motors are of the wet type, water filled and rewindable with an integral motor lead. The stator windings are encapsulated within a water proof synthetic film. All H Series motors are pre-filled with de-ionized water providing cooling and lubrication of the rotor brushes and thrust bearing. Refilling and draining of the motors can be accomplished by removing the fill plugs located at the top of the motor.

DATE OF MANUFACTURE

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

INSTALLATION, OPERATION & MAINTENANCE MANUAL IDENTIFICATION

Prepared:	March, 2006
Edition:	01
Revision:	02
Date of Revision:	November, 2006



WARRANTY

American-Marsh Pumps guarantees that only high quality materials are used in the construction of our pumps and that machining and assembly are carried out to high standards.

The motors are guaranteed against defective materials and/or faulty craftsmanship for a period of one year from the date of shipment unless specifically stated otherwise.

Replacement of parts or of the motor itself can only be carried out after careful examination of the motor by qualified personnel.

The warranty is not valid if third parties have tampered with the pump.

This warranty does not cover parts subject to deterioration or wear and tear (lip seals, pressure and vacuum gauges, rubber or plastic items, thrust bearings, etc.) or damage caused by misuse or improper handling of the pump by the end user.

Parts replaced under warranty become the property of American-Marsh Pumps.

Contact the American-Marsh Pumps' factory:

American-Marsh Pumps
185 Progress Road
Collierville, TN 38017
United States Of America

Phone: (901) 860-2300
Fax: (901) 860-2323
www.american-marsh.com

GENERAL INSTRUCTIONS

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

- ❖ **The construction materials**
- ❖ **The operating conditions**
- ❖ **The field of application**

In case of doubt, contact the manufacturer.

The unique design of the thrust bearing and water lubricated journal bearings of the 'E' and 'H' Series motors offer reliable service coupled with long life. Shaft seals, grommets and o-rings are used to prevent the ingress of sand and well water into the motor. A pressure equalizing diaphragm is provided to maintain pressure and volume variations within the motor. All 'E' and 'H' Series motors feature NEMA standard splines and shaft extensions.

LINEAR FLOW REQUIREMENTS

All submersible motors require a constant flow of liquid past the motor to provide adequate cooling so that the motor does not overheat.

CAUTION

A minimum linear flow of 0.55 ft/sec (0.17 m/sec) MUST be maintained at all times or severe damage can/will occur to the motor.

HANDLING AND TRANSPORT

METHOD OF TRANSPORT

The motors can be transported in the horizontal or vertical position

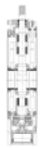
INSTALLATION

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 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. The 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 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 at 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.

STORAGE

SHORT-TERM STORAGE

Normal packaging is designed to protect the pump during shipment and for dry, indoor storage for up to one year or less. During this time the motor can be stored in the horizontal orientation. Ensure that all motors are completely filled with water.

LONG-TERM STORAGE

Long-term storage is defined as more than one year, but less than 2 years. During this time the motor must be stored in the vertical orientation. Ensure that all motors are completely filled with water.

The storage time of E Series motors are limited to two years when the ambient temperature DOES NOT exceed 100° F (38° C). If temperatures exceed 130° F (54° C) the storage time should be limited to one year.

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

INSTALLATION

INTRODUCTION

Submersible motors are carefully constructed of high quality materials and are designed to give long trouble-free life. This manual describes the basic procedure for installing, operating, and maintaining a submersible motor. Failure to read, understand, and follow the instructions in this manual, the motor manual, and the instructions for accessory equipment can cause personal injury, poor performance of the equipment, shortened life of the equipment, and can void the warranty on the equipment.

A major portion of the work associated with submersible motor installation, operation, and maintenance is electrical. It is not the intent of the manual to provide detailed instructions for this electrical work. A brief summary of the electrical work that is required is given in ELECTRICAL TESTS on page 21. The service of a competent power electrician or electrical contractor will be required.

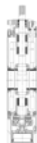
This manual will reference the pump motor manual in several places. Read the motor manual and the instructions for other equipment that is part of the installation and integrate these instructions with the basic instructions contained in this manual.

Hoisting equipment capable of controlled hoisting and lowering of the combined weight of the pump, motor, drop cable, column pipe, and discharge head.

CAUTION

The height of the equipment must be sufficient to accommodate the longest component to be installed.

Pipe elevators (or equivalent) and lifting bail (or equivalent) for handling and installing sections of column pipe. The elevators and lifting bail must be capable of carrying the combined weight of the pump, motor, drop cable, and column pipe.*



WARNING

Equipment for removal of the motor after it has been in operation must be capable of lifting the above weight plus the weight of the water in the column pipe.

WELL (OR SUMP) REQUIREMENTS

The well must comply with applicable codes.

The well should be developed with a test pump prior to installing the submersible pump. Test pumping the well serves several purposes. It removes the excess sand encountered during the initial pumping of the well. Attempting to pump mud or sand with a submersible pump can bury the pump motor causing it to overheat and burnout. Test pumping also provides a means of determining the capacity and drawdown (lowering of the water level in the well during pumping). Pumping sand or other abrasives with a submersible pump will shorten the life of the pump and can void the warranty.

The well capacity should equal or exceed the pump capacity. If the pump removes water at a higher rate than the well produces, the drawdown will be excessive and the pump will cavitate or "starve" resulting in damage to the pump and motor.

The well must be deep enough so that the pump suction is at least 10 feet below the expected drawdown level. See Figure 3. The lower end of the pump should be at least 10 feet from the bottom of the well.

WARNING

*The motor **MUST** always be immersed in flowing water.*

The flow rate must be adequate to cool the motor. If the pump is set below the well screen openings or other conditions exist that cause the water to be supplied from above the pump, a flow inducer sleeve may be required. Flow inducer sleeves are generally required for all pit or tank applications. Detailed information concerning the required flow rate around the motor and the design of flow inducer sleeves is given in the motor manual.

Water temperature in excess of 80° F may require special considerations concerning the pump motor.

The inside diameter of the well casing must be large enough to allow lowering the unit into the well without damaging the drop cable, the splice between the drop cable and the motor leads, or the motor leads. A slightly enlarged area may be required immediately underneath the discharge head to prevent pinching the cable against the well casing. The drop cable must be pulled away from the column pipe in this area to allow it to pass through the threaded opening in the surface plate of the discharge head. See Figure 2.

ABOVE GROUND PIPING

The system must meet applicable codes.

The system must be designed to match the flow and pressure produced by the pump. Systems that allow the pump to operate at low pressure/high flow conditions can cause cavitation or up-thrust problems and damage the pump or the motor. Systems that allow the pump to run at high pressure/low flow conditions (i.e. operating at or very near shutoff) for extended periods of time can cause the motor to overheat and burn out. A pressure relief valve should be installed if the pump shutoff pressure exceeds the pressure rating of the system.

The system must be designed so that the pump is not cycled ON and OFF excessively.

All piping must be independently supported, accurately aligned and preferably connected to the pump by a short length of flexible piping. The pump should not have to support the weight of the pipe or compensate for misalignment. It should be possible to install discharge bolts through mating flanges without pulling or prying either of the flanges. All piping must be tight. Pumps may air-bind if air is allowed to leak into the piping. If the pump flange(s) have tapped holes, select flange fasteners with thread engagement at least equal to the fastener diameter but that do not bottom out in the tapped holes before the joint is tight.

