PUMPS UNLIMITED

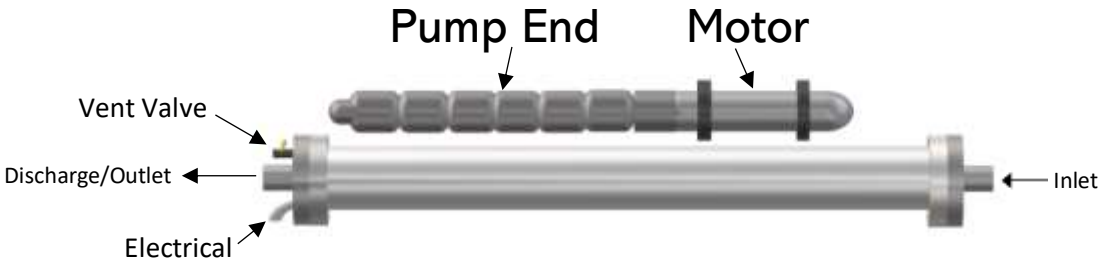
INSTALLATION & OPERATING INSTRUCTIONS

TORPEDO PUMP

with 6", 8" and 10" Motors

(HIGH PRESSURE Reverse Osmosis FEED PUMP)

PUMPS UNLIMITED is pleased to supply the TORPEDO PUMP for your Reverse Osmosis (feed pump) requirements. The pump is shipped to you, complete, and ready for installation. No disassembly, shaft/coupling alignment, or other adjustments are required. Mount the TORPEDO PUMP on your system, connect the water inlet and discharge, and hook up the power wiring. The motor is the heaviest part of the assembly and is located toward the INLET END of the TORPEDO PUMP. The DISCHARGE END is distinguished by the entrance of the wire/cables and the VENT VALVE.



Installation

Mechanical

The TORPEDO PUMP can be installed either horizontally or vertically. Most TORPEDO PUMPS have been installed horizontally. Support the TORPEDO PUMP in pipe saddles, off hangers, in membrane racks, or on any structure strong enough to hold the weight of the operating pump.

When the pump starts, a high thrust is exerted toward the suction (inlet) end of the pump. Ensure the pump is securely braced or secured for this thrust load. The TORPEDO PUMP is a "turbine pump" and, as such, has high thrust and high torque values. If the pump is being used in "parallel" with other pumps, an external check valve MUST be installed on the discharge side of the TORPEDO PUMP.

Mount the unit so that the small "vent valve" on the discharge endplate is at the top of the endplate (12 o'clock position). Incline the pump assembly slightly (the discharge end should be approximately 2 inches higher than the suction end) to allow any air entrapped in the containment vessel to move toward the vent valve. For vertical installations, mount the TORPEDO PUMP with the suction (inlet) end down. We recommend that the discharge end of the TORPEDO PUMP be approximately 1" to 2" higher than the inlet end to allow trapped air to move to the vent valve and away from the motor end of the pump.

ELECTRICAL

IMPORTANT NOTE - The TORPEDO PUMP will work very well with a VARIABLE FREQUENCY DRIVE and/or a "SOFT-START" electric motor starter.

A "SOFT-START" is a solid-state device that allows the pump motor to start up at a lower speed, then accelerate to full speed over an adjustable period. IF YOU ARE USING A SOFT-START ... BE SURE TO SET THE STARTER TO BEGIN THE "RAMP UP" AT 50% OF RATED FULL SPEED AND TO ACCELERATE THE MOTOR TO 100% IN ABOUT 3 SECONDS.

A Variable Frequency Drive is a solid-state device that allows the speed of the pump to be varied during operation. The VFD usually contains a "soft start" feature. IF YOU ARE USING A Variable Frequency Drive ... BE SURE TO SET THE VFD TO BEGIN THE "RAMP UP" AT 50% OF RATED FULL-SPEED, AND TO ACCELERATE THE MOTOR TO THE DESIRED SPEED WITHIN 3 SECONDS. AFTER ACCELERATION "RAMP UP" MODE IS COMPLETED, REGULATE THE PUMP'S SPEED WITHIN THE UPPER 30% OF RATED MOTOR SPEED (e.g., 2500 to 3600 RPM in the case of 3600 RPM motors).

