Canyon Hydro

M300 Pico Hydro System

Installation - Operations - Maintenance

Version 2.0.0.1

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1. Introduction

The M300 Pico-Hydro is a water-driven power generation and storage system.

Commonly installed in remote or unpowered locations the M300 system provides electrical power to run a variety of equipment. Power generated is often used for data aquisition and transmission and powering local devices.

Common equipment powered by the M300 Pico-Hydro system include Remote Terminal Units (RTUs) for SCADA systems, pressure or flow control devices, radios, blowers, fans, sump pumps, and LED lighting.

Unlike wind or solar, the M300 Pico-Hydro operates efficiently in any kind of weather and can be installed out of sight in secure locations. Because power generation is readily available at all times smaller energy storage components are required thereby reducing system cost.

This manual is intended to help with installation, operation, and maintenance operations for the M300 Pico-Hydro System.

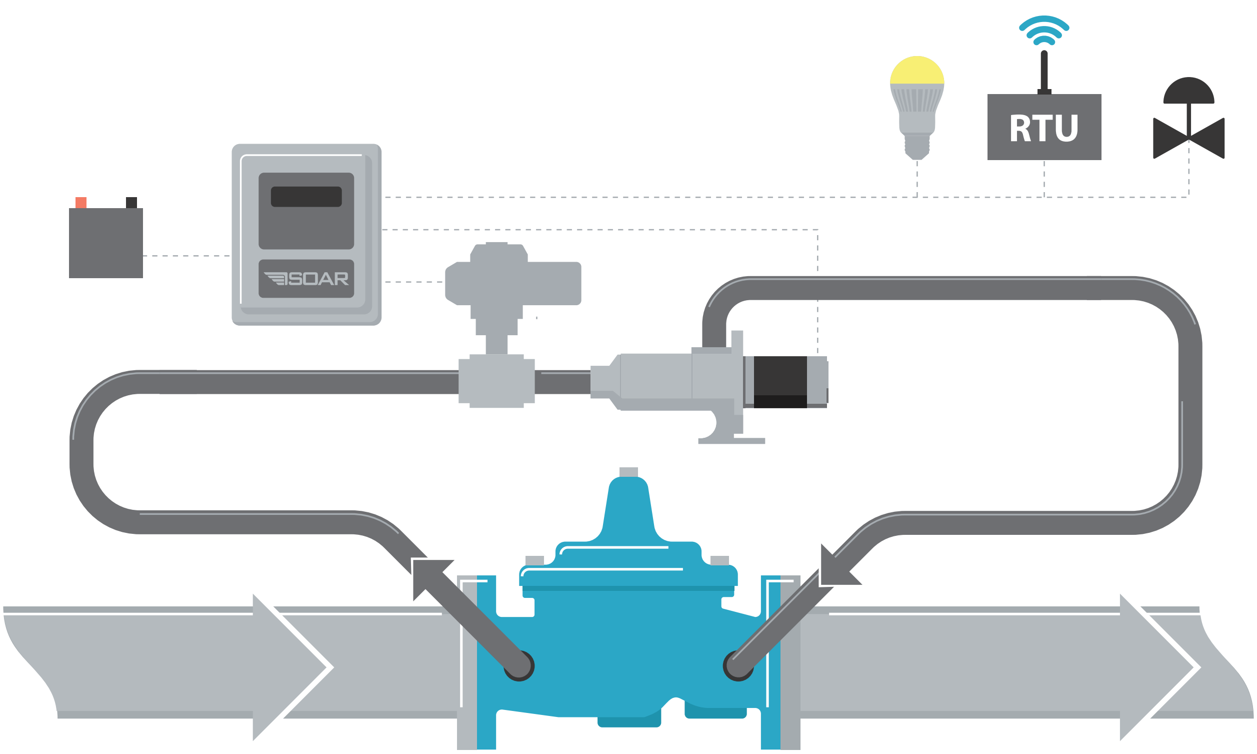
2. Theory of Operation

The M300 Pico Hydro System generates power by recovering energy at water network pressure drop locations. Water networks frequently use pressure reduction valves (PRVs) to reduce water pressure for water delivery operations. The Pico Hydro is installed in parallel with a pressure reduction valve and generates electrical power from the pressure differential.

