ETAPUMP®
Solar Water Pump

and *ETAPUMP Integrated System*™

INSTRUCTION MANUAL

THIS IS A QUICK–DOWNLOAD VERSION WITH REDUCED GRAPHICS

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WARNINGS TO INSTALLER

Failure to follow these instructions will void the warranty.

⚠	Open circuit (no-load) voltage above 100V will destroy the controller. This may occur if the wrong PV modules (solar panels) are used, or if the solar array is incorrectly wired. Measure the array voltage before connecting to the controller. A “48V” (nominal) array should produce an open circuit voltage around 75-90V under any daylight conditions. (See Solar Array Wiring, Section 5.3)
⚠	Do not attempt to run the ETAPUMP Motor without the ETAPUMP controller. Do not attempt to use ETAPUMP controller for any pumps other than ETAPUMP.
⚠	To be installed, connected and serviced by qualified personnel only. Ensure all power sources are disconnected when making connections to this unit. Follow all appropriate electrical codes. There are no user serviceable parts inside the motor or the controller.
⚠	Undersized wire will cause failure to start. See Section 5.7.
⚠	Install proper grounding for safety and lightning protection (See Section 5.2)
⚠	Do not touch the controller input or pump wires together to test for a spark.
⚠	Do not run the pump dry. (Exception: to test direction of rotation, only for a few seconds)
⚠	Test the direction of motor rotation before installing the pump (counter-clockwise looking down). If direction is reversed, exchange the connection of any two of the three power wires to the pump. (See Section 5.8)
	When pump is stopped by a shadow or by action of the float switch, it will restart after a delay as long as 90 seconds. This is normal.
	If the low water probe is installed, it must be submersed along with the pump motor, or the pump will stop for 30-35 minutes. A ground connection to the pump (4th wire) is required for low water probe to function. If the probe is not to be used, connect the controller’s probe terminal to ground. (See section 5.5 and 5.9)

Installation should be in accordance with local regulations and accepted codes of good practice.

This manual is the property of the *ETAPUMP* owner.
Please give it to the owner or maintenance personnel when you are finished!
You may request additional copies from your *ETAPUMP* supplier

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Version 1.83 – QUICK DOWNLOAD VERSION
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2 SYSTEM REPORT FORM

Please enter system data before you start

This is necessary if you ever need advice or parts.

ETAPUMP Integrated System™ Number _ETA - ____ - _____.
(Most non-battery *ETAPUMP* are sold with a complete system)

System Voltage _____ Date of Purchase _____

Purchased from _____

Battery System? _____ or Quantity of Solar Modules (panels) _____

Solar Module Brand _____ Module Model # _____

Pump Model # _____ Pump End Serial # _____

Controller Model: [ ] EP600 (solar-direct only) Controller Serial # _____
[ ] ME24/48 (battery only)

Motor Serial # ___ _____ ← 1st two digits = voltage "55 …" is 48V
"24 …" is 24V

Installation Report

Installation Date _____ by: _____

Well Depth _____ [ ] feet [ ] meters Pump depth _____

Additional Vertical Lift (up to top of tank) _____

Static Water Level _____ Variable? _____

Drop Pipe (vertical from the pump)

Size _____ Type _____ Length _____

Additional Pipe Length (to tank)

Size _____ Type _____ Length _____

Submersible Pump Cable

Wire size _____ Total Length (controller to pump) _____

NOTES

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3 INTRODUCTION

Thank you for purchasing *ETAPUMP* *ETAPUMP* sets a new standard for quality and economy in solar pumping. It incorporates the best solar pump technologies that were very expensive until now. *ETAPUMP* is engineered in Germany and made in China by a German-owned high technology factory. Key components of the pump are made in Germany. It is imported for the Americas by Dankoff Solar Products, a pioneering solar pump developer since 1983.

Before you begin Check the model numbers of all the components of your system, and verify that they are the items that you ordered. Also check against the *ETAPUMP* specifications and performance charts (end of this manual) to be sure the system is appropriate for your application.

Please fill in the SYSTEM REPORT on page 3. This will be essential information if any problems occur.

System Wiring Diagram If your pump was purchased as part of an *ETAPUMP INTEGRATED SYSTEM*™, a System Wiring Diagram should be attached at the back of this manual. Be sure the diagram is the correct one for the system you have.

REFERENCE SECTION (Section 13) Most *ETAPUMP* installers are new to solar pumping, so we provide helpful information—principles of operation, instructions for wellhead assembly, water storage, control and monitoring of water supply, pipe sizing, freeze protection, and a glossary of technical terms.

MOST REFERENCE SECTION HAS BEEN REMOVED FROM THIS DOWNLOAD VERSION.
See www.dankoffsolar.com Reference Section

4 INSTALLING THE SOLAR ARRAY

4.1 Location of the Solar Array

Sunlight is the “fuel” that drives a solar pump. Positioning of the solar array is critical for full performance.

Choose a location for the solar array that has unrestricted sun exposure through the day and through the year. The array can be placed several hundred feet (100 m) or more from the wellhead. There will be no loss of performance if the electrical wire is sized properly, but naturally, the cost of wire will increase significantly. The *ETAPUMP* System Sizing Table specifies wire size requirements for both normal and extended wire lengths.

WARNING Shading a small portion of a PV array will cause the pump to slow or stop completely.

Each PV module (panel) contains a series of solar cells (typically 36 or 72 cells). Every cell that is shaded acts like a resistor, reducing the output of the entire array. Shading just one corner of the array will reduce the power disproportionately, and may even stop the pump. Consider this when deciding where to install the array.

To determine where shadows may be cast at any time of the year, you can survey the site with a *Solar Pathfinder®.* This device is especially useful in forested areas or wherever there are obstructions nearby. It is available directly from Solar Pathfinder (USA) Tel. & fax (931) 593-3552, www.solarpathfinder.com.

Place the bottom edge of the array at least 2 feet (.6 m) above ground to clear rain spatter, growing vegetation and snow. Keep in mind that trees and perennial plants will grow taller over the years, especially if they receive runoff from a solar water pump!

4.2 Solar Array Mounting Rack

WARNING All parts of your mounting structure must be engineered for wind resistance, ease of adjustment, and safety. Follow the rack manufacturer's instructions that are packed with your rack.

Solar Tracking A solar tracker is a special pole-mounted solar array rack that tilts automatically to follow the daily path of the sun. In clear summer weather, it can increase your daily water yield by 40-50%. (It is much less effective in winter and in cloudy weather.) A tracker is an option with *ETAPUMP* Integrated Systems™.

4.3 Orienting the Solar Array to Solar South

For full performance, your solar array must be oriented within 10° of true (solar) south. Depending on your location, a compass reading may show an error of as much as 20°. To correct this discrepancy, apply the magnetic declination for your region. Many regional maps indicate the magnetic declination. If you don't have a compass but can see your shadow and know the time of day, use the ***Sun Compass***™.

Sun Compass™

For the USA (lower 48 states) and other 25° to 55° North latitude regions.

Find True South quickly and accurately using only your shadow. No magnetic compass needed!

DIAGRAM REMOVED FOR DOWNLOAD VERSION

Sun Compass Instructions

1. Draw an arrow from Month dot to intersection of your Standard Time and Latitude. (The gray line is an example: August, 2 PM at 40° N lat.)
2. Stand and face your shadow.
3. Hold this page horizontally.
4. Point the arrow that you drew to center of your shadow.

Sun Compass™ is available for the following latitudes:

1. U.S.A. (25° to 55°) – shown here
2. Northern (50° N to 70° N)
3. Equatorial (20° N to 20° S)
4. Southern (10° S to 40° S)

4.4 Solar Array Tilt Angle

Factory-built solar array racks are adjustable to the desired angle, to accommodate both the location and the season. We offer these choices for seasonal management.

1. YEAR-ROUND COMPROMISE (no seasonal adjustment) Set the angle equal to the latitude of the location and "forget it". This is practical because people often forget to adjust the array. The *ETAPUMP* System Sizing Table is based on this fixed angle setting.
2. SEASONALLY ADJUSTED It is sufficient to perform the adjustment only twice per year, at the spring and autumn equinoxes, to the angles indicated below. For central USA, daily water production will be increased by about 8% in summer, 5% in winter compared to option 1. There is less advantage in a cloudier climate.
3. SEASONAL USE ONLY (summer-half or winter-half of the year) If the pump is to be used no more than 6 months of the year, set the array to the seasonal angle shown below, and "forget it".

CAUTION People often forget to make seasonal adjustments. If you use the pump all year but do not want seasonal adjustment to be required, set the angle equal to your latitude (Year-Round Compromise).

Ideal angles (from horizontal) are: Summer optimum = latitude – 15° Winter optimum = latitude + 15°

Solar Array Tilt Angles by latitude

Location (examples)	Latitude	Summer Tilt	Winter Tilt	Year-Round Compromise
Southern Canada	50°	35°	65°	50°
Upper Third of USA	45°	30°	60°	45°
Middle Third of USA	40°	25°	55°	40°
Lower Third of USA	35°	20°	50°	35°
Central Mexico	20°	5°	35°	20°

Equatorial Zone Do not set the array horizontal (0°), or dust and debris will accumulate.

5 ELECTRICAL INSTALLATION

5.1 Controller, Disconnect Switch and Conduit

WARNING To be installed, connected and serviced by qualified personnel only. Ensure all power sources are disconnected when making connections to the controller. Follow all appropriate electrical codes. There are no user serviceable parts inside the motor or the controller.

Location Place the controller close to the solar array, not the pump. This will reduce the risk of lightning damage.

Explanation — The controller's input circuitry is more sensitive to surges than the output. It is safest to minimize the length of the input wiring.