NOTE: DO NOT USE "MOTOR SAVER" DEVICES WITH VFDs. SymCom "Motor Savers" and other monitoring devices will not work correctly in conjunction with Variable Frequency Drives. The VFD creates a false reading that the "Motor Saver" will interpret as "overload." Please refer to page 4 of this manual for further explanation. "Motor Saver" should work well with "Soft Starts."

Either device can be used to reduce mechanical shock to equipment and reduce water surges and hammer on startup

The power wiring extending from the discharge end plate is connected to the motor via a watertight connector. A watertight bulkhead fitting (conduit sealing bushing) has been installed to prevent water from passing out of the electrical conduit. Cut the power leads to suit your installation or extend via a J-Box to your disconnect switch or motor starter. If you are installing an SYMCOM "MOTOR SAVER" (solid state motor protector), refer to the instructions packaged with that unit. It is very important that you use Class 10 "quick trip" overload heaters in your starter wiring circuit. Refer to the motor manual for ratings of fuses, circuit breakers, and overload heaters.

PRE-INSTALLATION

1) Maximum water temperature:

   A) 350C (950F): 6" (5~40HP) motors

   B) 250C (770F): 6" (50,6OHP), 8", 10", 12" and 14" motors

2) Maximum chlorine content: 500 PPM

   Maximum Sulfuric acid iron content: 15 PPM

   Maximum Fluorine content: 0.8 PPM

   Maximum Electric conductivity: µ118 MHO/INCH

3) Proper approved three-phase overload protection. See Table A.

4) Proper fusing for motor circuit protection.

5) Proper line voltage during running conditions:

   460V +/-10%, i.e., 506 to 414 volts

   230V +/-10%, i.e., 253 to 207 volts at the 60-cycle system at the motor lead wire terminal. (User should consider voltage drop of cable.)

   Combination of voltage and frequency variation: 110% (sum of absolute values of voltage and frequency)

   Phase unbalance: 5% (3 phase)

6) Proper sizing of motor (current, thrust, voltage, etc.).

7) In the case of horizontal installation, the pump is to be firmly mounted to prevent any load on the shaft and bearings and to avoid damaging vibrations to the motor.

8) The motor must always be immersed in water so that the flow velocity of cooling water at a rate of 0.5 feet per second flows past any parts of the motor.

9) For 3k motors, a balanced and properly sized transformer bank shall be provided. Improper electrical supply (e.g., phase converter, V-connection transformer, etc.) or connections will void the warranty.

10) Single-phase protection is recommended for the protection of the installation. Any failure due to the single phasing of the incoming voltage causing the motor to fail will void the warranty.

11) In the event that a reduced voltage starter is used to start the motor, the following should be verified:
    A. Correct quick trip ambient compensated overloads are incorporated.
    B. Proper short circuit protection is utilized.
    C. The torque required by the motor and pump package is attainable by this type starter.
    D. The lead arrangement of the motor is acceptable with the proposed starter load connections.
    E. Verify that if any time delay relays are used in switching contractors in and out, that the time settings are not too long, as this could damage the motor. Begin the "ramp up" at 50% of rated full speed and accelerate the motor to the desired speed within 3 seconds. After the acceleration "ramp up" mode is completed, regulate the pump's speed within the upper 30% of the rated motor speed (e.g., 2500 to 3600 rpm in the case of 3600 rpm motors).
    F. If a manual auto transformer starter is used, don't wait too long to go into the "Run." condition, and don't "tease" the contacts. Double-check Table A for correct protection.

START-UP

Inspect the pump nameplate to determine that it is the correct H.P., voltage, and size for the job and that there is no shipping damage.