The M300 system works by diverting a small portion of the flow around the PRV and into a hydroelectric turbine. Flow passes through the turbine and is converted from hydraulic energy into electric energy.

Generated electricity is sent to the control panel which provides system monitoring and control. The control panel intelligently distributes power to connected devices and a battery bank. Charge level is monitored and power generation is automatically matched to demand. Power output is regulated by a motorized valve which precisely modulates generation.

The battery bank’s stored power allows for uninterrupted operation of the connected devices in times of diminished water flow and permits short term high power consumption periods such as surge loads.



3. M300 System Components

M300-30 or M300-60 Turbine Generator Assemblies
- Converts hydraulic energy into electric energy

MHC2500 Control Panel & Motorized Valve
- Provide system optimization and generation control

Low Voltage Battery Bank
- Acts as a system ballast and stores energy for later use

3.1 M300-30 Turbine-Generator Assembly

M300-30 Turbine-Generator

- 15-32 PSI Net Head Applications
- 1.25 NPT Inlet / 1.50 NPT Discharge
- 1/2” Electrical Conduit Connection
- 300-Watt Maximum Output
- 11 x 10 x 9 Inch Overall Size

3.2 M300-60 Turbine-Generator Assembly

M300-60 Turbine-Generator

- 27-73 PSI Net Head Applications
- 1.25 NPT Inlet / 1.25 NPT Discharge
- 1/2” Electrical Conduit Connection
- 300-Watt Maximum Output
- 15 x 7 x 4 Inch Overall Size

3.3 Control Panel & Motorized Valve

MHC2500 Control Panel

- Provides system monitoring and control
- Displays current operation information
- Dynamically matches generation to load
- Maintains optimum battery charge levels
- Ensures battery bank is not depleted
- 12/24 VDC compatible
- 12 x 10 x 6 Inch Enclosure Size

Motorized Valve

- Modulates flow through system
- Operates on 4-20 mA signal
- 1.25 NPT Connections

3.4 Component Details

3.4.1 M300-30 & M300-60 Turbine-Generator Assemblies

Both the M300-30 and M300-60 Turbines are reaction style hydro turbines. Reaction style turbines develop torque by reacting to a fuild's pressure.

The amount of torque generated by a reaction style turbine is proportional to the pressure differential across it. The power generated by the turbine is a result of both the torque generated and the shaft speed.

In a water network application the pressure differential across the turbine is set by the PRV in parallel with the system. The PRV's upstream and downstream pressure settings will dictate those of the turbine.

The pressure differential across the turbine determines the maximum power output of the turbine as well as the flow rate through the turbine.

Both the M300-30 and M300-60 Turbines have a maximum rated output of 300-watts even though they operate across different pressure ranges. The M300-30 Turbine operates at lower pressure and passes more flow. The M300-60 Turbine operates at a higher pressure differential and requires less flow. This is reflected in the turbine performance charts located in the appendix.

Choosing the correct turbine for a particular application is done by evaluating the available net pressure differential (upstream pressure - downstream pressure). It is also important to consider the turbine's required flow rate to ensure adequate flow is available.

The maximum pressure differential across each of the turbines must be within their rated limits. Exceeding the rated pressure differentials can cause the turbines to over power the generator, damaging it.

> *CAUTION: Over powering the turbine-generator will result in permanent damage to the equipment and must be avoided.*

For applications in excess of each turbine's rated operating range it is possible to install a small pressure reducing valve in line with the turbine-generator, limiting the incoming pressure to the turbine. Consult the in line PRV diagrams in the appendix for further details.

For applications where flows drop below the turbine's rated flow or where flows diminish completely a small pressure reducing valve can be placed after the system to maintain downstream pressure. Consult the in line PRV diagrams in the appendix for further details.