Protection from heat Electronic devices are most reliable when they are protected from heat. Mount the controller in the shade of the mid-day sun. An ideal location is directly under the solar array or in a nearby shaded location. An alternative is to fold a piece of sheet metal so that it mounts behind the controller and curves over it to provide shade. This provides protection in extremely hot climates.

Battery system Place the controller near the batteries but safely isolated from the battery terminals and from corrosive gasses. (Batteries must be in a cool location for best longevity, and enclosed for cleanliness and safety.)

Position If it is outdoors, mount the controller in a vertical position to assure that rain will not enter the box.

Mounting method There are 4 mounting holes at the corners of the box. Mount the unit using screws or bolts.

Electrical conduit is recommended We urge you to use electrical conduit (pipe) to protect outdoor wiring from the weather, from human activities, and from chewing animals. See photos on the following pages. If you don't use conduit, use sealed strain-relief cable connectors where cables enter the controller and disconnect switch. Rubber plugs are supplied with the controller to seal any holes that you don't use.

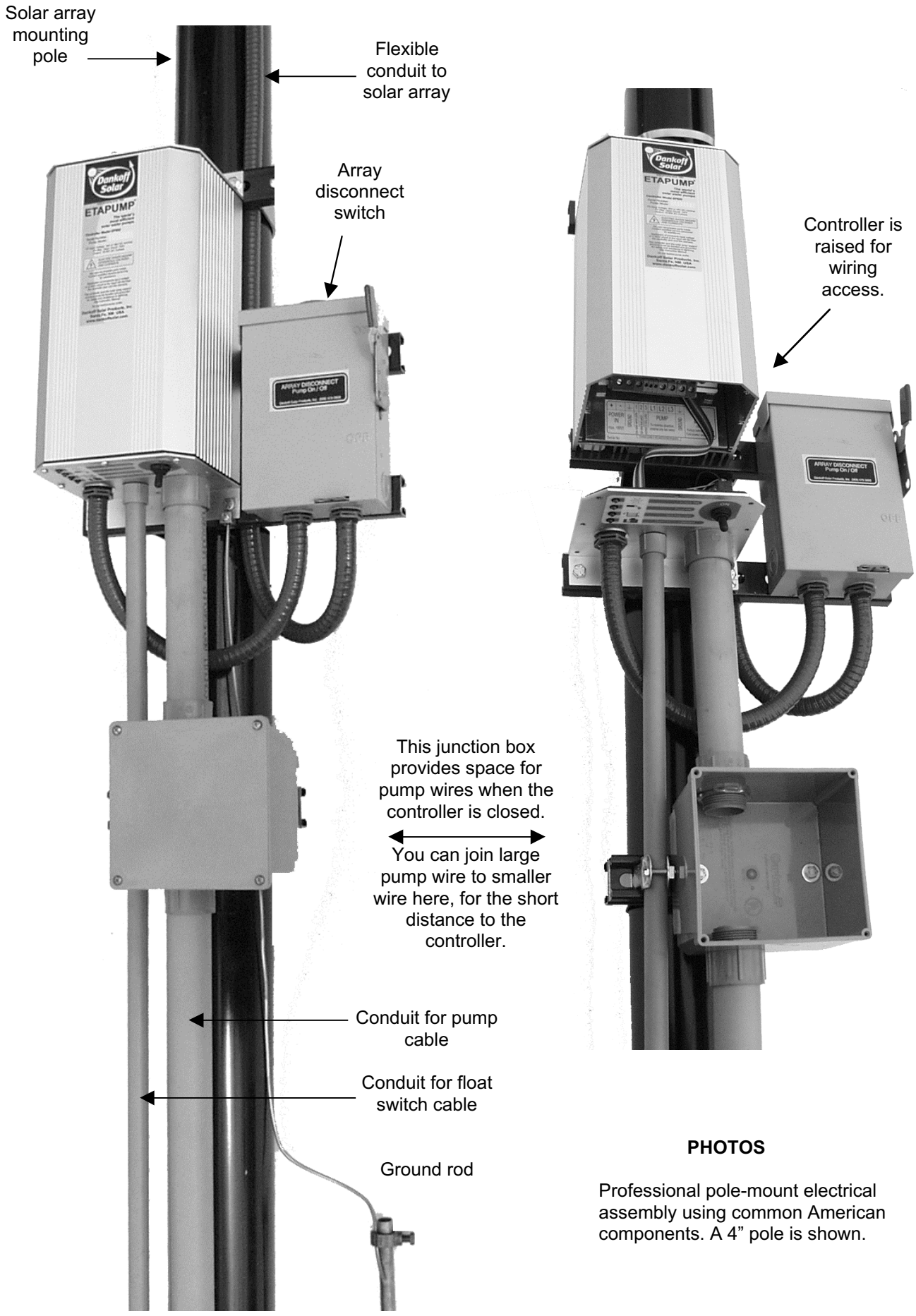
CAUTION If electrical conduit is to be used, be sure the top of the controller can be easily raised. While the bottom plate is fixed to the conduit, you will need to lift the box for access to the terminals. Leave about 6" (150mm) clearance above the box.

POLE MOUNTED ELECTRICAL ASSEMBLY — SEE PHOTOS on the following pages

The controller can be mounted onto the solar array support pole using ordinary materials available from your local electric supply store. The photos show a professional system that is easy to assemble. It makes the wiring easy, and allows easy access for testing. These are American style electrical parts. Outside of North America, styles and sizes vary.

HELPFUL HINTS

1. The controller does not have sufficient space to bend large pump wires. Install a junction box as shown in the photos. This allows plenty of space to manage excess wire when you close the controller. Cut holes in the box as shown in the photos.
2. If your pump wires are #8 (6 sq. mm) or larger, you can join them to smaller wires in the junction box. #12 (4 sq. mm) or larger is acceptable for this very short length. Use stranded wire for flexibility.
3. If you can't get the wire into a terminal (in the controller), PUSH the screw in. That will open the terminal. Don't remove the screw.
4. After tightening screw terminals, pull the wires hard, to confirm that they are in tight.



PHOTOS

Professional pole-mount electrical assembly using common American components. A 4” pole is shown.

PHOTOS REMOVED FOR DOWNLOAD VERSION

PHOTO ABOVE — Parts used in pole-mount assembly
clockwise from top:
PVC outdoor rigid conduit (1 1/4” to hold pump wires)
PVC outdoor rigid conduit (1/2” for float switch cable, optional)
Ground rod (copper-plated steel, 8 feet long)
Flexible outdoor conduit (1/2”) with threaded adapters
2 hose clamps to hold the flexible conduit (up the pole to the array)
4 conduit clamps to fit the mounting pole (4” shown here)
Conduit clamp to fit the float switch conduits (1/2”)
7 each—bolts, nuts, flat washers, lock washers (1/4” and 5/16”)
Conduit male thread adapter (1/2”), lock nut, 3/4X1/2” reducing washers
3 conduit male thread adapters (1 1/4”), lock nut (1 of 3 shown)
Ground rod clamp
Solderless lug for controller grounding (AL/CU rated)
Slotted strut (Unistrut) cut to lengths: 14” (2) and 8” (3)
Junction box (6” X 6” X 4” PVC) is not shown

PHOTO RIGHT — Internal parts of the controller, showing rubber plugs in the conduit holes.

5.2 Grounding and Lightning Protection

WARNING Failure to install and connect an effective grounding system will greatly increase the risk of lightning damage and will void your warranty. We suggest you wire the grounding system FIRST.

Experience has taught us that surges induced by nearby lightning are unlikely to damage a solar pump system if these instructions are followed. A properly made discharge path to ground (earth) will discharge static electricity that accumulates in the above-ground structure. This helps prevent the attraction of lightning. When there is a nearby lightning strike, a well-grounded structure diverts the surge AROUND the power circuitry, greatly reducing the probability or the intensity of damage. The *ETAPUMP* controller has built-in surge protectors that function ONLY if it is effectively grounded.

System Wiring Diagram If your pump was purchased as part of an *ETAPUMP INTEGRATED SYSTEM*™, a System Wiring Diagram should be attached at the back of this manual.

Bond (interconnect) all the metal structural components and electrical enclosures Interconnect the PV module (solar panel) frames, the mounting rack, and the ground terminals of the disconnect switch and the controller, using wire of minimum size #8 (6mm2), and run the wire to an earth connection. When connecting dissimilar metals, use connectors that are approved for the materials involved. Example: at the aluminum framework of the solar array, use connectors labeled “AL/CU”. This will reduce the potential for corrosion.

Ground connections at the controller The controller has two ground terminals on the inside. They are both connected in common with the aluminum enclosure box. Ground connections to the controller can be made to one or both of the internal ground terminals, or to the box—whatever is expedient.

Ground connections to aluminum Connections to aluminum must be made using terminal lugs that have an aluminum-to-copper (AL/CU) rating, and stainless steel fasteners.

Earth connection – Create an effective discharge path Install one or more 8-foot (2.5m) copper-plated ground rods, preferably in moist earth. Where the ground gets very dry (poorly conductive), install more than one rod, spaced at least 10 feet (3m) apart. You can also bury #6 (16 sq. mm) or double #8 (10 sq. mm) or larger BARE copper wire in a trench at least 100 feet (30m) long. Connect one end to the array structure and controller. Or, cut the ground wire in half and spread it in two directions. Think of this as a “drain field“ for electrons. If a trench is to be dug for burial of water pipes, ground wire can be run along the bottom of the trench. If you have a steel well casing near the array, you can use it as a ground rod. Drill and tap a hole to make a strong bolted connection to the casing. Cemented footers of a ground-mounted array will NOT provide adequate grounding.

Grounding the pump *ETAPUMP* requires four-conductor (four-wire) cable between the controller and the pump. Three wires carry power and one conducts ground to the motor case. Connect the ground wire to a ground connection in the controller or to the controller enclosure. This helps to prevent shock if there is a fault in the motor.