WARNING

Piping Forces: Take care during installation and operation to minimize pipe forces and/or moments on the pump casing.



! WARNING

When fluid velocity in the pipe is high, for example, 10 ft/s (3 m/s) or higher, a rapidly closing discharge valve can cause a damaging pressure surge. A dampening arrangement should be provided in the piping.

ELECTRICAL CONSIDERATIONS

A major portion of the work associated with a submersible pump is electrical. 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:

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 percent 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. Notify the factory of this requirement. 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, lightning, 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

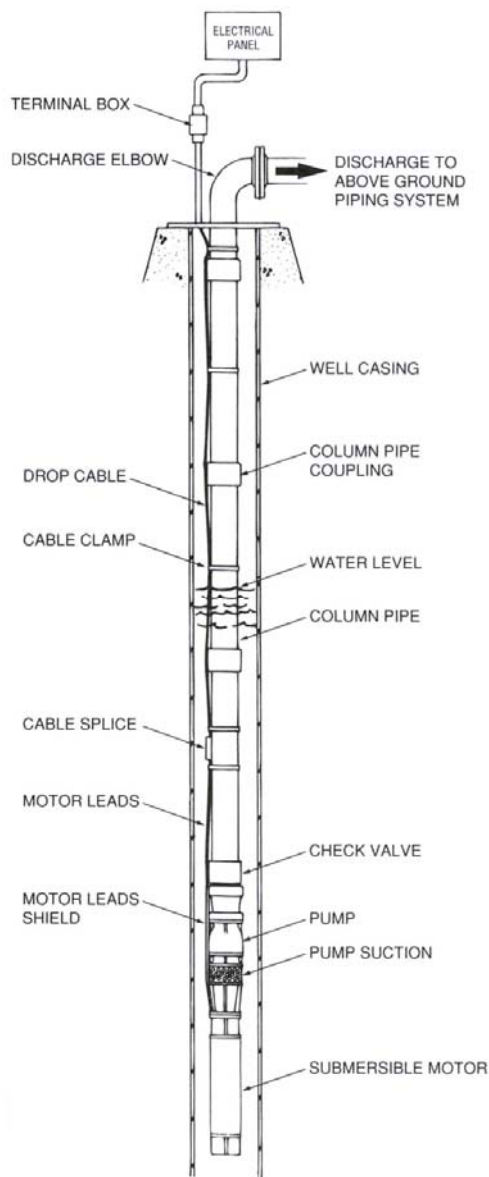
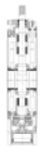


FIGURE 2 – Typical Submersible Pump Installation

DISCHARGE PIPING

Install a valve in the discharge line. This valve is required for regulating flow and/or to isolate the pump for inspection and maintenance.



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, troubleshooting, 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 21. 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. 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



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.

MOTOR SERVICING

Consult the motor manual and perform any pre-installation servicing that is required. H Series motors require filling with water prior to starting. Refilling of the motor can be accomplished by unscrewing the two water fill ports located on the top of the motor. See Figure 3.

All H Series motors feature water cooled and water lubricated bushings and thrust bearings. The pre-filled water acts as a coolant and lubricant for the rotor, brushes and thrust bearing and it dissipates the heat generated whenever electricity is supplied through the windings. The stator is wound with water proof, encapsulated copper winding wire.

PRIOR to installing the motor into service all H Series motors MUST be completely filled with water and topped off. In colder climates and where allowed by local jurisdictions, the water mixture can be mixed with 50% propylene glycol to resist freezing and damage to the motor assembly.

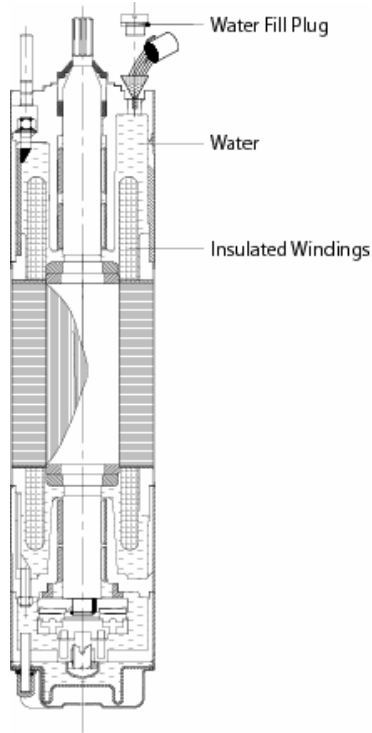
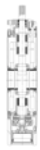


FIGURE 3 – Filling the Motor with Lubricant

SHAFT EXTENSION HEIGHT

To ensure that the motor is in proper working order and that no damage is present to the thrust bearing, the shaft extension height **MUST** be checked prior to coupling the pump to the motor. See Figure 3 for correct measurement.

Motor Diameter	Nominal Shaft Extension	Free Shaft End Play	
		Minimum Inches	Maximum Inches
4" E Series	1.496 to 1.508	0.004	0.008
6" H Series	2.862 to 2.866	0.004	0.008
8" H Series	3.989 to 4.000	0.004	0.008

FIGURE 4 – Shaft Extension Height

ATTACHMENT OF MOTOR TO PUMP

If the pump motor has not already been attached to the pump, attach it per the instructions given in **ASSEMBLY OF PUMP & MOTOR** on page 26. For extra long 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 21.

MOTOR TESTS

Measure the resistance between each motor lead and ground with the motor submerged in water. See **ELECTRICAL TESTS** on page 21.

- Measure the resistance of the motor windings. See Section **ELECTRICAL TESTS** on page 21.
- 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.

! CAUTION

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.

DROP CABLE TEST

- Measure the resistance between the cable conductors and ground with the cable submerged in water. See **ELECTRICAL TESTS** on page 21.

SPLICING 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. The splice should be located above the pump bowl. 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. See Figure 5.

1. Check the motor cable and drop cable carefully for damage.
2. Cut the motor leads in a staggered manner. Cut the ends of the drop cable so that they match up with the motor cable leads. Be sure to match the colors.



3. Strip back and trim off 1 inch of insulation from each lead, making sure to scrape the wire conductor bare to obtain a good connection. Be careful not to damage the copper conductor while stripping off the insulation.
4. Insert a properly sized connector on each lead, making sure that the lead colors are matched. Using crimping pliers, indent the copper lugs. Be sure to apply the proper amount of pressure especially when dealing with larger diameter conductors. When the connector outer diameter is not as large as the cable insulation, build up the difference in diameter with rubber electrical tape up to the diameter of the cable.
5. Wrap the individual joints again with rubber electrical tape using two layers, the first extending two inches beyond each of the conductor insulation ends and the second two inches beyond the end of the first layer. Wrap the insulation tightly eliminating any spaces where possible.
6. Wrap PVC electrical tape over the electrical tape. Using two layers as in step 5 overlap each additional layer 2 inches beyond the previous layer. Total thickness of the tape should not be less than the thickness of the conductor insulation.
7. To finish the cable splicing, combine the individual spliced leads together and tape the joining area with at least two layers of electrical tape. Using two layers as in step 5 overlap each additional layer 2 inches beyond the previous layer. Wrap the insulation tightly eliminating any spaces where possible. Wrap PVC electrical tape over the electrical tape. Using two layers as in step 5 overlap each additional layer 2 inches beyond the previous layer.
8. To check the insulation of the splice, conduct a megger test with 500 volts after submerging the splice in water.