A minimum 5 PSI of pressure must be maintained on the discharge side of either turbine. Maintaining this downstream pressure significantly reduces shaft thrust loads transmitted to the generator bearings. Discharging the turbine to atmospheric conditions can prematurely wear the bearings and lead to mechanical failure.

CAUTION: Discharge pressure must be equal to or greater than 5 PSI to avoid mechanical failure.

CAUTION: Water must be kept from entering the generator at all times. If water enters the generator it can damage the bearings and lead to premature failure.

3.4.2 MHC2500 Control Panel

The MHC2500 control panel is the brain of the M300 pico hydro system.

The user interface on the control panel provides information including system power output, battery voltage, and state of charge. If necessary this panel can be used to evaluate operating conditions and change control settings or setpoints. An explanation of the charge theory and a complete list of system menus/options with explanations are located in the appendix.

The control panel takes incoming AC power from the turbine-generator, regulating and rectifying it for DC operation.

Battery state of charge is continuously evaluated by the control panel. The control panel matches demand with generation by modulating the motorized valve and adjusting the turbine pressure differential.

In times of zero load and full charge capacity the system will go into standby, stopping generation (and flow through the system) until additional power is needed. Once load resumes the control panel will re-open the motorized valve and the turbine will resume generation.

The control panel automatically adjusts itself for 12V or 24V operation, no configuration is needed. In most cases the default settings and setpoints can be left as-is and the unit can be used as shipped from the factory. Always use caution when adjusting factory setpoints.

3.4.3 Electronic Motorized Valve

The electronic motorized valve provides power output control of the turbine-generator. It does so by modulating from fully open to fully closed, precisely controlling the pressure differential available to the turbine. Control of the motorized valve is done with a 4-20 mA signal from the control panel. There is an additional 4-20 mA signal sent back to the control panel to verify position. The control panel is specifically configured for the factory supplied valve. Alternate valves may require adjustment of the control panel setpoints.

3.4.4 Battery Bank

Battery quantity and capacity depend on each specific configuration.
A battery bank sizing worksheet is located in the appendix to assist wth determining the size and quantity needed. The configuration MUST be determined before the unit can be installed.

It is always recommended to run a 24-volt system rather than a 12-volt system as transmission currents are significantly reduced. 12-volt systems do require an additional power supply to provide 24 vdc power to the factory supplied motorized valve.

If connecting multiple batteries together always consult local electrical specifications to determine the wire weight needed.

<u>A minimum 100 amp-hour battery bank is recommended for all applications.</u>

> *CAUTION: A 12V or 24V DC power source must be connected to the Control Panel for proper voltage regulation. Attempting to operate the system without a battery bank connected will result in damage to the control panel.*

4. Equipment Installation

4.1 Parts List

The following parts are necessary or recommended for installation and operation of the M300 Pico Hydro System.

4.1.1 M300 Pico Hydro System Components

- M300-30 or M300-60 Turbine/Generator Assembly
- Control Panel
- Electronic Motorized Valve
- Battery Bank

4.1.2 Additional Materials Required

- Y-Strainer
- Electrical Wire
- Battery Housing
- Junction Box
- Conduit
- Pipe and Fittings
- Mounting Hardware

4.1.3 Additional Materials Recommended

- Upstream Pressure Gauge
- Turbine Inlet Pressure Gauge
- Downstream Pressure Gauge
- Isolation Valves
- Pipe Unions
- Battery Disconnect Switch

4.2 Additional Materials Required

4.2.1 Y-Strainer

The Y-strainer is highly recommended for every application. If any debris enters the system it will immediately impact the system's operation. Cleaning the Y-Strainer is much less involved than removing the turbine-generator for dissasembly and removal of debris.

4.2.2 Electrical Wire

Enough electrical wire to connect all components to the charge controller. The table below specifies recommended wire weights for each circuit given a distance. Always refer to your local electrical specifications to verify the wire weight needed.