CAUTION If the pump is not grounded, the low-water shutoff will not function.

Float switch cable A long run of control cable to a float switch can pick up damaging surges from nearby lightning. The best protection is to use shielded, twisted-pair cable (Dankoff Solar Item #10326). Shielded cable has a metallic foil or braid surrounding the two wires. **Ground the cable shield at the controller end only, not at the float switch.**

Additional lightning protection The *ETAPUMP* controller has built-in surge protection devices. Additional grounding measures or surge protection devices are recommended under any of the following conditions:

1. Isolated location on high ground in a severe lightning area
2. Dry, rocky, or otherwise poorly conductive soil
3. Long wire run (more than 100 feet / 30m) from the controller to the wellhead, or to the float switch.

NOTE about grounding power conductors *For a solar-direct system, the best lightning protection results from NOT grounding the positive or the negative of the solar input. If system grounding is required by your local electrical authority, connect the PV array negative to a ground terminal in the controller and switch only the positive conductor in the array disconnect switch. This may increase the risk of lightning damage.*

5.3 Solar Array Wiring

WARNING: Your photovoltaic array generates hazardous voltages. A 48 Volt (nominal) array can generate nearly 100 volts when disconnected from load. A short circuit or loose connection will produce an arc that can cause serious burns. All wiring must be done by qualified personnel, in compliance with local, state, and national electrical codes.

The solar array can produce hazardous voltage even under low light exposure. To prevent shock hazard while wiring the array, leave one or more wires disconnected or cover it with opaque fabric.

ETAPUMP solar-direct (non-battery) systems use a variety of array configurations. Some use 12V (nominal) and some use 24V modules. Modules are connected in series for 36 or 48V, and sometimes also in parallel to increase the current. Refer to the System Wiring Diagram at the end of this manual. Be sure the modules (panels) match the description on your System Wiring Diagram.

Solar module connections The terminals in the module junction boxes can be confusing. Refer to the module manufacturer's instructions that are packed with the modules. Make strong connections that will hold for many years. Most array failures are caused by loose or corroded connections.

PHOTOS REMOVED FOR DOWNLOAD VERSION

PHOTOS show two types of PV module junction systems.

LEFT: Quick-connect system using "MC" connectors.

RIGHT: Conventional junction box with conduit holes.

Type of wire Use either electrical conduit or outdoor UV-resistant wire. The solar array has a life expectancy beyond twenty years. Don't degrade it with inferior materials! Use minimum wire size #12 (4 sq. mm) for the connections between modules and for short distances to the controller. Some appropriate types of wire are: USE, UF, SE and SOOW.

Solar tracker wiring If you are installing a solar tracker, pay careful attention to the wire section that leads from the moving rack down to the stationary mounting pipe. Use materials that are suitable for highly flexible applications, and leave some extra length to form a drip loop that will shed water and minimize stress. Secure the assembly mechanically at each end so the insulation and the connections are not stressed by the tracker's motion. Swing the tracker fully in each direction, at various seasonal tilt angles, to verify that the cable does not rub or restrict the tracking motion. See photo.

MC connectors Some PV modules have these quick connectors. If the connector is not appropriate at some junctions, it is acceptable to cut the wire and make a conventional connection.

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PHOTO LEFT
Typical wiring of a solar array on a passive (non-electric) tracker. Wire is single-conductor type USE (outdoor rated). See how the wire is looped. This allows it to shed water, and to flex easily as the tracker swings East-West. Wires enter the conduit through a “weatherhead” fitting. Conduit enters the disconnect switch through a “conduit hub”. The tracker pipe was extended to about 10 feet (3m), by welding it to a larger pipe. The array was assembled and wired on the ground, then lifted and lowered onto the pole using a backhoe and chain.

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PHOTO BELOW

Installing a PV array with a crane. Water well contractors often use their pump pulling rig to do this. Assembly can be done piece-by-piece on the pole, but this is easier if the equipment is available.

Photo courtesy of Skyline Solar, ETAPUMP dealer in Idaho, USA

5.4 Solar Array (PV) Disconnect Switch

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For PV-direct systems, a two-pole disconnect switch must be installed between the solar array and the controller. Switch it off to prevent shock and arc burn hazard during installation and maintenance, or if the system will be shut down for the season.

The photo shows the PV Array Disconnect Switch that is included with the *ETAPUMP* Integrated System™ (Dankoff Solar Item #11430).

Overload protection (fuse or breaker) is NOT required in the PV circuit. However, we have not found a UL-listed switch of sufficient DC rating that does not hold fuses. Install fuses with any rating between 20 and 30 amps. They are NOT expected to blow during a fault. Type FRNR or FLNR fuses have sufficient DC ratings. Copper buss bar replacements can be used instead of fuses.

Explanation – Overload protection is not required in the array circuit, for two reasons. (1) Short circuit current from the solar array can never reach the ampacity (maximum safe capacity) of the recommended wire, and (2) the ETAPUMP controller has internal overload protection.

CAUTION Loose connections are the most common cause of system failures. Pull on each connection to confirm that it is secure.

5.5 Controller Input Wiring

Refer to the System Wiring Diagram at the end of this manual.

WARNING TEST THE VOLTAGE before connecting power to the controller. Voltage (open circuit) must not exceed 90V. (In cloudy weather, the open circuit voltage will be near maximum.)

WARNING Some thin-film modules (panels) may produce excessive voltage, especially when they are new. If the open circuit voltage exceeds 90V, DO NOT connect power to the controller. Contact your supplier. (*ETAPUMP Integrated System*™ does not use this type of module.)

WARNING Observe polarity (+ and –). Reverse polarity at the controller input will blow an internal fuse. The fuse is located on the circuit board behind the POWER IN terminals. A spare fuse is taped inside the box.

WARNING Do not apply a direct connection or an amp meter between + and – at the controller input. A short circuit at this point will damage the controller.

Ensure that the controller's ON/OFF switch is in OFF position and that the solar array disconnect switch (or battery fuse or circuit breaker) is also OFF. Connect the power from the solar array to the disconnect switch, then to the controller. Observe polarity. If your wires are not clearly marked +/–, test them using a DC voltmeter or multitester.

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PHOTO Terminals inside the controller

RPM Setting is shown in normal, maximum position (fully clockwise)

5.6 Maximum RPM Setting

This setting is only present on solar-direct (non-battery) controllers. The Max. RPM Setting knob is located inside the controller, to the right of the terminals, as shown in the photo above. **It limits only the MAXIMUM flow rate.** It sets a limit to the pumping rate under maximum sunlight conditions. It will NOT reduce the ability to start or the performance in low sunlight.

Reasons to reduce the maximum RPM

1. To prevent over-pumping a limited water source (see Section 6.7)
2. To limit the back-pressure (and prevent possible pump overload) when pumping into a direct-pumped irrigation system, a filtration system, or an undersized pipeline
3. Model ETA-107C, or any system that stops from overload during full sunlight

WARNING For model ETA-107C or any other model that comes with a warning requiring this adjustment, you are required to reduce the setting to position 2. If this is not done, the system may stop during full-sun conditions, due to power overload.

ILLUSTRATION Position 1 is the normal factory setting, to allow maximum pump performance for most pump models. Position 2 is the required setting ONLY for model ETA-107C, to prevent overload.

5.7 Submersible Pump Cable and Splice

Selection of cable Use only an approved type of submersible pump cable, the same type that is used for conventional AC pumps. It is available from your local water well supplier or from your *ETAPUMP* supplier. You need 4-conductor cable. It is often called “3-wire-with-ground” because it has 3 power wires and a ground wire. To determine the minimum required wire size, refer to the *ETAPUMP* Systems Sizing Table.

Submersible Splice A splice kit is included with *ETAPUMP Integrated System*™. It includes crimp connectors to join the copper wires, adhesive heat-shrink tubing, and instructions. If the drop cable wire is too large to fit in the crimp connector, cut off some of the wire strands to make it fit. Use a standard crimping tool, then observe that the wires are held very securely.

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PHOTO – Submersible cable splice, before protective tape is applied

When the heat-shrink tubing is heated, it shrinks and the adhesive melts and bonds to the wires. Each wire must be sealed 100% water-tight. After this is complete, wrap tape around the entire splice, to give mechanical protection. It is NOT necessary to provide a water-tight seal around the outer jacket of the cable. If you make a mistake or lose your *ETAPUMP* splice kit, you can obtain a submersible splice kit from any pump supplier.

5.8 Wiring Order for Correct Rotation

WARNING If the pump wires are in the wrong order, the motor will run in reverse and the pump will not function. Damage may result if the pump is run in reverse for a long period. Check the direction BEFORE installing the pump. The proper direction is COUNTER-CLOCKWISE when viewed from above.

WARNING If you run the motor dry WITH the pump end installed, do not run it dry for more than 10 seconds. If the pump end is NOT installed, the motor can be run dry without harm.

PHOTO REMOVED FOR DOWNLOAD VERSION

The power wires on the pump are black with white lettering to indicate L1, L2 and L3. WRITE DOWN the colors that you splice to L1/ L2 / L3 so you can match them with the L1/ L2 / L3 terminals in the pump controller.

If your pump cable has the colors shown below, you can use the following sequence as your standard:

RED L1	BLACK L2	YELLOW L3	GREEN Ground

If you did not write down the color match (or the wind blew your note away) connect the three power wires to the controller in ANY order (random). Apply power and turn the controller on. Observe the pump shaft rotation, then turn the power off. If the direction is wrong, exchange ANY TWO of the power wires at the controller. In any case, when you are finished connecting the pump to the controller, test it to assure the proper direction.

Question *The motor shaft is hard to turn by hand. Is this normal?*
Answer *YES. This is caused by permanent magnets in the motor. It is hardest to turn when it is connected to the controller or if all the wires are connected together.*

Did you install the pump in the well without checking the wiring order or the direction?
OR – Is it running but very noisey or not pumping properly?