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 21.
- 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 21.

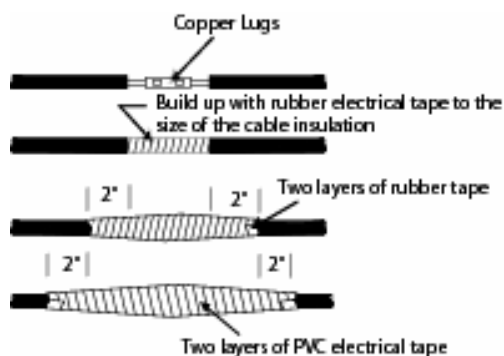
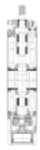


FIGURE 5 – Cable Splicing



INSTALLING THE MOTOR

WARNING

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.

The method of installing the 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 26. 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 24.
- 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).

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.

WARNING

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.

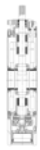
On 3-phase units, check for proper rotation during this test. If the unit kicks clockwise (when viewed from above), the rotation is correct and the wires should be tagged so that they can be reconnected to the same terminals in the panel. If the unit kicks counter clockwise, interchange any two of the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

Install a cable clamp on each side of the cable splice. 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.

CAUTION

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 in the well.

CAUTION

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. The remaining small threaded hole is for connection of a well vent or other accessories. 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 21.
- Measure the resistance of the drop cable and motor circuit. See ELECTRICAL TESTS on page 21. 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.

TRANSFORMER CAPACITY FOR SINGLE/THREE PHASE MOTORS

Transformer capacity shall be selected based on the horsepower of the submersible motor. When the transformer capacity is not of sufficient capacity based on the motor load, reduced voltage and reduced rotational speed is the result. Select the capacity of the transformer based on the following table:

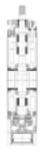
Three Phase Motor		Total KVA Required	Total KVA Rating For Each Transformer	
HP	KW	(Minimum)	2 Transformers Open Wye-Delta or Across The Line	3 Transformers Closed Wye-Delta or Across The Line
1.5	1.1	3.0	2.0	1.0
2.0	1.5	4.0	2.0	1.5
3.0	2.2	5.0	3.0	2.0
5.0	3.7	7.5	5.0	3.0
7.50	5.5	10.0	7.5	5.0
10.0	7.5	15.0	10.0	5.0
15.0	11.0	20.0	15.0	7.5
20.0	15.0	25.0	15.0	10.0
25.0	18.5	30.0	20.0	10.0
30.0	22.0	40.0	25.0	15.0
40.0	30.0	50.0	30.0	20.0
50.0	37.0	60.0	35.0	20.0
60.0	45.0	75.0	40.0	25.0
75.0	56.0	90.0	50.0	30.0
100.0	75.0	120.0	65.0	40.0
125.0	93.0	150.0	85.0	50.0

FIGURE 6 – Details of Transformer Capacity

CONTROL BOXES/STARTER

SINGLE PHASE THREE WIRE MOTORS

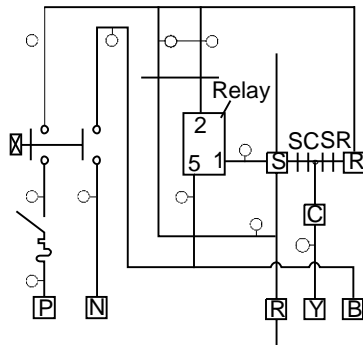
All single phase three wire submersible motors require an external control box. To obtain proper pump



performance it is recommended that the American-Marsh submersible motors be supplied with an American-Marsh single phase control box. Single phase submersible motors MUST be connected per the following wiring diagrams. See Figures 7, 8 & 9.

- SC – Built in Auto Cutoff Start Capacitor
- SR – Run Capacitor
- B – Blue
- R – Red
- Y - Yellow

FIGURE 7 – Wiring Diagram of Control Box for H



Series, Single Phase, 230V, 3-Wire Submersible Motor

- BLU – Blue
- RED – Red
- YEL – Yellow
- BLK - Black
- GRND - Ground

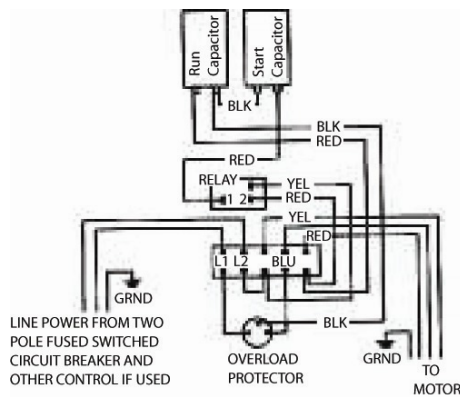
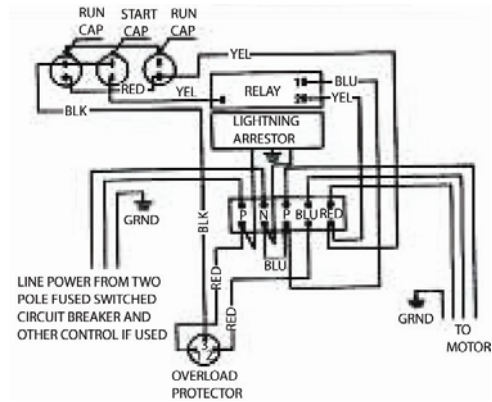


FIGURE 8 – Wiring Diagram of Control Box for E & H Series, Single Phase, 230V, 3-Wire Submersible Motor

- BLU – Blue
- RED – Red
- YEL – Yellow

BLK - Black



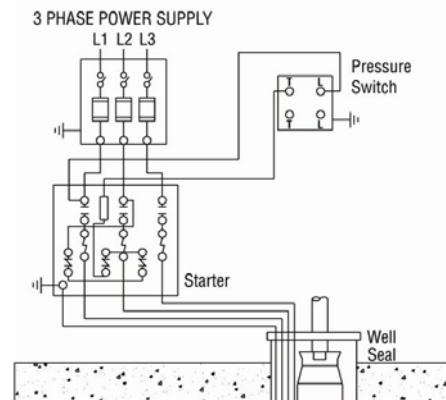
GRND - Ground

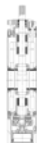
FIGURE 9 – Wiring Diagram of Control Box for E & H Series, 3 HP & 5 HP, Single Phase, 230V, 3-Wire Submersible Motor

THREE PHASE THREE MOTORS

A good quality starter of appropriate size and type should be used to give total electrical protection to the three phase submersible motor against low voltage, high voltage, overload current, phase failure, unbalanced current between phases and dry run. The thermal overload relays used shall trip within 12 seconds at locked rotor current. Connect the starter per Figure 10.

FIGURE 10 – Wiring Diagram of Three Phase Submersible Motor





CAUTION

The control box or starter **MUST** be mounted vertically upright and be protected from rain and direct sunlight. The enclosure **MUST** have good air circulation and be away from high temperature locations as this will decrease the life of the capacitors and also lead to frequent tripping of the overload relays. Also ensure that the control box/starter location is easily accessible for regular inspection and it should be relatively free from dust, fumes and moisture.