Open the water (inlet-low pressure) valve to the pump. Crack the vent valve and allow the air to completely purge from the containment vessel. When water starts coming out of the vent valve, close the vent valve. Do not allow water to "flush" through the Torpedo Pump at high velocity while the motor is not energized. This "flushing" causes the pump's internals to rotate like a water turbine and results in impeller "up-thrust" and damage to rotating parts. Prior to energizing the motor or after motor shutdown, all "flushing "of the pump should be limited to low velocity and for a minimum period of time, perhaps 30 seconds or less.

NOTE: IT IS IMPORTANT THAT THE VENT VALVE BE CRACKED OPEN OCCASIONALLY, WHILE THE PUMP IS RUNNING, TO ASSURE THAT ANY TRAPPED AIR BUBBLES ARE VENTED FROM THE CONTAINMENT VESSEL.

Open the discharge valve (pump outlet to high pressure). Start the pump. The pressure and amperage should come up immediately. If the pressure does not come up to the expected value, the rotation of the motor is probably wrong. If this is the case, change the rotation and restart the pump. Observe the running amperes and ensure the reading does not exceed the "max. full load amps" stamped on the nameplate (the nameplate is located on the discharge end plate.)

Place an "Amprobe" (portable ammeter) on one of the power cables. Start the pump. The pressure and amperage should come up immediately. If the pressure does not come up to the expected value, the "rotation" of the motor is probably wrong. If this is the case, change the rotation and restart the pump. Observe the running amperes and make sure that the reading does not exceed the "max. full load amps" stamped on the nameplate (the nameplate is located on the discharge endplate).

ONGOING MAINTENANCE

THERE IS NO REQUIRED MAINTENANCE WITH THE TORPEDO PUMP. It is advisable to crack open the vent valve occasionally to purge any trapped air from the containment vessel.

- The "critical" component of our T-PUMP is the motor. Your TORPEDO PUMP utilizes a stainless-steel submersible motor, and PUMPS UNLIMITED stocks, the frequently ordered sizes.
- About the only thing that will cause a problem for the motor on a typical R.O. system is lack of water flow. The motor is water-cooled, and this is one of the added benefits of using the TORPEDO PUMP. Rejected motor heat preheats the R.O. feed water, raising the membrane efficiency. We design the clearances within the TORPEDO PUMP enclosure to obtain the correct water velocity as it crosses the motor casing.

SUGGESTIONS

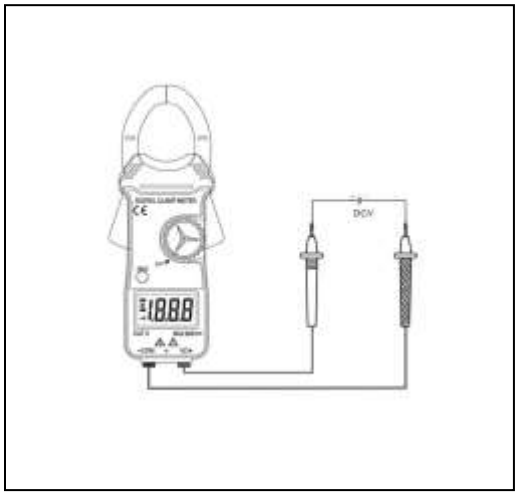
Install a flow switch on the water inlet (low pressure) side. This flow switch will shut down the pump in no-flow condition. In order to start the pump, the switch will have to be wired in parallel with a pressure switch and time delay relay. In other words, the pump will start if sufficient pressure is available on the suction side. The time delay relay will take the pressure switch out of the control circuit after a few seconds, and the pump will continue to run as long as there is adequate flow.

Install an SYMCOM "MOTOR SAVER" unit in the control panel. The "MOTOR SAVER" is a solid-state motor monitoring device. All motors supplied on our TORPEDO PUMPS are equipped for this type of monitoring. This device mounts within the control panel and receives signals transmitted back up the power cables. It monitors amperage readings and provides automatic shutdown for the motor.

NOTE: DO NOT USE "MOTOR SAVER" WITH VFDs. SymCom "Motor Savers" and other motor-monitoring devices will not work correctly in conjunction with Variable Frequency Drives, as described previously in this manual. The VFD creates a false reading that the "Motor Saver" will interpret as "overload."