If your pump model number contains "C" it has a centrifugal pump end. If it runs in reverse, it will produce a reduced amount of pressure and may produce little or no flow. This will NOT damage the pump.

If your pump model number does NOT contain "C" it has a helical rotor (positive displacement) pump end. If it runs in reverse, it will try to pump downward. You will here a loud vibration as it comes up to speed (due to cavitation). Turn off the pump immediately! Reverse the direction. If it is much quieter, that should fix it. (In reverse, the pump will run dry. If the pump is new from the factory, it is lubricated with temporary (non-toxic) grease so it can run dry for about 90 seconds without damage. If the pump is not new, it must not be run for more than about 15 seconds.

5.9 Low-Water Probe for Dry-Run Protection

The purpose of the low-water probe is to sense the loss of water just above the pump, so that the pump will shut off and not run dry. Running completely dry will damage the pump end and void the warranty. For shipment, the probe assembly is packed with your *ETAPUMP* controller.

Install the probe either above or just below the check valve at the pump outlet. Splice its wire to a single-conductor submersible wire of #18 AWG or larger, using the materials in your splice kit. The splice uses heat-shrink tubing, same as your main pump splice (see splice kit instructions). In the controller, connect the well probe wire to the well probe terminal.

PHOTO REMOVED FOR DOWNLOAD VERSION

CAUTION The well probe must not make contact with any other metal parts.

Operation The probe senses electrical conductivity through the water, between the probe and the metal body of the pump. If the water level drops below the probe, continuity is lost. The controller will stop the pump and the "Low-Water OFF" light will indicate. The controller will attempt to restart the pump automatically after a delay of 30-35 minutes. To force it to restart, turn the controller off for two seconds, then on again.

The Low Water-OFF light stays on for the remainder of the day or until power to the system is interrupted. Even if the water recovers and the pump restarts, this will tell you that the water source ran low at least once during the day.

CAUTION For the well probe (dry run prevention) system to work, the pump's ground wire must be connected to ground at the one of controller's ground terminals or the controller's metal enclosure.

CAUTION If you are not using the well probe, connect a short wire from terminal 1 to ground. If you feel certain about the reliability of the water source and you choose not to install the well probe, connect the well probe terminal to ground.

WARNING A combination of salty or mineralized (highly conductive) water and a coating of minerals, bacteria or algae may cause failure of the low-water probe to detect a low-water condition. If deposits on the probe are a problem, consider using a different type of probe or a different way to mount it, to isolate it more from the motor. It may help to mount it higher on plastic drop pipe. You can also substitute a float switch if there is sufficient space in the water source. Connect one side of the switch to the probe terminal in the controller, and the other side to ground. Or, call your *ETAPUMP* supplier for advice. You may want to reduce the "Maximum RPM" adjustment (see Section 6.7 Utilizing a Low-Production Water Source).

5.10 Automatic Control For Full-Tank Shutoff

We recommend the use of a float switch or other means to prevent overflow of your tank. This accessory will stop the pump when the tank is full, then reset when the level drops. This conserves ground water, prevents overflow, and eliminates unnecessary pump wear. You can obtain Float Switch Kit (Dankoff Solar Item # 10320) from your *ETAPUMP* supplier. The Float Switch Kit includes float switch, cable weight and cable clamp as illustrated.

DIAGRAM REMOVED FOR DOWNLOAD VERSION

WARNING The float switch must MAKE contact on rise to turn the pump OFF.

Our pump controllers allow the use of small signal cable to a remote float switch, even if the tank is a long distance away. Any small 2-wire cable will work, but it must be suitable for the environment to which it is exposed. If it must run a long distance, use twisted-pair shielded cable to reduce the chance of damage due to lightning-induced surge (Dankoff Solar Item #10326. See Section 5.2 Grounding and Lightning Protection.

If you are not using a float switch, leave the float switch terminals in the controller disconnected.

Overriding the float switch You may want to disconnect your float switch (1) to allow overflow for irrigation purposes or (2) to test or observe your system. To do this, install a switch to disconnect either of the two float switch wires. Use any size of toggle switch available from an electronic supply, electrical supply, or hardware store.

Connection to the controller Connect the float switch cable to the two float switch terminals of the controller. If you use shielded cable (containing an outer metallic foil or braid, like Dankoff Solar Float Switch Cable), connect the shield to ground AT THE CONTROLLER ONLY. Do NOT ground the shield at the float switch. This will help protect the system from surges induced by nearby lightning.

Operation When the water level is high, the float switch will MAKE (close) contact to stop the pump. The FULL-TANK OFF indicator on the controller will light up.

***Wireless Level Controller* eliminates float switch cable** This device will provide full-tank shutoff by means of a pressure sensor. It eliminates the need to run wires to your tank. It also displays the discharge head (for tank level monitoring). It draws its power (<1 watt) from one of the PV modules (solar panels) in your pump system. Order from your *ETAPUMP* supplier as follows:

For 0-230 vertical feet from wellhead (ground level) up to top of tank: Item # xxxx *available*
For 150-460 vertical feet from wellhead (ground level) up to top of tank: Item # xxxx *summer 2002*

Manual remote control The float switch circuit can be used with a manual switch to turn the pump on and off from a distance. Any commonly available on/off switch can be used. Mount the switch upside-down because when it is in the ON position, it will turn the pump OFF.

5.11 Battery-Based Systems

***ETAPUMP* using a storage battery system must use controller Model ME 24/48.** This controller is designed to operate from a 24 volt or a 48 volt battery system. DO NOT run it directly from a solar array without batteries, or damage will result.

WARNING OVERLOAD PROTECTION IS REQUIRED FOR BATTERY SYSTEMS Install a fuse or circuit breaker between the battery and the pump controller. It should be located close to the power source. This will protect the battery, the wiring, and the controller, in case of a short circuit or overload. Fuse or breaker rating for both 24V and 48V systems is 10 AMPS.

CAUTION ME 24/48 controller does NOT have a low-voltage disconnect function. If the voltage of a lead-acid type battery falls below 21V (24V system) or 42V (48V system), permanent battery damage will result. It is the

responsibility of the installer to provide a suitable low voltage disconnect (LVD) system. LVD function is built into many solar charge controllers and is also available as a separate device. Most LVD devices will not reset until the battery re-gains a substantial charge. This can take hours of charging time. Be sure the operator of the system understands LVD function.

ME 24/48 Controller is a motor controller. It is NOT a charge controller. A conventional charge controller should be a part of any renewable energy battery charging system, to prevent overcharge. If you have questions about battery charge control or low voltage disconnect, contact the supplier of your power system.

5.12 Pressurizing Systems

ETAPUMP is appropriate for automatic water pressurizing when powered by a battery system. If you are raising water vertically AND pressurizing, note the relationship: 2.31 ft. = 1 PSI. Example: A pump that lifts 100 vertical feet and pressurizes to 60 PSI must pump the equivalent of 240 feet. Be sure your pump was chosen correctly for your application. The installation is the same as for a conventional AC pump, with the exception of the power switching.

WARNING A reverse action pressure switch is required. Do not use a conventional pressure switch. Do not switch the controller's primary power. The pump will not start reliably in this mode.

Pressure switch (reverse action) A pressure switch is required to turn the pump on when the pressure is low (the *cut-in pressure*) and off when it is high (the *cut-out pressure*). *ETAPUMP* uses its FLOAT SWITCH terminals for pressure switch control. The float switch circuit uses "reverse logic" – making contact will STOP the pump. You must use a REVERSE ACTION pressure switch (Dankoff Solar item # 20222, set at 20/40 PSI, adjustable to 65 PSI max.). It can be wired using very small wire (#18 AWG minimum) regardless of the distance between the controller and the switch.

CAUTION Label the pressure switch "reverse action" to avoid confusion in the future.

If you wish to obtain the reverse action switch locally, it is Square-D model 9013FRG-2J23 adjustable to 65 PSI (Grainger catalog #5B416) or model 9013FRG-62J23 adjustable to 100 PSI (Grainger catalog #1V630).

WARNING INSTALL A PRESSURE RELIEF VALVE. If the pressure switch fails, this will prevent extreme pressure from bursting the tank or piping and causing a flood.

Pressure relief valve Install the valve near your pressure tank. Purchase a 1/2" (or larger) valve that is set in the range of 25-75% higher than the cut-out pressure. Run a pipe or hose from its outlet to a drain or to the outdoors where water can drain away safely. When the system is operating, watch the valve to verify that it does not leak under normal conditions.

Pressure tank A pressure tank is required. We recommend a captive-air pressure tank of 40 gallons (150 liters) or more, to avoid rapid on/off cycling and to add some reserve supply. The air bladder in the tank must be properly pre-charged to function in your system. If pre-charge is set too high, the pressure tank will be of little or no benefit.

How to pre-charge a captive-air pressure tank Follow the instructions that came with the tank, or do as follows:

1. Make note of the cut-in setting of the pressure switch.
2. Turn off the pump and exhaust the water from the tank, so the water pressure is 0.
3. There is an air fitting on top of the tank. This allows you to pressurize the rubber bladder in the tank (like a balloon). Measure the air pressure in the tank using a tire gauge. Adjust the pressure to 2 or 3 PSI (.15-.2 bar) LESS THAN THE CUT-IN PRESSURE.
4. If you readjust the cut-in setting of the pressure switch, remember to adjust the pre-charge too.

NOTE If power to the controller is disrupted, you will need to switch the controller off, then on again for it to restart.

6 PREPARING TO INSTALL THE PUMP

6.1 Pump End to Motor Assembly

PHOTO REMOVED FOR DOWNLOAD VERSION

After you have confirmed that the motor runs in the proper direction, mount the pump end to the motor. Be sure the matching surfaces are free of dirt. Set the pump end down onto the motor with the groove positioned around the motor cable. Make sure the shaft coupling engages properly, as shown in the photo.