CONTROL BOXES/STARTER

Certain models of the 4 inch E Series single phase, resin filled motors up to 2 HP are fitted with integral lightning arrestors. Lightning arrestors are used to give protection to the submersible motor against high voltage surges caused by lightning or other high voltage sources. For all three phase motors and single phase models that do not have an integral lightning arrestor, **MUST** be fitted with an external voltage overload protection device. The lightning arrestors of required voltage should be installed in the power supply line of the control box or starter. These lightning arrestors should be installed by technically qualified personnel, complying with applicable local electrical codes and/or regulations. A typical single phase and three phase wiring diagram is shown in Figure 11.

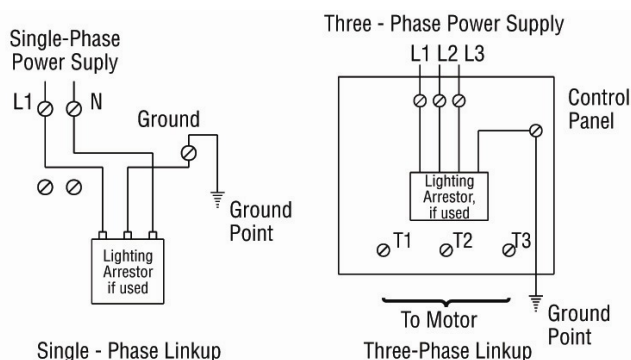


FIGURE 11 – Wiring Diagram of Lightning Arrestor

GROUNDING THE CONTROL BOX/STARTER

It is mandatory that the control box/starter be grounded prior to operation and **MUST** be per local electrical codes and regulations. A bare copper conductor of at least the same gauge of the incoming power line **MUST** be firmly connected to the control box.

Reduce the length of the ground wire as much as possible and connect to a grounding rod, steel well casing, etc.

DANGER

DO NOT use gas supply lines as sources for grounding the control box.

STARTING & SWITCHING FREQUENCY

The life of a submersible motor depends upon the average number of starts per day over a period of months or years. The life of control components such as pressure switches, starters, relays, capacitors and the splines and bearings are also effected by higher than normal start and stop cycling. To dissipate heat build up from starting or inrush current, the motor must be allowed to run for a minimum of 5 minutes. Whenever possible, the motor should be limited to the allowable maximum starts per hour as listed in Figure 12 below.

Motor Series	Motor Diameter	Maximum Starts Per Hour
E – Series	4"	20
H - Series	6"	20
	8"	4

FIGURE 12 – Maximum Starts Per Hour

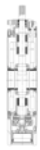
STARTING THE MOTOR

Initial start-up and testing may require starting and

CAUTION

stopping the pump several times. **BE SURE TO ALLOW ADEQUATE COOLING OFF PERIOD BETWEEN STARTS.** See Figure 12 above.

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 21.

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 21. 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 is operating properly, a performance test should be considered. See ROUTINE OPERATION AND MAINTENANCE on page 17. If a performance test is conducted when the pump is new, subsequent tests can be used to determine the degree of wear or deterioration of the pump without removing it from the well.

After the unit has been in operation for approximately one week, perform the routine tests listed in ROUTINE OPERATION AND MAINTENANCE on page 17.

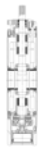
ROUTINE OPERATION AND MAINTENANCE

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.

have been corrected and that a thorough diagnosis has been made indicating that the problem is underground.

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 21.
- 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 21. 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.

TROUBLESHOOTING

If an operational failure occurs, conduct a routine inspection of the unit. In many instances this simple inspection will reveal the cause of the failure. If the cause of the failure is not immediately obvious, the troubleshooting chart below will be helpful.

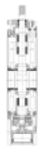
Note that a large portion of the "Probable Causes" are electrical and also that a large portion of these electrical problems are due to above ground equipment. Before going to the time and expense of removing the pump from the well, be sure that all above ground problems



PROBLEM	POSSIBLE CAUSE	RECOMMENDED REMEDY
Problem #1 Pump not reaching design flow rate.	1.1 Insufficient NPSH _A . (Noise may not be present)	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.
	1.2 System head greater than anticipated.	Reduce system head by increasing pipe size and/ than or reducing number of fittings. Increase impeller diameter. NOTE: Increasing impeller diameter may require use of a larger motor.
	1.3 Entrained air. 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.
	1.4 Entrained gas from process.	Process generated gases may require larger pumps.
	1.5 Speed too low.	Check motor speed against design speed.
	1.6 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 it is restarted.
	1.7 Impeller too small.	Replace with proper diameter impeller. NOTE: Increasing impeller diameter may require use of a larger motor.
	1.8 Impeller clearance too large.	Reset impeller clearance.
	1.9 Plugged impeller, suction line or casing which may be due to a product or large solids.	1. Reduce length of fiber when possible. 2. Reduce solids in the process fluid when possible. 3. Consider larger pump.
	1.10 Wet end parts (casing cover, impeller) worn, corroded or missing.	Replace part or parts.
Problem #2.0 Pump not reaching design head (TDH).	2.1 Refer to possible causes under Problem #1.0.	Refer to remedies listed under Problem #1.0 and #3.0.
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.



PROBLEM	POSSIBLE CAUSE	RECOMMENDED REMEDY
Cont. Problem #3.0 No discharge or flow	3.3 Entrained air. Air leak from atmosphere on suction side.	Refer to recommended remedy under Problem #1.0, Item #1.3.
	3.4 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.
	3.5 Damaged pump shaft, impeller.	Replace damaged parts.
Problem #4.0 Pump operates for short period, then stops too often.	4.1 Insufficient NPSH.	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 #1.3.
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. Check and reset impeller clearance. 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	7.1 Incorrect control box.	Replace with correct control box.
	7.2 Incorrect, loose or corroded electrical connections. Damaged submersible electrical cable. Defective capacitors (single phase).	Replace defective item. Refer to ELECTRICAL TESTS.
	7.3 Incorrect voltage.	Correct line voltage.
	7.4 Current overload.	Check for: 1. Tight motor or pump bearing. 2. Pump clogged with sand. 3. Unbalanced voltage. 4. Grounded cable, splice or motor winding. Refer to ELECTRICAL TESTS. 5. Low Voltage. 6. Insufficient cooling of motor.



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 ohm-meter. 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:

Turn off all power and disconnect the leads to be tested from the electrical 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 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 13.

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 14. 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.

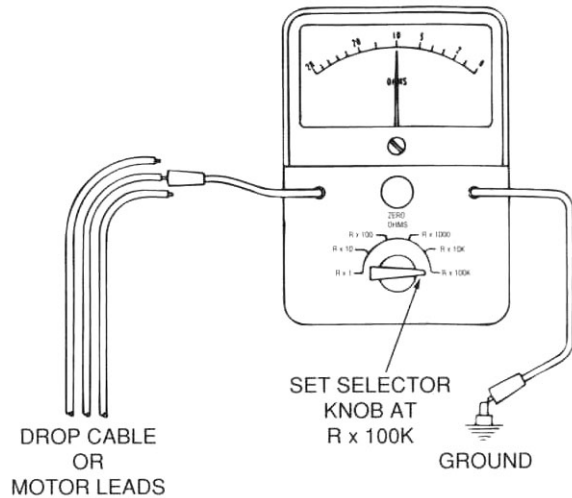
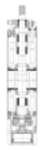


FIGURE 13 – Measuring Insulation Resistance

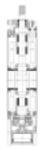


Insulation resistance does not vary with rating. All motors of all HP, voltage, and phase rating have the same insulation resistance ranges.