TROUBLESHOOTING

SUPPLY VOLTAGE



TO MEASURE: By means of a voltmeter, which has been set to the proper scale, measure the voltage at the control box or starter between the legs (phases).

When the motor is under load, the voltage should be within + 10% of the nameplate voltage. Larger voltage variations may cause winding damage. Large variations in the voltage indicate a poor electrical supply, and the pump should not be operated until these variations have been corrected. If the voltage constantly remains high or low, the motor should be changed to the correct supply voltage.

CURRENT MEASUREMENT

By use of an ammeter set on the proper scale, measure the current on each power lead at the control box or starter. See Electrical Data, Table B, for motor amp draw information. Current should be measured when the pump is operating at a constant discharge pressure with the motor fully loaded.

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

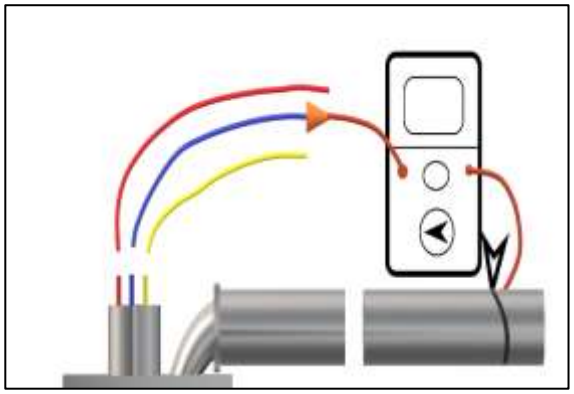
1. Burnt contacts on the motor starter.
2. Loose terminals in the starter or control box or possible cable defect. Check winding and insulation resistances.
3. Supply voltage too high or low.
4. Motor windings are shorted.
5. Pump is damaged, causing a motor overload.

WINDING RESISTANCE

TO MEASURE: Turn off the power and disconnect the drop cable leads in the control box or starter. Using an ohmmeter, set the scale selectors to Rx1 for values under 10 ohms and Rx10 for values over 10 ohms. Zero-adjust the meter and measure the resistance between leads. Record the values. Motor resistance values can be found in Electrical Data, Table B.

If all the ohm values are normal, the cable colors are correct, and the windings are not damaged. If any single ohm value is less than normal, the motor may be shorted. If any single ohm value is greater than normal, there is a poor cable connection or joint. The windings or cable may also be open. If some of the ohm values are greater than normal and some less, the drop cable leads are mixed.

INSULATION RESISTANCE



TO MEASURE: Turn off the power and disconnect the drop cable leads in the control box or starter. Using an ohm or mega ohmmeter, set the scale selector to Rx100K and zero-adjust the meter. Measure the resistance between the lead and ground (discharge pipe or well casing, if steel).

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

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

PRE-START UP

1. Pump emitting "metal to metal" sounds during flushing.

    A. Care must be taken to minimize flushing in water quantity, pressure, and duration. When the Torpedo Pump is flushed without the motor running, it wants to run like a water turbine and upthrusts the impeller stack (drives impellers upwards in the wrong direction towards the discharge end of the pump); This causes the impellers to rub on the diffusers, making a grinding sound; This will damage the TORPEDO PUMP over time.

    Keep flushing to a minimum. Never flush with high-pressure water or at high flow rates.

2. Water is leaking out of the electrical conduit.

    A. Where the wires (motor leads) exit the TORPEDO PUMP, there is a compression-type conduit sealing bushing, “CSB”. This sealing device has three Allen head cap screws that are visible when you look up into the 45N elbow on the discharge end plate (conduit connection). Tighten these three cap screws to stop any water leakage past the sealing conduit bushing. Tighten all cap screws evenly. The conduit sealing bushing only "sees" pump inlet pressure.