Fasten the pump end to the motor with the four nuts and lock washers provided. Tighten the nuts securely.

***ETAPUMP* models without a "C" in the model number** (most models) have two setscrews in the pump shaft coupling. In that case, tighten the screws with the 3mm Allen (hex) wrench provided.

Explanation—The only purpose of these screws is to prevent the coupling from rising up off the motor shaft if the motor is accidentally run in reverse.

Pumps with a "C" in the model number have no setscrews. They do have a cable guard, not shown in this photo. Mount it to the pump with the screws provided.

6.2 Drop Pipe

Type of pipe *ETAPUMP* can be installed using the same pipe materials as conventional submersible pumps. *ETAPUMP* produces a smooth flow (no pulsation). It starts slowly, without sudden torque. Thus there is no need for flexible (damping) pipe or a torque arrestor. Use any suitable rigid pipe or flexible pipe.

Size of pipe *ETAPUMP* systems use the same pipe-sizing criteria as conventional pump installations. Undersized pipe will reduce the performance of the system. Pipe size is based on the maximum flow rate and the TOTAL length of pipe from the pump to the pipe outlet or tank. Refer to the pump specifications at the end of this manual to determine the peak flow rate for the system you are installing. If a long run of pipe is required, it may need to be larger than the outlet size of the pump. Refer to Section 13.2 Water Pipe Sizing Chart.

Reduced pipe size should be considered in the following situations:
1. Sandy water conditions – especially with a solar-direct system that pumps very slowly on cloudy days. Smaller pipe will increase the flow velocity and help exhaust sand that may accumulate in the drop pipe. (See Section 6.6 "Coping with Dirty Water Conditions".)
2. Hand installation, to reduce the weight and increase flexibility.

Balance these factors against the friction loss that will result from using smaller pipe. You can use a pipe size that is smaller than the pump outlet by using a reducer bushing. Do not screw a metal fitting into a plastic bushing. The bushing may crack.

6.3 Safety Rope and Binding

Safety rope can prevent loss of the pump. If pipe breaks, the rope can be used to pull the pump out. Use 1/4" (6mm) water well safety rope. It can be purchased from *ETAPUMP* supplier (Dankoff Solar Item #10360) or from a local pump supplier. Polypropylene marine rope is a good substitute. Do NOT use nylon.

WARNING Safety rope is for emergency pump removal. It must not be a primary means of support. Make it slightly longer than the drop pipe so it does not bear any weight.

WARNING Do not use nylon rope in water. Nylon absorbs water and weakens after a few years. Failure can cause damage or loss of your equipment. Use polypropylene rope that is sold for water well or marine applications.

WARNING Plastic rope will weaken from long exposure to sunlight. Secure it inside the well casing to avoid exposure, or substitute stainless steel wire rope.

Safety rope at wellhead Prepare to tie the rope underneath the well seal or well cap. If your well cap does not have a place to tie the rope, drill a hole in the casing and install an eye bolt. Prepare this detail before you install the pump! (See Section **Error! Reference source not found.** Wellhead Assembly for Drilled Wells.)

Rope exposed to sunlight If the safety rope must be exposed to sunlight, use stainless steel wire rope or chain

Safety rope at the pump Run the rope through both eyelets on the pump and tie a knot

Bind the drop pipe/cable/rope with tape Lay out the pipe, cable, and rope on the ground. Do not twist them together. Bind the cable and rope to the pipe every 10-15 feet (3-4m) using vinyl tape. Use either standard (UL-listed) electrical tape (about 6 to 8 turns) or “pipe wrap tape”, which is wider and requires fewer turns. Pipe wrap tape is available from water well or electric supply stores. Remember that the pipe will stretch, and the cable will not. Leave a slight excess length of cable between each wrap.

WARNING Do not use nylon cable ties in water. Nylon absorbs water and gets weak after a few years. Failure can cause damage or loss of your equipment. To bind the pump cable to the drop pipe, use vinyl electrical tape or pipe-wrap tape.

6.4 Installation in a Surface Water Source

This refers to installation in a surface well, spring, pond, lake, river or tank.

Positioning the pump Your pump may be placed in either a vertical or a horizontal position. The intake must be fully submerged. To reduce the intake of sediment, do not place the intake very close to the bottom.

River or stream If you install the pump in a river or stream, secure it from logs and debris that may float downstream. Use stainless steel wire rope or chain instead of plastic safety rope (plastic rope will weaken in sunlight). Consider digging a shallow well near the stream. This will allow filtration of the water through the earth, and will protect the pump from floating debris or human tampering.

No cooling requirement! Unlike conventional pumps, *ETAPUMP* does NOT require moving water to cool the motor. The high-efficiency motor generates very little heat. There is no need for a flow shroud to force water past the motor. (For temperature tolerance, see Section 12.)

6.5 Deep Well Setting — How Deep?

ETAPUMP may be submersed as deep as necessary to ensure reliable water supply. The lift load on the pump is determined by the vertical head of water starting at the SURFACE of the water in the source. Increasing the submergence of the pump (placing it lower in the well) will NOT cause it to work harder or to pump less water, nor will it increase the stress or wear on the pump.

There are two reasons NOT to set the pump near the bottom of the well (if it isn't necessary)
1. A deep setting will increase the size requirements, costs and weight of pipe and cable.
2. A deep setting will increase the chance of sand or sediment being drawn into the pump.

To make an informed decision about setting the pump, it is helpful to have accurate data for your water source. In most places, drillers are required to report the details and the performance of wells that they drill. If you do not have the well record (driller's log), you can obtain a copy from your regional government office that oversees ground water resources and issues drilling permits. In USA, it is a state office, typically called Department of Natural Resources or State Engineer's Office. However, the data may be missing or inaccurate, and conditions can change over the years. If necessary, you can have the well tested by a water well contractor.

6.6 Coping with Dirty Water Conditions

ETAPUMP has good resistance to quantities of sand and fine silt that can normally occur in a well. However, any amount of abrasive material will reduce the life of the pump end. Wear from abrasive material is not covered on warranty. In some cases, sediment may settle from the drop pipe each time the pump stops, and will block the flow. If your water contains high amounts of sand or sediment, follow these instructions.

To avoid pumping dirty water
1. Have your well purged or otherwise improved by a water well contractor.
2. Temporarily install a larger pump to draw at a high flow rate until silt is purged from the well.
3. Set the pump as high as possible in the well. If the pump can be placed higher than the perforations in the well casing, it will probably avoid all but the finest silt.
4. If your water source is a river or stream, dig a shallow well next to the stream to obtain clean water.

If dirty water cannot be avoided
1. Use a reduced size of drop pipe. This will maximize the velocity of water flow in order to exhaust sand particles. Refer to Section 13.2 Water Pipe Sizing Chart. Select the smallest size pipe that does not impose excessive friction loss. Use a reducer bushing on the pump if necessary, to adapt it to a smaller pipe size.
2. Monitor the situation occasionally by observing the rate or the daily volume of water pumped. As a pump wears, its flow rate will decrease gradually (so will the current draw). Replace the pump end when reduced performance is observed, or before your season of greatest water demand.

Question *What effect does hard, mineralized, alkaline or salty water have?*
Answer *Generally, none. Dissolved minerals and salts are not abrasive. If hard mineral deposits accumulate on the intake screen (in an extreme case) it may need to be cleaned.*

6.7 Utilizing a Low-Production Water Source

ETAPUMP is can make the best of a limited water source, even if the pumping rate can exceed the recovery of the well. You want to draw the most water possible, but you do not want the pump to run dry. *ETAPUMP* can handle this situation in two ways.

1. The low-water probe The low-water probe (included with *ETAPUMP*) allows the pump to work to its full potential until the water level drops (see Section 5.9). This is a good strategy because you get all the water you can before the sun is possibly disrupted by clouds. Place the pump near the bottom of the well to utilize the storage of water in the well. When the pump is stopped by the low-water probe, it re-starts after a 30-35 minute time delay. The Low Water OFF light will stay on even after the water recovers and the pump restarts, to indicate that the level got low at some time during the day. See Section 5.9 Low Water Probe.

2. Reduce the Maximum RPM setting If the well has little storage capacity, the supply may recover before the pump restarts. In this case, reduce the Maximum RPM setting in the controller (solar-direct systems only). See Section 5.6.

WARNING Do not use a valve as a means of reducing the flow. With a helical rotor pump, excessive pressure may result. Use the Maximum RPM setting instead.

Question *How dry is "dry run"?*
Answer *If water is only trickling into the pump, it will provide enough lubrication to prevent damage.*

7 IN-WELL ASSEMBLY AND INSTALLATION

SEE REFERENCE SECTION At the end of this manual (Section 13) you will find instructions for wellhead assembly, water storage, control and monitoring of water supply, pipe sizing, freeze protection, and more.

7.1 Rubber Spacers (Models –07 and –14 only)

This applies ONLY to models ETA-07 (HR-07 pump end) and ETA-14 (HR-14 pump end)

Helical rotor pumps vibrate due to the eccentric rotation of the helical rotor. This is normal. Rubber spacers reduce the vibration that may be transferred to the well casing. Models –03 and –04 vibrate only slightly so they are not supplied with rubber spacers.

PHOTOS REMOVED FOR DOWNLOAD VERSION

PHOTO LEFT
These helical rotor models do NOT have rubber spacers ETA-03 (HR-03)
ETA-04 (HR-04)
ETA-04H (HR-04H)

PHOTO RIGHT
These models have rubber spacers

ETA-07 (HR-07)
ETA-14 (HR-14)

Clearance for drilled well casings Rubber spacers fit a 6” (150 mm) inside-diameter or larger well casing.