CONDITION OF MOTORS AND LEADS	OHMS	MEGOHMS	METER READING	
			R x 100K or R x 100,000 scale	R x 10K or R x 10,000 scale
BENCH TESTS				
<ul style="list-style-type: none"> A new motor (without drop cable) 	20,000,000+	20+	200+	2000 + or 2K +
<ul style="list-style-type: none"> A used motor which can be reinstalled in the well 	10,000,000+	10+	100+	1000 + or 1K +
<ul style="list-style-type: none"> Cable splice after immersion for one hour in water 	2,000,000+	2+	20+	200+
WELL TESTS Ohm readings are for drop cable plus motor.				
<ul style="list-style-type: none"> A new motor or used motor in good condition. 	2,000,000 +	2+	20+	200+
<ul style="list-style-type: none"> A motor in reasonably good condition. 	500,000-2,000,000	0.5-2.0	5-20	50-200
<ul style="list-style-type: none"> A motor which may have been damaged by lightning or with damaged leads. Do not pull the pump for this reason. 	20,000-500,000	0.02-0.5	0.2-5	2-50
<ul style="list-style-type: none"> 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. 	10,000-20,000	0.01-0.02	0.1-0.2	1-2
<ul style="list-style-type: none"> A motor which has failed or with completely destroyed cable insulation. The pump must be pulled and the cable repaired or the motor replaced. 	less than 10,000	0-0.01	0-0.1	0-1

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

FIGURE 14 – 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.

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 "Rx 1 ". Clip the meter leads together and adjust the meter to zero.

Unclip the leads and attach them. See Figure 15.

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.

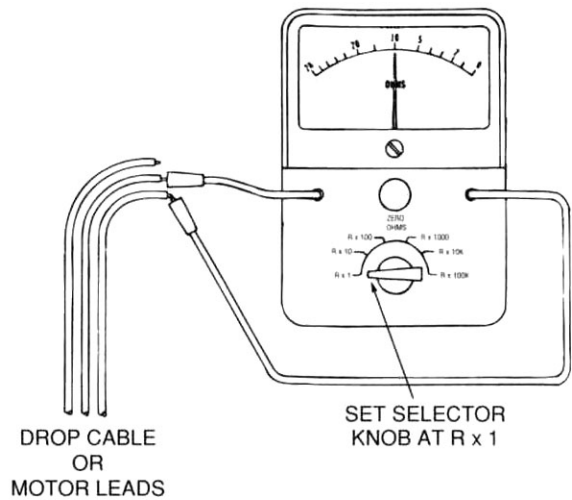
Motor Winding - Resistance -

Reading taken Cable resistance at Drop Cable -from Figure 16.

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).

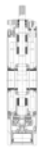
A considerably lower winding resistance than shown in the motor manual indicates a possible shorted (burned together) winding or the wrong motor.

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



- SINGLE PHASE, 2 WIRE - MEASURE BETWEEN TWO WIRES
- SINGLE PHASE, 3 WIRE - MEASURE BETWEEN BLACK AND YELLOW AND THE MEASURE BETWEEN RED AND YELLOW.
- THREE PHASE - MEASURE BETWEEN EACH PAIR, AB, AC,

FIGURE 15 – Measuring Winding Resistance



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.

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 17.

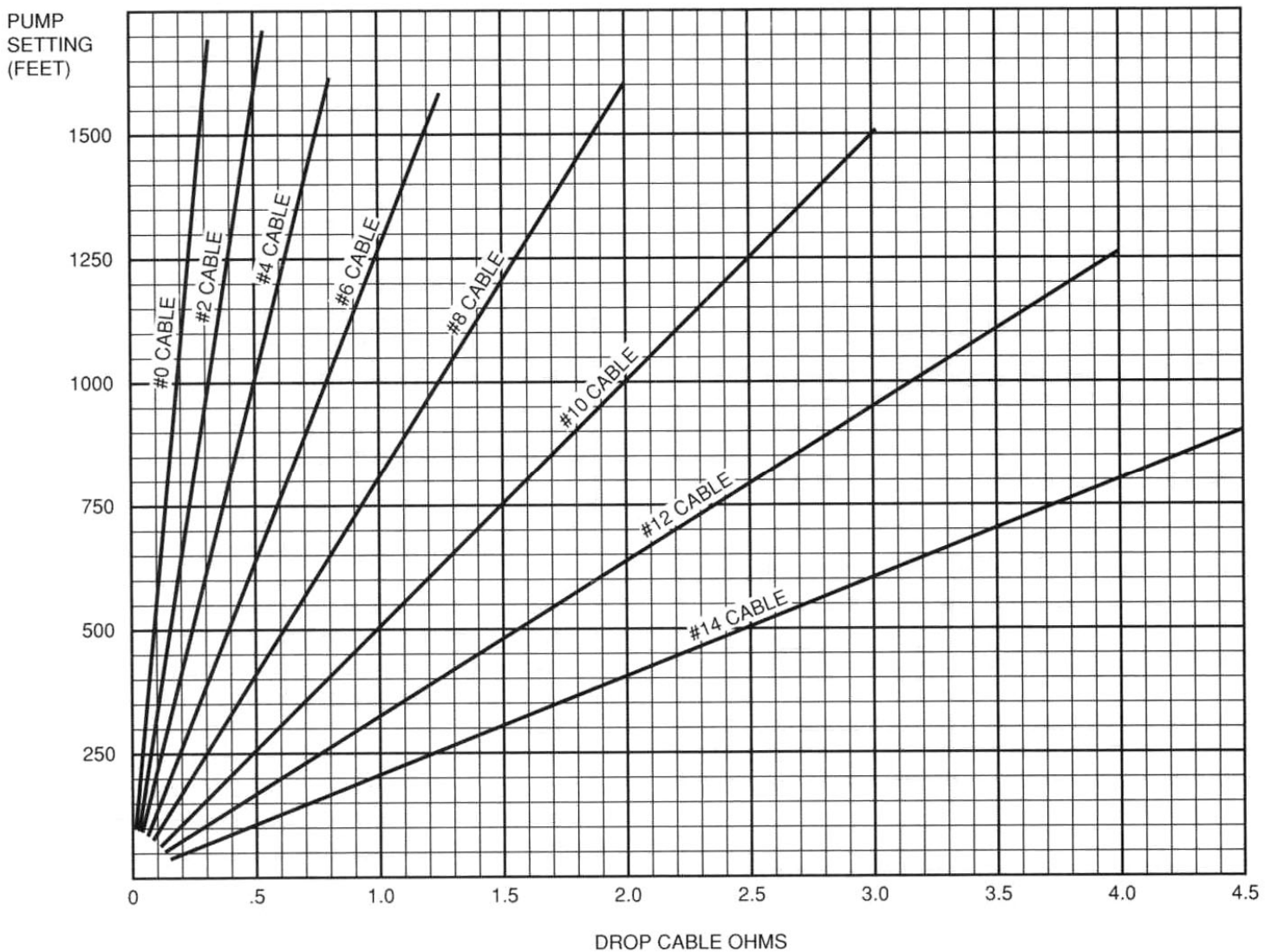
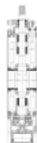
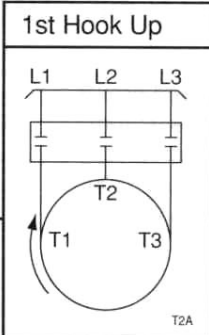
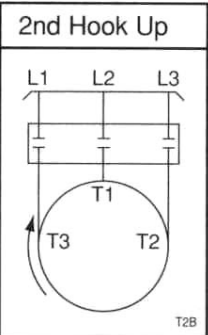
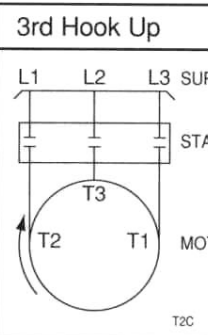