DURING START-UP

1. Pump does not start.

    A. Check for power on all three legs.
    B. Check motor overload heaters for trip/reset.
    C. If the motor has a "MotorSaver," bypass it in the control circuit ("jumper" the contacts). Set up and tune in the MotorSaver after the TORPEDO PUMP has been in operation. Adjust the MotorSaver according to the separate instructions included with it and while the TORPEDO PUMP is running. When you are satisfied with the setup on the MotorSaver, remove the "jumpers" on the MotorSaver control contacts

2. Low Pump Performance After Start-Up.

    A. Check for correct rotation. The TORPEDO PUMP works very well when turning in the correct rotation; and very poorly when running backward.
    B. If desired pressure is not achieved and rotation is correct, check for open valves in the system. Low discharge pressure means high flow, and water may be flowing to the drain, etc.
    C. Recheck amperage. The TORPEDO PUMP has a relatively "flat" power curve and should be pulling close to full load amps throughout its flow range.

After Start-Up

1. Pump is making a "growling" or "screeching" noise during operation.
   A. Unusual high-pitched or screeching sounds usually come from the pump end section of the TORPEDO PUMP and indicate the "metal to metal" contact of impellers and diffusers.
   B. Low-pitched growling sounds are usually an indication of motor problems. The sensitive portion of the motor is the thrust bearing. This Kingsbury shoe-type bearing is located at the base of the motor and is water-cooled, and product lubricated. If this bearing overheats (due to lack of cooling water flow), it will be damaged. When the thrust bearing in the motor ultimately fails, it will collapse, making "metal-to-metal" contact. When it collapses, the impeller stack in the pump end section also collapses (drops) and will make the high-pitched "metal to metal" noise previously described.

2. Amperage rises over time while the pump maintains the same flow rate and pressure.
   A. The TORPEDO PUMP is constructed with two major rotating components, the pump end and the motor. If the amperage is increasing over time, the problem could be in either or both components. The pump end has rubber elastomers used as seal rings (wear rings) within the impeller stages. If these NBR (Nitrile Butyl Rubber) rings and bearings are exposed to hydrocarbons and/or caustic solutions, they may swell up, causing extra resistance to the rotating parts of the pump end.
   B. Have the water analyzed. Look for chemical introduction that would have a swelling effect on NBR.
   C. Rising amperage could also be a result of the deterioration of the bearings in the motor. Consult with Pumps Unlimited on matters of rising amperage.

3. Pump is Vibrating.
   A. The TORPEDO PUMP is a turbine pump, and it does not have any non-offset radial thrust loads. Water is discharged equally around the circumference of the impellers, and the impellers operate on an equalized "water-bearing." There should be no vibration associated with the TORPEDO PUMP.
   B. Check for phase imbalance. Amperage on all three power legs should be within 5% maximum. Phase imbalance is the primary cause of pump vibration.

4. Pump emits a loud slamming or thumping sound on start-up. Piping systems are shaking on pump start-up.

A. The TORPEDO PUMP delivers water under pressure instantly upon start-up. Unlike a single stage centrifugal pump, a multi-stage pump has a fast ramp-up.
B. Brace pump adequately for high thrust/high torque start-up loads.
C. Install a "soft start" motor starter (either solid state or reduced voltage mag starter). Remember to accelerate the motor to full speed in 3 seconds (see Operating and Maintenance Manual for discussion on soft starts and variable speed drives).
D. Eliminate "flushing" prior to start-up as much as possible.
E. When the pump is flushed without the motor running, the impeller stack is forced upwards towards the discharge end of the pump. When the motor is energized and the pump starts to rotate, the impeller stack comes crashing down to bear on the motor shaft, causing a loud "thumping" sound.

5. Pump Stops Working.

A. Motor won't start, breakers pop. Usually a motor problem. Remove leads from the motor starter; using a megger (megohm meter), check the resistance of each lead to the ground. The motor is defective if readings are less than ten megohms or are dead short to the ground.
B. Motor runs at reduced amperage, and the pump does not increase water pressure.
C. A broken component in the drive train could be a broken pump shaft, coupling, or keyway component.