Cut the rubber spacer legs shorter if you are installing the pump in a smaller well casing. Grooves indicate where to cut for a 4” (100 mm) casing. Use a fine-tooth saw to cut the rubber.

7.2 Machine Installation

If you are professionally equipped to install conventional AC submersible pumps, you can use the same equipment and methods for *ETAPUMP*. *ETAPUMP* has no special pipe requirements. You can use any suitable rigid or flexible pipe. See Section 6.2 Drop Pipe, and Section 13.2 Water Pipe Sizing Chart.

7.3 Hand Installation

WARNING Hand installation can be hazardous. There are potential hazards in handling any heavy mechanical assembly. We do not encourage hand installation or removal except in shallow-water situations. If you have any doubts about your ability to install or removal a pump safely and economically, hire a professional pump service contractor!

Before considering installation or removal by hand, calculate the weight of the system (with water in the pipe) and make sure you have enough people to help. If you have any doubts about the safety or feasibility, hire a professional pump service contractor.

Example of cable weight — #10-4 submersible cable weighs approximately 25 lbs. per 100 ft. (40 kg per 100m). Each larger size (smaller AWG#) weighs approximately 30% more.

Weight of water in a pipe (lbs.) = pipe diameter (inches)^2 X 0.34 X length (feet)
Example: Water in 100 feet of 1" pipe weighs about 34 lbs.

Polyethylene pipe (black rolled pipe) Polyethylene (PE) is often used for solar pumps that are installed by hand, especially in remote areas that are not accessible to a pump service truck or where transportation of rigid pipe is difficult. You can expect good results if you follow these warnings.

WARNING Follow these precautions when using polyethylene (PE) pipe.

1. In North America, most professional pump contractors do NOT have the equipment to pull PE pipe. Their equipment is designed for rigid pipe in 21' joints. Do not use PE pipe unless you can be prepared to handle its total weight (full of water) in the future, in pump service is required.
2. Do not exceed the pressure rating of the pipe. The most widely available PE pipe has a maximum pressure rating of 100 PSI (7 bar). This is equal to 230 feet (70m) of total vertical lift.
3. Use only threaded adapters that are designed for the pipe you choose. Do not use galvanized steel adapters. They will rust through.
4. Do not use any sealing compound with PE pipe adapters.
5. If you use insert adapters with hose clamps, use TWO clamps at each adapter. Tighten the clamps with a wrench, not just a screwdriver. Use "all stainless" hose clamps. (Automotive clamps have carbon steel screws that will rust and fail.)
6. Have some extra hose clamps on hand in case you strip one.
7. Have an extra coupling on hand in case you bend the pipe too sharply (kink it) and make a weak spot.
8. PE pipe will stretch about 1%. Make the electrical cable and safety rope about 1.5% longer than the pipe so when the pipe stretches, the cable and splice will not be stressed.

WARNING DO NOT USE A ROPE WINCH to install or remove a pump in a drilled well casing (borehole). If you use a winch to pull the pump by winding up rope or wire rope, the electrical cable can slip down the pipe and/or the pipe can collapse. If the pipe or cable jams and gets wedged in the casing, you can lose your equipment and even permanently block the well! Some installers use a winch with a reel of about 3 feet (1m) diameter or larger, to pull flexible pipe. This is ideal if you have the equipment and experience to do the job safely.

WARNING DO NOT USE A VEHICLE to install or remove a pump. During removal, the pump can catch on joints or edges in the well casing. Damage or loss of the pump can occur before the vehicle operator can react.

7.4 Sanitizing the Well

Sanitizing a well will kill bacteria that may have been introduced during the pump installation. This can be done with chlorine bleach or a dry chlorine compound poured down the well just before or just after a pump is installed. Consult a local supplier or environmental health authority for a recommended procedure. *ETAPUMP* will not be damaged by normal quantities of chorine compound.

8 OPERATING THE ETAPUMP (Solar-Direct)

PHOTO – Control panel REMOVED FOR DOWNLOAD VERSION

The control panel is located at the end of the controller (generally the bottom) where the wires enter.

INDICATOR LIGHTS

System ON	***green***	The system is switched on and solar array voltage is present
Pump ON	***green***	Motor is running
Tank FULL / OFF	***red***	Connection is made between the float switch terminals, pump is off
Water Source LOW / OFF	***red***	Low-water probe is out of the water (or its connection failed). After the water level recovers, the light will stay on for the remainder of the day (or until power is interrupted). This will inform you that the water source ran low at least once during the day.

Starting the pump Be sure there is not a closed valve or other obstruction in the water line! Switch on the array disconnect switch and the power switch on the controller. Leave the switches on at all times, unless you desire to have the system off.

The pump should start under the following conditions
1. clear sun at an angle of about 20° or more from the surface of the solar array
2. cloudy conditions, if the sunshine is bright enough to cast a slight shadow
3. low-water probe submersed in the water source (or bypassed in the controller)
4. full-tank float switch in low (break) position (or no connection in the controller)

When sunshine is insufficient When sunshine on the array is too weak for the pump to run, it will attempt to start about every 90 seconds. During each attempt, you will hear a slight noise in the controller.

When pump runs slowly (Pump ON) under weak sun conditions
1. ETAPUMP models that have “C” in the model number – These use a centrifugal pump end. In weak sun, the pump may spin without lifting water all the way to the outlet. This is normal.
2. ETAPUMP models that do NOT have “C” in the model number – These use a helical rotor (positive displacement) pump end. If the pump is turning, even slowly, water will be delivered at a slow rate.

When pump stops from a sudden shadow on the solar array
If a shadow suddenly passes over the array, like if you walk in front if it, the controller may get confused by the rapid voltage drop. It may make rapid on/off noises and a high-pitched noise, then stop. This does NOT indicate a problem. The pump will attempt to start again after the normal delay.

Time delays
1. After pump stops due to insufficient sunshine or overload fault – 90 SECONDS or less
2. After full-tank float switch resets – 20 SECONDS or less
3. After low-water probe regains contact with water in the source – 20 MINUTES

To force a quick start
To test or observe the system, you can bypass the normal time delays. Switch the on/off switch (or the power source) off for 2 seconds, then on again. The pump should start immediately if sufficient power is present.

When there is NO load on the motor
If the motor is tested without the pump attached, it will run for about 40 seconds, then it will stop. This is the controller’s normal response when there is no load on the motor.

8.1 Normal Noise and Vibration

Controller noise As the pump starts, you may hear slight high-pitched noises from the controller. This is normal.

Pump vibration Most *ETAPUMP* models use a HELICAL ROTOR pump end (those that do NOT have a “C” in the model number. Some vibration is normal with these pumps, especially at slow speed. Model ETA-14 (HR-14) vibrates the most, because of its large rotor. If this is disturbing, try to change the pump’s position so it does not hit the side of the well. If the pump is extremely noisy and not pumping water, the motor may be running in reverse. This is only possible if it was just installed or reconnected (see Section 5.8).

ETAPUMP models that have a “C” in the model number use a CENTRIFUGAL pump end similar to conventional pumps. They produce no significant vibration.

9 TROUBLE SHOOTING

If you have trouble, please read this section before calling for help.

If you call for help, please refer to the model and serial numbers of your pump and your controller or your *ETAPUMP Integrated System*™.
See SYSTEM REPORT, page 3.

We suggest that you obtain a MULTIMETER to make electrical measurements.
See Section 13.4 Obtaining and Using a Multimeter

9.1 If the Pump Doesn't Run

Most problems are caused by wrong connections (in a new installation) or failed connections, especially where a wire is not secure and falls out of a terminal. Please follow these instructions before calling for help.

The *System ON* light will indicate that system is switched on and power is available. This indicates that the connection to the power source is probably correct. It indicates that VOLTAGE is present. There may not be enough power behind it to start the pump, but it should make starting attempts about every 90 seconds.

Pump attempts to start every 90 seconds but doesn't run
The controller makes a slight noise as it tries to start the pump. The pump will start to turn or just vibrate a little.

1. There may be insufficient power reaching the controller. A solar-direct (non-battery) system should start if there is enough sun to cast a slight shadow. A battery system should start if the supply voltage is greater than 22V or 44V.
2. If the *Pump ON* light flickers more than once during the start, the controller needs repair.
3. If the pump was recently connected (or reconnected) to the controller, it may be running in reverse direction. See Section 5.8.
4. If the motor shaft only vibrates and will not turn, it probably has power on only two of its three wires. This will happen if there is a broken connection or if you accidentally exchanged one of the power wires with the ground wire. See Section 9.3, testing the motor circuit and the controller output.

9.2 Inspecting the System

Many problems can be located by simple inspection. No electrical experience is required for these steps.

Inspect the solar array

1. Is it facing the sun? (See solar array orientation, Sections 4.3 and 4.4)
2. Is there a partial shadow on the array? If only 10% of the array is shadowed, it can stop the pump!

Inspect all wires and connections

1. Look carefully for improper wiring (especially in a new installation).
2. Make a visual inspection of the condition of the wires and connections. Wires are often chewed by animals if they are not enclosed in conduit (pipe).
3. Pull wires with your hands to check for failed mechanical connections.

Inspect the controller

1. Remove the screws from the bottom plate of the controller. Move the plate downward (or the controller upward) to reveal the terminal block where the wires connect. (See Section 5.5.)
2. First, check for a burnt smell. This will indicate a failure of the electronics. Look for burnt wires and any signs of lightning damage.
3. Pull on the wires to see if any of them have come loose from the terminal block.
4. Inspect the grounding wires and connections! Most controller failures are caused by an induced surge from nearby lightning where the system is not effectively grounded. Ground connections must be properly made, tight, and free of corrosion. (See Section 5.2.)