FIGURE 16 – Drop Cable Resistance



$$\text{Percent Current Unbalance} = \frac{\text{max. current difference in any leg from average current}}{\text{average current}} \times 100$$

	Sample Calculation	1st Hook Up 	2nd Hook Up 	3rd Hook Up 
<ul style="list-style-type: none"> Measure current in each leg. Add leg currents to determine total current. Calculate average leg current. 	T1 L1 51 amps T2 L2 46 amps T3 L3 <u>53</u> amps 150 amps ÷ 3 ===== 50 amps	T1 L1 _____ T2 L2 _____ T3 L3 _____ _____ ÷ 3 =====	T3 L1 _____ T1 L2 _____ T2 L3 _____ _____ ÷ 3 =====	T2 L1 _____ T3 L2 _____ T1 L3 _____ _____ ÷ 3 =====
<ul style="list-style-type: none"> Determine max. difference of any one leg from the average. 	51 - 50 = 1 50 - 46 = 4 ← max. 53 - 50 = 3	____ - ____ = ____ ____ - ____ = ____ ____ - ____ = ____	____ - ____ = ____ ____ - ____ = ____ ____ - ____ = ____	____ - ____ = ____ ____ - ____ = ____ ____ - ____ = ____
<ul style="list-style-type: none"> Calculate percent unbalance using formula above. 	$\frac{4}{50} \times 100 = 8\%$	____ x 100 = ____%	____ x 100 = ____%	____ x 100 = ____%

THE MAXIMUM ALLOWABLE UNBALANCE IS 5%.

FIGURE 17 – Load Datasheet

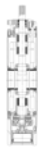
Since loads on a transformer bank may vary during the day, readings should be taken at least twice; once during the day at what would be considered the normal load period and once in the evening during the usual peak load period.

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.

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.

CAUTION

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 at the well site, perform the ELECTRICAL TESTS on page 21 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 18. 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 18 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 21. Ignore this step if the pump was assembled at the well site.

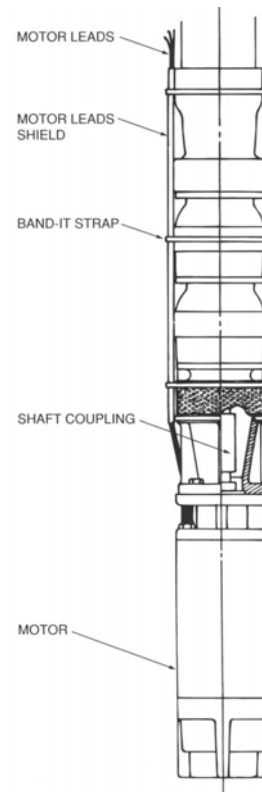
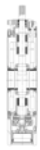


FIGURE 18 – Typical Pump/Motor Assembly



SPARE PARTS

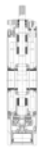
RECOMMENDED SPARE PARTS

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 “American-Marsh Pump Parts Catalog” for more information. Prior to resizing impellers in high chrome iron and nickel, please consult your local American-Marsh sales representative.

HOW TO ORDER SPARE PARTS

Spare parts can be ordered from the local American-Marsh Sales Engineer, or from the American-Marsh Distributor or Representative. The motor size and type can be found on the name plate on the motor housing. See Figure 1. Please provide the item number, description, and alloy for the part(s) to be ordered.

To make parts ordering easy, American-Marsh has created a catalog titled “American-Marsh Pump Parts Catalog.” A copy of this book can be obtained from the local American-Marsh Sales Engineer or Distributor/Representative.



APPENDIX A – ELECTRICAL MOTOR DATA

Electrical Data											Dimension		
Motor				Full-load current [A]	Motor efficiency (%)			Power factor			S.F.	Length [in]	Weight [lbs]
Type	Size	Power [hp]	Power [kw]		50%	75%	100%	50%	75%	100%			
3M4-05-S2	4"	0.50	0.37	5.2	43	52	56	0.44	0.50	0.58	1.15	10	14.99
3M4-07-S2	4"	0.75	0.55	7.1	43	52	58	0.47	0.56	0.62	1.15	11.5	18.07
3M4-10-S2	4"	1.0	0.75	8.6	48	56	62	0.50	0.58	0.64	1.15	12	19.62
3M4-15-S2	4"	1.5	1.1	11.0	54	63	67	0.56	0.60	0.68	1.15	13.6	23.14

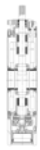
FIGURE 19 – 4 Inch, 3 Wire, 230 Volt, Single Phase, 3450 RPM

Electrical Data											Dimension		
Motor				Full-load current [A]	Motor efficiency (%)			Power factor			S.F.	Length [in]	Weight [lbs]
Type	Size	Power [hp]	Power [kw]		50%	75%	100%	50%	75%	100%			
3M4-05-T2	4"	0.50	0.37	2.5	58	65	69	0.48	0.50	0.56	1.15	8.875	12.12
3M4-07-T2	4"	0.75	0.55	3.4	58	66	69	0.47	0.56	0.62	1.15	9.500	13.88
3M4-10-T2	4"	1.0	0.75	4.2	61	67.5	72	0.50	0.60	0.68	1.15	10.88	16.97
3M4-15-T2	4"	1.5	1.1	5.6	65	71	74	0.50	0.60	0.70	1.15	12.00	19.62
3M4-20-T2	4"	2.0	1.5	7.2	68	74	76	0.54	0.67	0.72	1.15	13.63	23.14
3M4-30-T2	4"	3.0	2.2	10.2	74	77	78	0.58	0.70	0.73	1.15	17.88	35.27
3M4-50-T2	4"	5.0	4.0	1.08	80	80	80	0.68	0.70	0.73	1.15	22.50	46.29
3M4-75-T2	4"	7.5	5.5	24.7	78	81	79	0.64	0.69	0.74	1.15	26.50	57.32

FIGURE 20 – 4 Inch, 3 Wire, 230 Volt, Three Phase, 3450 RPM

Electrical Data											Dimension		
Motor				Full-load current [A]	Motor efficiency (%)			Power factor			S.F.	Length [in]	Weight [lbs]
Type	Size	Power [hp]	Power [kw]		50%	75%	100%	50%	75%	100%			
3M6-75-T2	6"	7.5	5.5	22.6	76	80	81	0.63	0.73	0.79	1.15	21.25	78.26
3M6-100-T2	6"	10.0	7.5	29.7	78	82	83	0.66	0.76	0.80	1.15	22.50	81.57
3M6-150-T2	6"	15.0	11.0	43.5	80	83	83	0.71	0.78	0.80	1.15	24.88	100.31
3M6-200-T2	6"	20.0	15.0	56.8	82	84	85	0.70	0.81	0.83	1.15	27.38	115.74
3M6-250-T2	6"	25.0	18.5	70.0	82	85	85	0.68	0.80	0.82	1.15	29.50	127.86
3M6-300-T2	6"	30.0	22.0	62.0	84	85	86	0.73	0.80	0.82	1.15	32.00	141.09
3M6-400-T2	6"	40.0	30.0	112.2	84	85	85	0.72	0.80	0.83	1.15	37.00	170.85