Table A: SELECTION TABLE OF OVERLOAD RELAY OR HEATER

4 Inch Three Wire, Three Phase Motors

HP	Volt	Service Factor	Amperage			Full Load		Line to Line Resistance (Ohms)	KVA Code	Overload	
			Full Load	Lock Rotor	S.F. Amps	Eff.	Power Factor			Starter Size	Fumas Amb Comp
1.5	230	1.3	5.0	32.0	6.3	70.0	80.6	3.9	K	0	K41
	460	1.3	2.5	16.0	3.2	70.0	80.6	15.9	K	0	K32
	575	1.3	2.0	12.6	2.5	70.0	80.6	25.2	K	0	K28
2	230	1.25	6.0	12.8	7.5	73.0	86.8	3.0	J	0	K50
	460	1.25	3.0	19.0	3.8	73.0	86.8	12.1	J	0	K34
	575	1.25	2.4	15.2	3.0	73.0	86.8	18.8	J	0	K31
3	230	1.15	9.6	51.0	11.2	68.5	83.8	2.2	H	0	K54
	460	1.15	4.8	25.5	5.6	68.5	83.8	9.0	H	0	K37
	575	1.15	3.8	20.4	4.5	68.5	83.8	13.0	H	0	K36
5	230	1.15	15.2	89	17.8	71.9	80.0	1.2	H	1	K61
	460	1.15	7.6	45	8.9	71.9	80.0	5.0	H	0	K50
	575	1.15	6.1	35	7.1	71.9	80.0	7.3	H	0	K43

6 Inch Three Wire, Three Phase Motors

75	230 460	1.15 1.15	23.3 11.0	120 55	26.5 12.8	74.0 75.0	80.5 84.0	0.55 2.25	H G	1 1	K67 K56
10	230 460	1.15 1.15	30.0 14.8	150 70	34.5 17.0	74.9 75.0	85.0 86.2	0.41 1.70	G F	1.75 1	K70 K60
15	230 460	1.15 1.15	44.4 21.2	225 102	51 25	76.0 75.8	83.7 86.5	0.25 1.16	G F	2.5 1.75	K76 K67
20	230 460	1.15 1.15	56.1 28.0	290 145	66 83	78.0 77.5	87.8 87.0	0.20 0.78	G G	3 2	K79 K68
25	460	1.15	33.6	175	40	79	87.1	0.64	F	2	K73
30	460	1.15	40.8	220	48	78.8	88	0.52	G	2.5	K76

8 Inch Three Wire, Three Phase Motors

HP	Volt	Service Factor	Amperage			Full Load		Line to Line Resistance (Ohms)	KVA Code	Overload			
			Full Load	Lock Rotor	S.F. Amps	Eff.	Power Factor			Starter Size	Fumas Amb Comp	Starter Size	Allen Bradley Heater Code
40	460	1.15	54.3	380	60.9	83.9	82.1	0.37	J	3	K78	3	J46
50	460	1.15	64.9	435	73.6	84.1	85.7	0.33	H	3.5	K85	4	J71
60	460	1.15	77.8	510	88.5	84.7	85.3	0.28	H	3.5	K87	4	J74
75	460	1.15	96.7	650	110	84.9	85.9	0.22	H	4	K94	5	J13
100	460	1.15	127	795	145	85.2	86.6	0.16	H	4.5	K29	5	J16
125	460	1.15	172	980	192	84.2	80.9	0.14	G	4.5	K32	5	J18
150	460	1.15	187	1060	216	85.6	87.9	0.13	G	5	K33	5	J19

10 Inch Three Wire, Three Phase Motors

175	460	1.15	206	1030	240	86.4	92	0.121	E	5	K24	6	J10
200	460	1.15	233.3	1260	270	87.2	92.2	0.09	F	5	K29	6	J11
250	460	1.15	1500	1500	344	86.5	92.1	0.08	E	/	/	6	J14