		Minimum Recommended AWG for given Wire Run Length					
Circuit from Control Panel to:	**Maximum Current**	**5 feet**	**10 feet**	**15 feet**	**20 feet**	**25 feet**	**30 feet**
Battery Voltage to SCADA	20mA	22 ga	22 ga	22 ga	22 ga	22 ga	22 ga
Inlet Valve Command	20mA	22 ga	22 ga	22 ga	22 ga	22 ga	22 ga
Inlet Valve Position	20mA	22 ga	22 ga	22 ga	22 ga	22 ga	22 ga
Inlet Valve Power	3A	18 ga	18 ga	16 ga	16 ga	14 ga	14 ga
M300 Turbine/Generator	13.5A	12 ga	12 ga	10 ga	10 ga	Not Recommended	
Battery Bank	25A	10 ga	10 ga				
Low Voltage Disconnects	10A (each)	Depends on Device Load - 10A Max Current per Circuit					

4.2.3 Battery Housing

A protected enclosure to store the batteries in. This can range from a small plastic enclosure to a large weatherproof cabinet depending on the installation.

4.2.4 Junction Box

It is helpful to install a junction box near the turbine to connect the generator pigtail to the transmission wires. Since the box will be located near the turbine and therefore water, it is recommended to install one that is weathertight.

4.2.5 Conduit

Enough conduit to cover all wires in and out of the control panel. Rigid conduit should be used for long runs and flex conduit can be used for the short run between the generator and nearby junction box.

4.2.6 Pipe and Pipe Fittings

All piping to and from the system should be two inch diameter or larger. Pipe between system components can be 1.25" permitted they are short lengths. For all plumbing avoid sharp bends and long runs of pipe to reduce pressure losses. Pressure losses through the piping can result in power loss from the generator and must be accounted for.

The connections on the M300 turbines are NPT threaded connections, consult the turbine-generator drawings for specifics.

4.2.7 Mounting Hardware

The M300 turbine-generator assembly and control panel should be securely mounted in a location that will not be flooded and is protected from the elements. Mounting dimensions can be found on the drawings located in the appendix.

4.3 Additional Materials Recommended

Additional components listed below can be useful during setup and troubleshooting operations. Recommended layout diagrams are included in this section and drawings can be found in the appendix.

4.3.1 Upstream Pressure Gauge

An upstream pressure gauge placed before the y-strainer will help verify the upstream pressure available to the system.

4.3.2 Turbine Inlet Pressure Gauge

An inlet pressure gauge, placed directly before the turbine inlet, will verify inlet pressure to the turbine. This will differ from the upstream pressure if the modulating valve is partially closed or if the y-strainer is clogged.

4.3.3 Downstream Pressure Gauge

A downstream pressure gauge, placed directly after the turbine discharge, will verify pressure differential across the turbine when used in conjunction with an inlet pressure gauge. This will also serve to verify the 5 psi downstream requirement is met preventing damage to the turbine-generator.

4.3.4 Isolation Valves

Isolation valves are recommended on either side of the system installation. This allows water supply to be shut off for installation, maintenance and service operations. Isolation valves should be a minimum 2” full-port type.

4.3.5 Pipe Unions

It is recommended to install the motorized valve and turbine with pipe unions on either side to simplify removal for service.

4.3.6 Battery Disconnect Switch

A manual battery disconnect switch is recommended to be installed between the control panel and battery bank.

4.4 Connected Devices

4.4.1 Low Voltage Disconnects

Three relay circuits are provided for wiring connected devices to the control panel. Each circuit is rated for 10 amps maximum. These circuits will all operate at the supplied voltage level.

Each relay circuit can be configured to automatically disconnect if the battery reaches a low voltage setpoint. This can be useful to prevent over-draining the battery bank.

If the instantaneous load from the connected devices exceeds the generator output, battery voltage (charge level) will drop. If the load continues to deplete the battery bank charge level it can damage the battery and/or take the entire M300 system offline.