FIGURE 21 – 6 Inch, 3 Wire, 230 Volt, Three Phase, 3450 RPM



Electrical Data											Dimension		
Motor				Full-load current [A]	Motor efficiency (%)			Power factor			S.F.	Length [in]	Weight [lbs]
Type	Size	Power [hp]	Power [kw]		50%	75%	100%	50%	75%	100%			
3M4-05-T3	4"	0.50	0.37	1.5	58	68	70	0.52	0.6	0.70	1.15	8.88	12.12
3M4-07-T3	4"	0.75	0.55	2.0	58	68	69	0.47	0.59	0.70	1.15	9.50	13.88
3M4-10-T3	4"	1.0	0.75	2.3	61	67	71	0.50	0.63	0.70	1.15	10.88	16.97
3M4-15-T3	4"	1.5	1.1	3.2	65	72	72	0.49	0.62	0.72	1.15	12.00	19.62
3M4-20-T3	4"	2.0	1.5	4.0	68	74	76	0.53	0.67	0.75	1.15	13.50	23.14
3M4-30-T3	4"	3.0	2.2	6.0	71	75	76	0.52	0.64	0.73	1.15	17.88	35.27
3M4-50-T3	4"	5.0	4.0	10.0	78	80	80	0.60	0.74	0.76	1.15	22.50	46.29
3M4-75-T3	4"	7.5	5.5	13.4	80	81	80	0.60	0.74	0.78	1.15	26.50	57.32

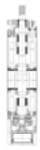
FIGURE 22 – 4 Inch, 3 Wire, 380 Volt, Three Phase, 3450 RPM

Electrical Data											Dimension		
Motor				Full-load current [A]	Motor efficiency (%)			Power factor			S.F.	Length [in]	Weight [lbs]
Type	Size	Power [hp]	Power [kw]		50%	75%	100%	50%	75%	100%			
3M6-75-T3	6"	7.5	5.5	13.2	76	80	81	0.58	0.70	0.78	1.15	21.25	78.26
3M6-100-T3	6"	10.0	7.5	17.0	80	82	82	0.64	0.74	0.82	1.15	22.50	81.57
3M6-150-T3	6"	15.0	11.0	25.0	80	83	83	0.66	0.76	0.80	1.15	24.88	100.31
3M6-200-T3	6"	20.0	15.0	33.0	81	83	84	0.64	0.76	0.82	1.15	27.38	115.74
3M6-250-T3	6"	25.0	18.5	41.0	82	84	84	0.64	0.76	0.82	1.15	29.50	127.86
3M6-300-T3	6"	30.0	22.0	48.0	83	85	85	0.67	0.77	0.82	1.15	31.88	141.09
3M6-400-T3	6"	40.0	30.0	65.0	83	85	85	0.67	0.77	0.82	1.15	37.00	170.85

FIGURE 23 – 6 Inch, 3 Wire, 380 Volt, Three Phase, 3450 RPM

Electrical Data											Dimension		
Motor				Full-load current [A]	Motor efficiency (%)			Power factor			S.F.	Length [in]	Weight [lbs]
Type	Size	Power [hp]	Power [kw]		50%	75%	100%	50%	75%	100%			
3M8-40-T4	8"	40.0	30.0	74.0	82.4	84.6	84.5	0.80	0.86	0.88	1.15	44.88	308.6
3M8-50-T4	8"	50.0	37.0	92.0	83.0	85.2	85.4	0.73	0.81	0.85	1.15	44.88	308.6
3M8-60-T4	8"	60.0	52.0	111.0	83.6	85.7	85.8	0.73	0.81	0.85	1.15	48.25	343.9
3M8-75-T4	8"	75.0	64.0	138.0	84.4	86.5	86.5	0.71	0.80	0.84	1.15	52.75	394.6
3M8-100-T4	8"	100.0	86.0	175.0	86.3	87.8	87.4	0.77	0.85	0.88	1.15	61.44	473.9
3M8-125-T4	8"	125.0	107.0	223.0	88.0	88.6	88.4	0.77	0.83	0.85	1.15	68.50	544.5

FIGURE 24 – 8 Inch, 3 Wire, 380 Volt, Three Phase, 3450 RPM



Electrical Data											Dimension		
Motor				Full-load current [A]	Motor efficiency (%)			Power factor			S.F.	Length [in]	Weight [lbs]
Type	Size	Power [hp]	Power [kw]		50%	75%	100%	50%	75%	100%			
3M4-05-T4	4"	0.50	0.37	0.9	58.0	65.0	69.0	0.51	0.64	0.75	1.15	8.88	12.12
3M4-07-T4	4"	0.75	0.55	1.3	58.5	65.5	69.0	0.47	0.59	0.77	1.15	9.500	13.88
3M4-10-T4	4"	1.0	0.75	2.1	61.5	67.0	71.0	0.50	0.63	0.72	1.15	10.88	16.97
3M4-15-T4	4"	1.5	1.1	3.0	64.5	70.5	73.0	0.49	0.62	0.63	1.15	12.00	19.62
3M4-20-T4	4"	2.0	1.5	3.7	68.0	72.5	75.0	0.54	0.64	0.68	1.15	13.50	23.14
3M4-30-T4	4"	3.0	2.2	5.1	70.0	75.0	76.0	0.52	0.65	0.71	1.15	17.88	35.27
3M4-50-T4	4"	5.0	4.0	8.8	77.1	79.8	80.0	0.60	0.74	0.71	1.15	22.50	46.29
3M4-75-T4	4"	7.5	5.5	11.0	79.5	80.7	81.0	0.60	0.74	0.78	1.15	26.50	57.32
3M4-100-T4	4"	10.0	7.5	15.9	78.5	80.7	81.0	0.56	0.69	0.73	1.15	30.50	68.34

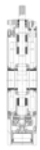
FIGURE 25 – 4 Inch, 3 Wire, 460 Volt, Three Phase, 3450 RPM

Electrical Data											Dimension		
Motor				Full-load current [A]	Motor efficiency (%)			Power factor			S.F.	Length [in]	Weight [lbs]
Type	Size	Power [hp]	Power [kw]		50%	75%	100%	50%	75%	100%			
3M6-75-T4	6"	7.5	5.5	11.7	76.0	79.5	81.0	0.56	0.68	0.73	1.15	21.25	78.26
3M6-100-T4	6"	10.0	7.5	15.6	78.0	79.0	81.0	0.61	0.73	0.75	1.15	22.50	81.57
3M6-150-T4	6"	15.0	11.0	22.0	79.5	82.5	83.0	0.66	0.76	0.76	1.15	24.88	100.31
3M6-200-T4	6"	20.0	15.0	28.8	81.0	83.5	84.0	0.64	0.75	0.78	1.15	27.38	115.74
3M6-250-T4	6"	25.0	18.5	36.0	81.0	84.0	84.0	0.62	0.73	0.77	1.15	29.50	127.88
3M6-300-T4	6"	30.0	22.0	41.8	82.0	85.0	85.0	0.67	0.78	0.78	1.15	32.00	141.09
3M6-400-T4	6"	40.0	30.0	56.5	82.0	84.0	85.0	0.66	0.76	0.78	1.15	37.00	170.85
3M6-500-T4	6"	50.0	37.0	67.5	82.0	84.0	85.0	0.63	0.75	0.81	1.15	51.44	235.89