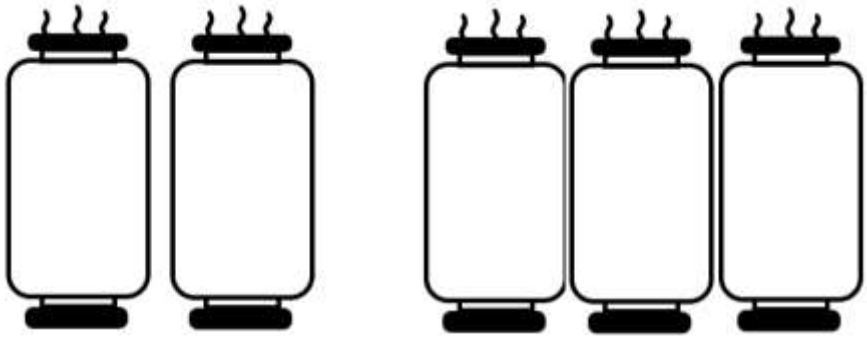
DEALING WITH THREE PHASE CURRENT UNBALANCE

Current unbalance can cause premature motor failure - a result of reduced starting and breakdown torque, excessive and uneven heating, and excessive vibration.

The electrical load on the submersible motor must be reasonably balanced. It is also essential that the installation be made properly. This will tell you how to install electrical properly and what to do if you can't.

Step 1 PREINSTALLATION

- ✓ Before installation, the power company should be notified of the motor data and other loads on the transformer bank.
- ✓ You should know if the service provided is a true three-phase three transformer system or one of the two transformer systems. This can be determined by counting the transformers if the service is in or by questioning the power company if the service is not yet in. Here is an open delta or wye system (on the left), with a true three-phase three transformer system on the right.



Open Delta or Wye True Three Phase

- ✓ Make sure that the transformer rating, in KVA, is adequate for the motor load by referring to this chart which references the KVA requirement by horsepower. Note that the minimum KVA rating, at the right on the chart, refers to each transformer used. This chart, incidentally, covers only the motor KVA requirements and does not make allowance for other loads.

		Smallest KVA Rating-Each Transformer	
Submersible 3 i Motor HP Rating	Total Effective KVA Required	Open WYE or DELTA 2 transformers	WYE or DELTA 3 transformers
10	15	10	5
15	20	15	7.5
20	27	15	10
25	32	20	10
30	40	25	15
40	53	30	20
50	65	37.5	25
60	75	40	25
75	90	50	30
100	120	65	40
125	150	85	50
150	175	100	60
175	200	115	70
200	230	130	75
250	275	145	85

Step 2 SYSTEM REQUIREMENTS

- ✓ Select the proper size magnetic starter or pump panel for the HP rating of the motor. Use ambient compensated extra class 10 quick trip heaters on all three legs. The recommended heater size for the make of panel is provided with the motor.

- ✓ Manufacturer's recommended cable size must be followed from the transformer to the pump panel and from the panel to the motor, based on HP and voltage rating. Make sure that the cable length in each case is at most the Manufacturer's recommendation for that size of cable.

- ✓ If the pump is to operate properly on a system with two transformers, it is good practice to use both the next higher HP motor rating and the next larger cable size. Taking these steps gives a greater margin of safety and provides more tolerance to current unbalance.

Step 3 START UP

- ✓ While the pump is uninstalled, check the insulation resistance of the motor to make sure that it is at least five million or more ohms (five megohms).

  After additional wiring has been attached to the motor leads and the pump is installed, check the insulation resistance again to determine if your connections and cables are good.

- ✓ If insulation resistance is still five million ohms or more, voltage can be applied to the motor.

- ✓ Whatever you do, remember Safety First! Before working inside the pump panel or magnetic starter, always disconnect the line to the panel or starter. Be sure it is off. Double check this with a voltmeter.

- ✓ Check for correct rotation of the motor by running it first in one direction and then the other. Use a discharge valve and pressure gauge. The rotation that gives the highest pressure is always the correct one.

  Rotation can be changed by switching any two of three motor leads at the pump panel.

- ✓ Now that correct rotation is established, the amount of current unbalance between legs should be calculated.