Check the low-water probe

1. The probe system will work only if the pump's ground wire is connected to the controller ground.
2. The low-water probe is located near the top of the pump. Inspect it if you can.
3. Did the probe or the probe wire break? To test, bypass it by connecting a small wire from the probe terminal in the controller, to ground. If the pump works, there is a fault in the probe circuit.
4. Does the pump run when the probe is OUT of the water? This can happen if it is coated with sediment, minerals, bacteria or algae. These deposits, when wet, can provide a conductive path to the pump body that makes the probe "think" it is in the water. This is most likely to happen if the water is highly mineralized or salty (highly conductive).
5. Raise the pump so the probe is above the water. If the pump doesn't stop, disconnect the probe wire from the controller. Measure the resistance between the probe wire and ground. If it is less than 17KΩ (17,000 ohms), there is conductivity between the probe and the pump and the pump will run. This can be caused by deposits on the probe structure that hold moisture, especially if the water is highly mineralized (conductive).
6. If deposits on the probe are a problem, consider using a different type of probe or a different way to mount it, to isolate it more from the motor. Mount it on plastic pipe above the pump. You can also substitute a float switch if there is sufficient space in the water source. Connect one side of the switch to the probe terminal in the controller, and the other side to ground.
7. After years of operation, the probe may be "eaten away" by electrochemical action, especially in highly mineralized water. Replace the probe.

Check the float switch

1. Inspect the float switch. Is it stuck in the UP position?
2. The float switch will CLOSE contact to stop the pump if the tank is full. Was the wrong type of switch installed (one that opens contact on rise)?
3. To test for a fault, bypass it by disconnecting one float switch wire from the controller.

Force a quick start

If you restore a connection or bypass the probe or float switch, there is no need to wait for the normal time delay. Switch the on/off switch (or the power source) off for a few seconds, then on again. The pump should start immediately if sufficient power is present.

9.3 Testing the System

Test the solar array circuit

1. OPEN-CIRCUIT VOLTAGE You can do this easily by opening and switching off the array disconnect switch. The reading should be 72-96V (with a 48V nominal array) or 55-72V (with 36V nominal solar array). This should vary only slightly with solar intensity. This is "idle" voltage when no current is being drawn (no load).
2. VOLTAGE UNDER LOAD (with pump running) This should be 60-73V (with a 48V nominal array) or 45-55V (with 36V nominal solar array). This should vary only slightly with solar intensity.
3. CURRENT UNDER LOAD Measuring current is the way to determine if the solar array's output is equal to its full potential. This requires either a DC clamp-on amp meter or a conventional meter wired in series with the array circuit (by breaking either + or – connection and running the circuit through the meter). The current is determined by both the array AND the load in the circuit (the pump system). If the pump is not drawing full power, it will not draw full current.
4. SHORT CIRCUIT CURRENT This will give you an indication of the array output independent of the function of the pump system. This is extremely helpful if the pump is trying to start or does not seem to be getting full power.

   WARNING DO NOT make a direct connection (short circuit) across the solar array wires while they are connected to the controller. An amp meter connected across the solar array will cause a short circuit. There will be a high discharge from capacitors in the controller. This can damage the controller and your meter and will void your warranty.

   Measure short circuit amps only with the array DISCONNECTED from the controller. This will not damage the solar array if it is done for a minute or less. You can do this easily by opening and switching off the array disconnect switch. You should see a blue spark when short-circuiting the solar array exposed to sunshine. (Unlike other power generators, a short circuit will only cause current slightly higher than normal.)

If the solar array was connected to the controller in reverse

Reverse polarity (+/–) at the controller's POWER IN terminals will cause a fuse in the controller to blow immediately. It's purpose is to prevent serious damage to the controller. To replace the fuse, remove the four screws from the back of the controller and slide out the internal assembly. The fuse will be found behind the POWER IN terminals. Test the fuse by removing it from its holder and using your multimeter to test continuity. A spare fuse is taped inside the box. Additional fuses are available from electronic suppliers. The description is "5 X 20mm, 10 amp, time-delay". Do not substitute a different fuse. If the fuse blows for any reason other than reverse polarity, the controller must be repaired or replaced.

Test the controller power output (with power on)

1. Make these tests with the pump connected and the power turned on. Observe caution!
2. Use an AC voltmeter or a multimeter set to AC volts.
3. Measure between each combination of two pump wires (L1–L2 / L1–L3 / L2–L3).
4. Voltage should be 20-60VAC, depending on the power available and the load. Each reading must be equal.

Note: Any AC meter should be sufficiently accurate. It does not need to be a "True RMS" meter.

Test the motor circuit (with power off)

This resistance test will confirm the condition of the entire motor circuit, including the motor, pump cable and splice. Make this test if there is proper voltage at the controller input but the motor does not run.

1. Disconnect power from the controller, or just turn it off.
2. Disconnect at least two of the three pump power wires from the controller terminals.
3. Use a multimeter set on resistance (RX1 or Ω).
4. Measure between each combination of two pump wires (L1–L2 / L1–L3 / L2–L3).
5. The resistance should be .1 to 1.5 ohm (Ω), depending on the length and size of the pump cable. EACH READING MUST BE EQUAL.
6. Measure resistance between the ground wire and the power wires. Your meter should show either no reading, or more than 100 MΩ (that means 100 million Ω or 100 megohms). A lower reading indicates an insulation fault in a power wire to the pump.

9.4 If the Pump Runs But Flow is Less Than Normal

1. Is the solar array receiving shadow-free light? Is it oriented properly toward the south, and tilted at the proper angle? See Section 4.
2. Be sure you have the right pump for the total lift that is required – out of the well + up the hill. In the case of a pressurizing system, the pressure head is equivalent to additional lift (1 PSI = 2.31 feet).
3. Be sure all wire and pipe runs are sized adequately for the job. Refer to wire sizing in the pump sizing table, and to the pipe sizing chart in this manual.
4. Inspect and test the solar array circuit and the controller output, as described above. Write down your measurements.

Has the flow decreased over time?

1. The pump end (pump mechanism attached to motor) may be worn from abrasive material (sand, silt, clay) in the water. Is sediment accumulating in the water tank or pipes? If this has happened, remove the pump from the water source and purchase a replacement pump end. It can be easily replaced with common hand tools. (The assembly of pump end to motor is identical to that of conventional AC submersible pumps.)
2. Inspect the intake screen on the pump (only pumps with "C" in the model number have an intake screen.) It may be blocked by accumulated material. Clean it.
3. Remove the pipe from the pump outlet (check valve) and see if sand or silt is blocking the flow. If there is, See Section 6.6 Coping With Dirty Water Conditions.

The pump may be running in reverse

Pumps with a "C" in the model number (centrifugal) will produce partial pressure if they are run in reverse. Pressure may be sufficient to produce some flow from the well, but far less than normal. Other models (helical rotor) will not pump in reverse. Motor reversal only happens if the pump is wired to the controller improperly. This is possible if the pump wires are connected to the controller in the wrong order. See Section 5.8 "Wiring Order for Correct Rotation".

BEFORE CALLING FOR HELP
please prepare the following information

1. Controller model and serial number
2. Pump model and serial number
3. The status of indicator lights on the controller
4. Any meter readings that you have taken
5. Any other observations

10 Maintenance

10.1 Controller and Pump

Controller The controller is electronic with no moving or wearing parts. It requires no regular maintenance. Inspect it annually to see that it is securely mounted and that the wire entrances are sealed.

Motor Moving parts are water-lubricated and require no regular or preventive maintenance. The motor is permanently sealed and has no brushes or other frequently-wearing parts.

Pump end The pump mechanism (pump end) may be worn after some years if there is abrasive solids in the water. If the performance of the pump has dropped (but electrical measurements are normal) Inspect the pump end. If it is not blocked by sediment or corrosion, it is worn and must be replaced.. This can be easily done in the field, after the pump is pulled from the well. Replacement of the pump end requires only a 13mm wrench and (for helical rotor models) a 3mm hex key (Allen wrench).

10.2 Solar Array

Solar array mounting bolts Bolts tend to loosen as the array structure flexes in high winds. Check tightness. All bolts should all have lock washers to keep them tight.

Sun exposure Cut away any vegetation that will grow enough to block solar illumination. Shading even a small corner of the solar array may stop the pump, or greatly reduce its flow.

Solar array cleaning If there is dirt, mineral deposits, bird droppings or other debris stuck to the solar array surface, clean it with water, vinegar or glass cleaner.

Solar Array Tilt See Section 4.4.

Solar Tracker If the system uses a solar tracker, lubricate the bearings, check mounting bolts and mechanism. on On a passive tracker, the shock absorber(s) may fail every few years. To test, swing the tracker by hand. It should return slowly due to damping action of the shock absorber. If it returns immediately (and swings in the wind) replace the shock absorber. Refer to tracker manufacturer's instructions.

10.3 Electrical Wiring

Power wiring Inspect carefully. Any wires that are hanging loose should be secured to prevent them from swinging in the wind. Exposed wiring must be sunlight resistant and in good condition. In the case of a tracking array, look carefully for any wire damage due to rubbing or pulling as the tracker swings. If wiring was not performed to professional standards, improve it to prevent faults in the future.

Grounding Inspect the grounding system carefully. All connections must be tight and free of corrosion. Poor grounding can lead to damage from lightning-induced surges. See Section 5.2.

11 ETAPUMP WARRANTY

***ETAPUMP*® pumps, motors and controllers are warranted to be free from defects in material and workmanship for two (2) years from date of purchase.**

When purchased as part of an *ETAPUMP INTEGRATED SYSTEM*™ supplied directly or indirectly by Dankoff Solar Products, Inc., the pump and controller warranty is extended to four (4) years

Failure to provide correct installation, operation, or care for the product, in accordance with the instruction manual, will void the warranty. Product liability, except where mandated by law, is limited to repair or replacement, at the discretion of the manufacturer or importer.

Neither manufacturer nor importer is responsible for the labor or other charges necessitated by the removal, transportation, or reinstallation of any defective product.