FIGURE 26 – 6 Inch, 3 Wire, 460 Volt, Three Phase, 3450 RPM

Electrical Data											Dimension		
Motor				Full-load current [A]	Motor efficiency (%)			Power factor			S.F.	Length [in]	Weight [lbs]
Type	Size	Power [hp]	Power [kw]		50%	75%	100%	50%	75%	100%			
3M8-40-T4	8"	40.0	30.0	61.0	81.5	83.6	83.5	0.82	0.86	0.89	1.15	44.88	308.6
3M8-50-T4	8"	50.0	37.0	75.0	83.8	85.3	84.8	0.77	0.84	0.87	1.15	44.88	308.6
3M8-60-T4	8"	60.0	52.0	89.0	85.0	85.0	86.6	0.77	0.84	0.87	1.15	48.25	343.9
3M8-75-T4	8"	75.0	64.0	109.0	85.8	87.1	86.7	0.76	0.83	0.87	1.15	52.75	394.6
3M8-100-T4	8"	100.0	86.0	145.0	86.3	87.8	87.4	0.77	0.84	0.87	1.15	61.44	473.9
3M8-125-T4	8"	125.0	107.0	180.0	86.7	88.3	88.3	0.75	0.83	0.87	1.15	68.50	544.5

FIGURE 27 – 8 Inch, 3 Wire, 460 Volt, Three Phase, 3450 RPM



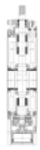
APPENDIX B – CABLE SELECTION TABLES

Motor Rating		Cable Size in American Wire Gauge														
Volts	HP	14	12	10	8	6	4	3	2	1	0	00	000	0000	Maximum Length In Feet	
230V 60 HZ 3 Phase	0.50	919	1480	2349	3691	5748	8900									
	0.75	659	1070	1690	2569	4180	6480	8052	9850							
	1.00	551	899	1421	2251	3511	5450	6769	8281							
	1.50	410	659	1050	1660	2599	4039	5020	6149	7520	9161					
	2.00	308	499	801	1270	2001	3120	3878	4757	5850	7159	8770				
	3.00	230	381	610	981	1529	2389	2969	3648	4469	5460	6680				
	5.00	131	220	361	581	909	1421	1782	2179	2681	3281	4019				
	7.50			249	410	640	1012	1260	1549	1910	2330	2861	3429			
	10.00			180	299	479	751	938	1161	1431	1749	2149	2599			
	15.00				200	322	509	640	791	971	1191	1460	1772	2139		
	20.00				151	240	390	489	597	751	919	1129	1371	1670		
	25.00						308	390	489	597	738	909	1109	1348		
	30.00						249	322	400	499	610	751	919	1119		

FIGURE 28 – Cable Selection Table, 230V, 60 Hz., 3 Phase Submersible Motors

Motor Rating		Cable Size in American Wire Gauge														
Volts	HP	14	12	10	8	6	4	3	2	1	0	00	000	0000	Maximum Length In Feet	
380V 60 HZ 3 Phase	0.50	2680	4280	6721												
	0.75	1992	3182	5001	7850											
	1.00	1610	2572	4051	6380	9970										
	1.50	1220	1960	3091	4881	7620										
	2.00	862	1381	2172	3441	5391	8370									
	3.00	671	101	1700	2671	4191	6490	8011	9821							
	5.00	392	632	1000	1580	2480	3860	4771	5861	7220	8820					
	7.50	263	432	681	1080	1700	2630	3251	3991	4920	6000	7280				
	10.00	190	311	501	790	1240	1920	2370	2900	3561	4320	5220	6252	7380		
	15.00			361	581	910	1420	1760	2180	3682	3281	3992	4832	5760		
	20.00				431	692	1080	1342	1660	2052	2522	3082	3752	4490		
	25.00				350	562	870	1091	1340	1662	2040	2500	3030	3632		
	30.00					460	720	901	1110	1370	1691	2072	2512	3012		
	40.00						520	650	810	1000	1231	1513	1832	2192		
	50.00							530	652	810	991	1212	1472	1760		
	60.00								552	680	841	1020	1240	1500		
	75.00									560	692	850	1050	1260		
	100.00											620	752	850		
125.00												612	732			
150.00													610			

FIGURE 29 – Cable Selection Table, 380V, 60 Hz., 3 Phase Submersible Motors



Motor Rating		Cable Size in American Wire Gauge														
Volts	HP	14	12	10	8	6	4	3	2	1	0	00	000	0000	Maximum Length In Feet	
460V 60 HZ 3 Phase	0.50	3760	6011	9449												
	0.75	2720	4341	6841												
	1.00	2287	3662	5761	9059											
	1.50	1690	2700	4259	6719											
	2.00	1289	2060	3261	5141	8038										
	3.00	991	1591	2510	3960	6191										
	5.00	581	938	1490	2349	3691	5738									
	7.50	410	669	1060	1680	2628	4091	5089	6250	7670						
	10.00	299	489	781	1240	1949	3041	3790	4669	5739	7040					
	15.00		331	532	840	1329	2080	2589	3189	3921	4799	5890	7100			
	20.00			400	640	1020	1601	1992	2461	3028	3721	4569	5530			
	25.00				518	820	1289	1608	1978	2441	2999	3691	4460	5430		
	30.00				420	669	1060	1319	1631	2021	2480	3050	3692	4992		
	40.00					489	781	971	1201	1480	1821	2250	2702	3192		
	50.00						630	787	971	1201	1470	1800	2180	2640		
	60.00							532	659	820	1011	1240	1532	1840		2230
	75.00									669	830	1020	1250	1512	1840	
100.00										610	751	932	1120	1380		
125.00												732	882	992		

FIGURE 30 – Cable Selection Table, 460V, 60 Hz., 3 Phase Submersible Motors

Motor Rating		Cable Size in American Wire Gauge														
Volts	HP	14	12	10	8	6	4	3	2	1	0	00	000	0000	Maximum Length In Feet	
575V 60 HZ 3 Phase	0.50	5889	9400													
	0.75	4259	6801													
	1.00	3619	5791	9111												
	1.50	2608	4170	6569												
	2.00	2021	3235	5099	8052											
	3.00	1572	2520	3967	6260											
	5.00	909	1470	2320	3671	5742										
	7.50	650	1050	1670	2630	4141										
	10.00	479	771	1230	1939	3051	4761	5930								
	15.00	322	518	840	1329	2080	3251	4049								
	20.00		400	640	1020	1601	2510	3130	3849	4750	5820					
	25.00			509	820	1289	2021	2520	3101	3830	4700					
	30.00			420	669	1060	1660	2070	2549	3150	3870	4761	5770	7021		
	40.00				489	781	1230	1529	1890	2320	2851	3500	4222	5132		
	50.00					630	991	1240	1529	1880	2300	2832	3412	4132		
	60.00						840	1050	1289	1591	1949	2389	2880	3490		
	75.00							679	850	1050	1299	1591	1959	2369	2880	
100.00									781	961	1181	1450	1759	2140		
125.00										761	938	1148	1391	1682		

FIGURE 31 – Cable Selection Table, 575V, 60 Hz., 3 Phase Submersible Motors