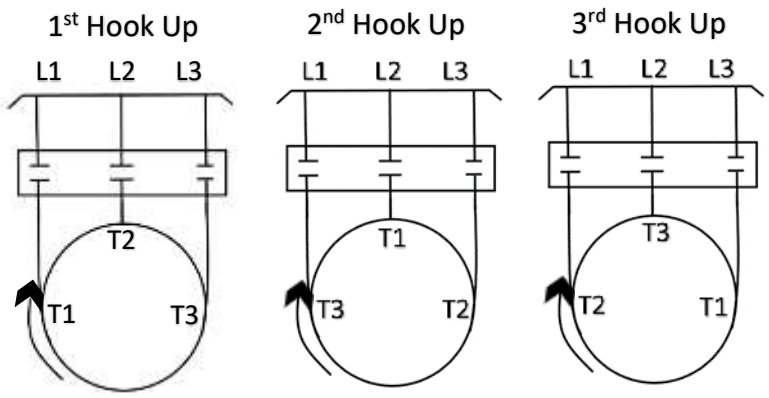
CURRENT UNBALANCE BETWEEN LEGS SHOULD NOT EXCEED 5%.

The percent of current unbalance is defined and calculated as follows:

$$\text{Percent current unbalance} = \frac{\text{maximum current difference from average current X 100}}{\text{average current}}$$

Current readings in amps should be checked on each leg using the three possible hookups shown in the illustration. The best hookup is the one that has the lowest percentage of unbalance.

To prevent changing motor rotation when taking these readings, the motor leads should be rolled across the starter terminals by always moving them in the same direction, as shown in the illustration.



Use simple arithmetic to calculate the percentage of current unbalance for all three hookups.

Here is an example of current readings at maximum pump loads on each leg of a three-wire hookup. You must make calculations for all three hookups.

Hook Up 1	Hook Up 2	Hook Up 3
T1 = 51 Amps	T3 = 50 Amps	T2 = 50 Amps
T2 = 46 Amps	T1 = 48 Amps	T3 = 49 Amps
T3 = 53 Amps	T2 = 52 Amps	T1 = 51 Amps

A. To start with, add all three readings for hookup number 1.

$$(T1)51\ Amps + (T2)46\ Amps + (T3)53\ Amps = Total: 150\ Amps$$

B. Divide the total by three to obtain the average.

$$\frac{150\ Amps}{3} = 50\ Amps$$

C. Calculate the greatest amp difference from the average.

$$50\ Amps - 46\ Amps = 4\ Amps$$

D. Divide this difference by the average to obtain the percentage of unbalance.

$$\frac{4.00\ Amps}{50} = .08 \text{ or } 8\%$$

In this case, the current unbalance for hookup number 1 is 8%.

If you use the same method of calculation, the maximum current unbalance for hookup number 2 is 4% and for hookup number 3 is 2%.

Next, compare the percentage of unbalance for all three hookups. The first hookup exceeds 5% current unbalance and should not be used. The second and third hookups did not exceed 5%, so either would be satisfactory. However, the third hookup had the lowest percentage of current unbalance, and it should be used since the motor will then be operating at maximum efficiency and reliability.

By observing where the highest current reading is for each leg on the various hookups, you can now determine if the unbalance is caused by the power source or the electric motor. Note in the example that the highest leg was always on the same leg, L3; this indicates that most of the unbalance was from the power source.

If the high current were on a different leg each time the motor leads were changed, you would know that the motor or a poor connection caused most of the unbalance.

Since loads on a transformer bank may vary during the day, readings should be taken at least twice - once during the day in what would be considered the normal load period and once in the evening during the usual peak load period. The installation should then be connected for the lowest percentage of current unbalance - again, not to exceed 5%.

Should you continue to have problems with balance, or if you encounter heater trip problems, contact your power company for help.

So you can fully explain the situation to the power use engineer or to your pump supplier, keep a complete log of your pump installation.

You should keep a record of:

1. Horsepower rating
2. motor make
3. size of control panel
4. heaters used
5. cable sizes and lengths
6. current voltage readings by leg

With this type of log, you will be on solid ground when you discuss the current unbalance problem with your power company. You can show what you did and why. This will help pinpoint the problem.

For further information, please contact:

PUMPS UNLIMITED Ltd.