Warranty does not cover damage due to failure to install the device properly, mishandling or abuse, failure to protect circuitry from weather exposure, failure to protect circuitry from overheating due to sun exposure, failure to protect from salt spray or other corrosive factors, failure to seal out insects, spiders or rodents, lightning, flood or other acts of nature.

Warranty does not cover damage due to sand or abrasive particles in the water, or incompatibility of pump materials with corrosive or reactive substances, or from running the pump with an insufficient supply of water.

No specific claim of merchantability shall be assumed or implied beyond what is printed on the manufacturer's or importer's printed literature. No liability shall exist from circumstances arising from the inability to use the product, or its inappropriateness for any specific purpose. It is the user's responsibility to determine the suitability of the product for any particular use.

In all cases, it shall be the responsibility of the customer to ensure a safe installation in compliance with local, state and national electrical codes.

12 ETAPUMP STANDARDS & ENVIRONMENTAL SPECIFICATIONS

ETAPUMP controllers are built to DIN-VDE regulations and carry the CE stamp indicating that the European Union electromagnetic interference standards (Dt. EMV) have been fulfilled. Printed circuit boards are conformal-coated against moisture. The enclosure is thick anodized aluminum, gasket-sealed and raintight for any outdoor environment (enclosure class IP55). The controller is suited to tropical conditions according to IEC 68-2-30. The controller is not submersible.

Temperature Ranges

Pump and motor	Water temperature 32° to 86°F (0 to 30°C)
Controller	Ambient temperature -13° to 140°F (-25° to 60°C)

Other system components The PV modules (solar panels) and the disconnect switch in the *ETAPUMP Integrated System*™ (complete PV-direct systems supplied by Dankoff Solar Products) are UL-listed and carry other international standard ratings.

13 REFERENCE SECTION

13.1 Principles of Operation

Solar array Photovoltaic (PV) cells produce electricity directly from sunlight (not from heat). Light causes electrons to jump from the top layer of the cell, into “holes” in the layer underneath. When a circuit is made between top and bottom layers, electric current. Each cell produces about 1/2 volt. As sunlight varies, the voltage stays nearly constant but the current (amps) varies.

A multitude of PV cells are connected in series for the desired voltage, and sealed under glass to make a “PV module”. *ETAPUMP* systems use 3 to 12 modules. The assembly of modules is called a “PV array”. There are no moving or wearing parts in PV modules. The glass used in high quality PV modules is tempered, and is extremely strong.

Brushless motor system *ETAPUMP* uses a brushless DC motor system consisting of a special 3-phase AC permanent magnet motor, and a controller that changes the solar DC power to 3-phase AC. The motor’s speed is determined by the frequency of the AC power. The controller varies the frequency to bring the motor up to speed slowly, without a power surge. It then adjusts the motor speed according to the power available from the sun.

Less expensive solar pumps have a traditional DC motor that uses “brushes” (small blocks of carbon-graphite) to conduct current to the spinning part of the motor. Not only do the brushes wear out in a few years, but it is necessary to have air in the motor and a perfect seal to keep water out. The *ETAPUMP* brushless motor is filled with water by design! It is lubricated by water and is entirely maintenance-free. It is similar mechanically to conventional AC submersible motors that have been proven for decades. It creates a spinning magnetic field that forces the shaft to spin.

Controller (EP-600 for solar-direct operation) The controller starts the pump slowly and adjusts its speed according to the pumping load and the power available from the solar array. Power output from the array is optimally matched to the load by *maximum power point tracker* (MPPT) and *linear current booster* (LCB) systems, to produce maximum power transfer throughout all conditions. The LCB function is analogous to an automatic transmission in an automobile. It starts the pump in “low gear” (it lowers the array voltage and boosts the current). Under low sun conditions, it stays in “low gear” to resist stalling. As sunlight increases, it advances continuously toward “high gear” (higher voltage). The MPPT system tracks changes in the array voltage. Array voltage varies primarily with temperature (higher at low temperatures). When the pump stalls in low sunlight, the controller switches the pump off to prevent heating of the motor.

The controller converts the DC power from the solar array to 3-phase AC power to run the motor. Motor speed (RPM) is proportional to the AC frequency. The frequency starts low (about 20 Hz), and increases gradually to a maximum of 3400 RPM (70 Hz). The pump is not allowed to operate below a minimum speed. The factory setting is 1000 rpm. This is a good setting under most conditions. It can be changed by an internal adjustment. A temperature sensor is installed in the controller to cut the power if it gets too hot for any reason.

The float switch circuit operates at 12VDC, carrying maximum current of 4.7mA. When the circuit is made, it stops the pump (opposite logic). This is so the pump will continue to operate if the circuit is accidentally broken.

The low-water probe circuit applies 5VDC to the probe. The water conducts a small amount of current from the probe to the body of the pump. If the probe is out of the water (the resistance of the circuit is more than 17 KΩ) the controller stops the pump. When the water level recovers, there is a 20 minute delay before restart.

Pump end – centrifugal models Pumps with a MODEL NUMBER CONTAINING “C” use a multi-stage centrifugal pump end, similar to that of conventional well pumps – this is for high volume at 75 feet (23m) or less.

Pump end – helical rotor models Pumps with a MODEL NUMBER THAT DOES NOT CONTAIN “C” have a helical rotor pump end (also called “progressive cavity” pump). The rotor fits closely into a rubber stator that has a helical groove. The space between the rotor and stator contains sealed cavities that trap water. As the rotor turns, the cavities progress toward the outlet. **PHOTOS REMOVED FOR DOWNLOAD VERSION**

13.2 Water Pipe Sizing Chart

Don't cheat yourself with undersized pipe! Use this chart to determine the additional head imposed on your pump due to pipe friction, based on flow rate, pipe size and pipe length. Consider the TOTAL pipe length from the pump to the pipe outlet or top of storage tank.

Pipe fittings impose additional friction loss. A 90° pipe elbow adds friction approximately equal to 6 feet (2m) of pipe.

SIZING CHART -- REFER TO www.dankoffsolar.com --- reference section.

13.3 Freeze Protection for Solar Water Pumps

Burying the pipe In a cold climate, water can freeze in a pipe and block the water flow. This will cause an electrical overload that will prevent the pump from reaching full speed. The best way to prevent freezing is to install a pitless adapter at the wellhead and bury all piping below frost line (see section **Error! Reference source not found.** Wellhead Assemblies for Drilled Wells).

Will the pump drain back when it stops? NO! The pump has a check valve that stops water from draining back down when it stops. Helical rotor models (model number not containing "C") will not drain back even if the check valve is removed.

WARNING Do not install the pump with its check valve removed.

Weep hole If you have above-ground piping that must be drained for freeze protection, make a tiny "weep hole" in the drop pipe, below frost line. This will cause a constant but small leakage of water back into the well. When the pump stops, the pipe will drain slowly. The pipe must be sloped without low spots, so it drains completely. In plastic pipe, a weep hole can be made with a hot needle or an extremely small drill bit, or a needle valve can be installed and adjusted.

Weep hole—high tech version The most reliable dripping device is one that is engineered for a similar purpose. Drip irrigation systems use precise emitters to drip water reliably. A drip emitter resists accumulation of debris and mineral deposits far better than a simple hole or a needle valve. Drip emitters are rated in very low gallons (liters) per hour. Use a relatively fast one for best reliability. Emitters are very inexpensive. They are available from irrigation suppliers, nurseries, and many hardware stores. Drill a hole in the pipe to fit the emitter, and push the emitter into the hole.

Pressure relief If there is any possibility of a pipe freezing, install a pressure relief valve to prevent excess pressure in the pump line. Install it below frost line. Adjust the valve to open if it exceeds the pressure exceeds normal.

13.4 Obtaining and Using a Multimeter for Trouble Shooting

Most on-site trouble shooting requires a test instrument called a multimeter, which is available at electrical supply, electronic supply, automotive and hardware stores. Use it to measure DC voltage, DC current (amps) and resistance (ohms, symbolized by Ω). A digital meter is best. Here are the criteria for selecting a good meter.

Resistance ranges The meter must read in the 0-10Ω range to one decimal place. This includes all but the cheapest digital meters, and any analog meter that has at least three resistance ranges.

Ammeter ranges These are the options, listed in order of benefit and cost:

1. Milliamp range but no Amp range (under $35 in USA). This will be useful for voltage and resistance measurement, but not for current. It is sufficient for the most elementary trouble shooting.
2. Amp range to 10 or 20A. This will measure PV array current and pump running current. This will help you to solve performance problems.
3. DC/AC clamp-on ammeter. This allows measurement of current without disconnecting wires. We strongly recommend this type of meter if you maintain numerous solar pumps or other electrical equipment. Fluke Model 33 or 36 is the professional favorite. Cheaper ones have been unreliable. AC-only clamp-on meters will NOT measure DC current.

True RMS accuracy This is NOT NECESSARY for testing *ETAPUMP*.

Use two meters for easier testing. It helps to measure voltage and current simultaneously. An inexpensive meter is adequate for voltage, because precision is not necessary. Clip-wires or clip-probes are also helpful, if you don't have three hands.

Resistance readings are always taken with NO POWER applied to the circuit. Always use the LOWEST scale that produces a reading (for example RX1, not RX10).

Zero adjustment Some meters require zero-adjustment to insure accuracy. This applies to analog meters measuring resistance, and to clamp-on ammeters measuring current. Be sure to set the zero if necessary!

WARNING Read the instructions that come with your meter, and follow the safety warnings.

WARNING Attempting to read current (amps) between the two poles of a power circuit causes a potentially dangerous short circuit. Connect the probes IN SERIES with the circuit (see your meter's instruction manual).

WARNING To read voltage, the red probe must NOT be in the Amps socket. This will cause a short circuit.