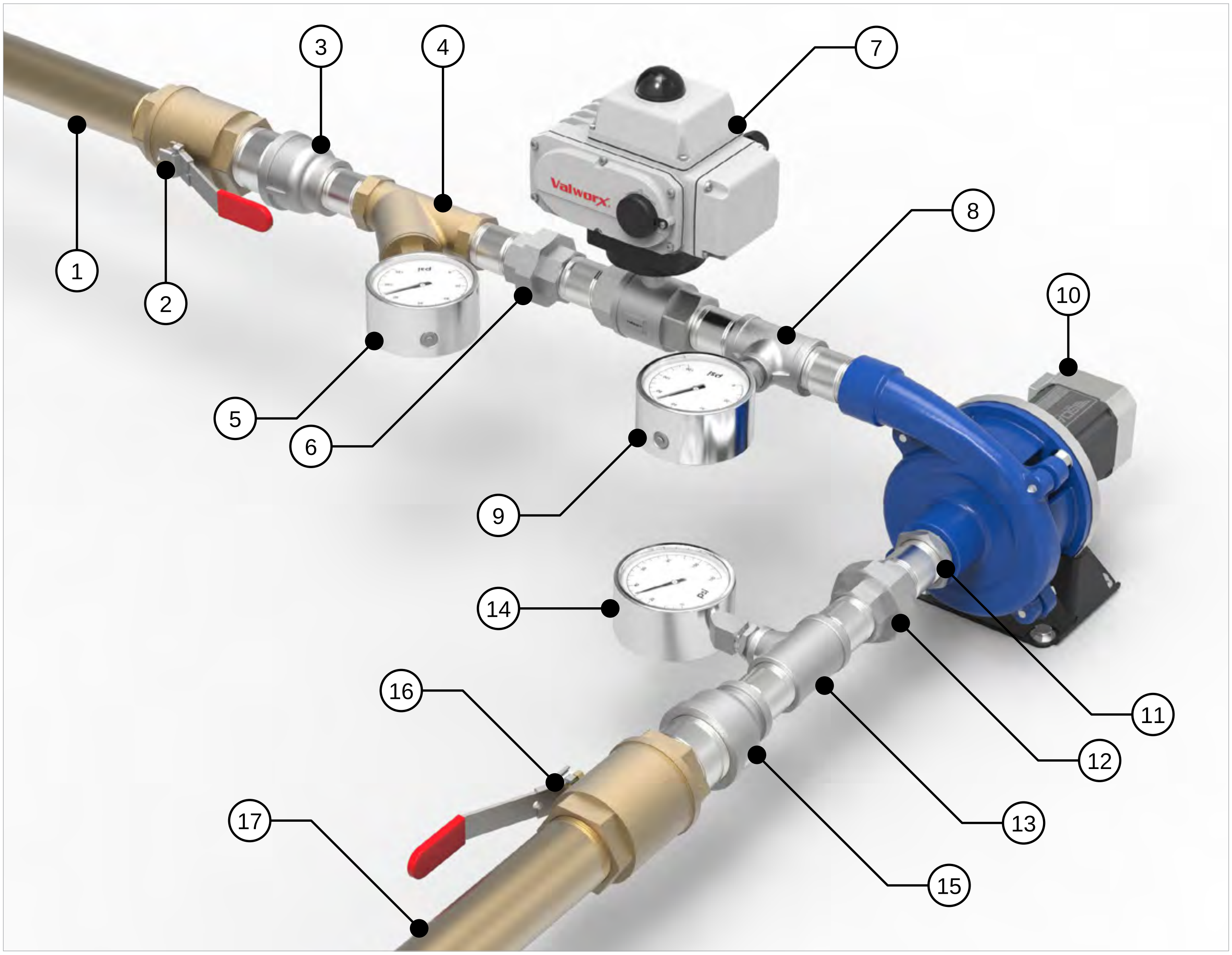
The low voltage disconnect option for the connected device circuits protects the system from fully draining itself. If this option is enabled the system wil automatically cut power to that circuit when battery voltage levels reach the low voltage disconnect setpoint.

By default this disconnect is disabled and can be enabled in the software settings within the control panel if desired.

It is recommended to enable this on circuits that may have loads higher than generation levels. For connected devices with low power draw where uninterrupted service is desired this option can be disabled.

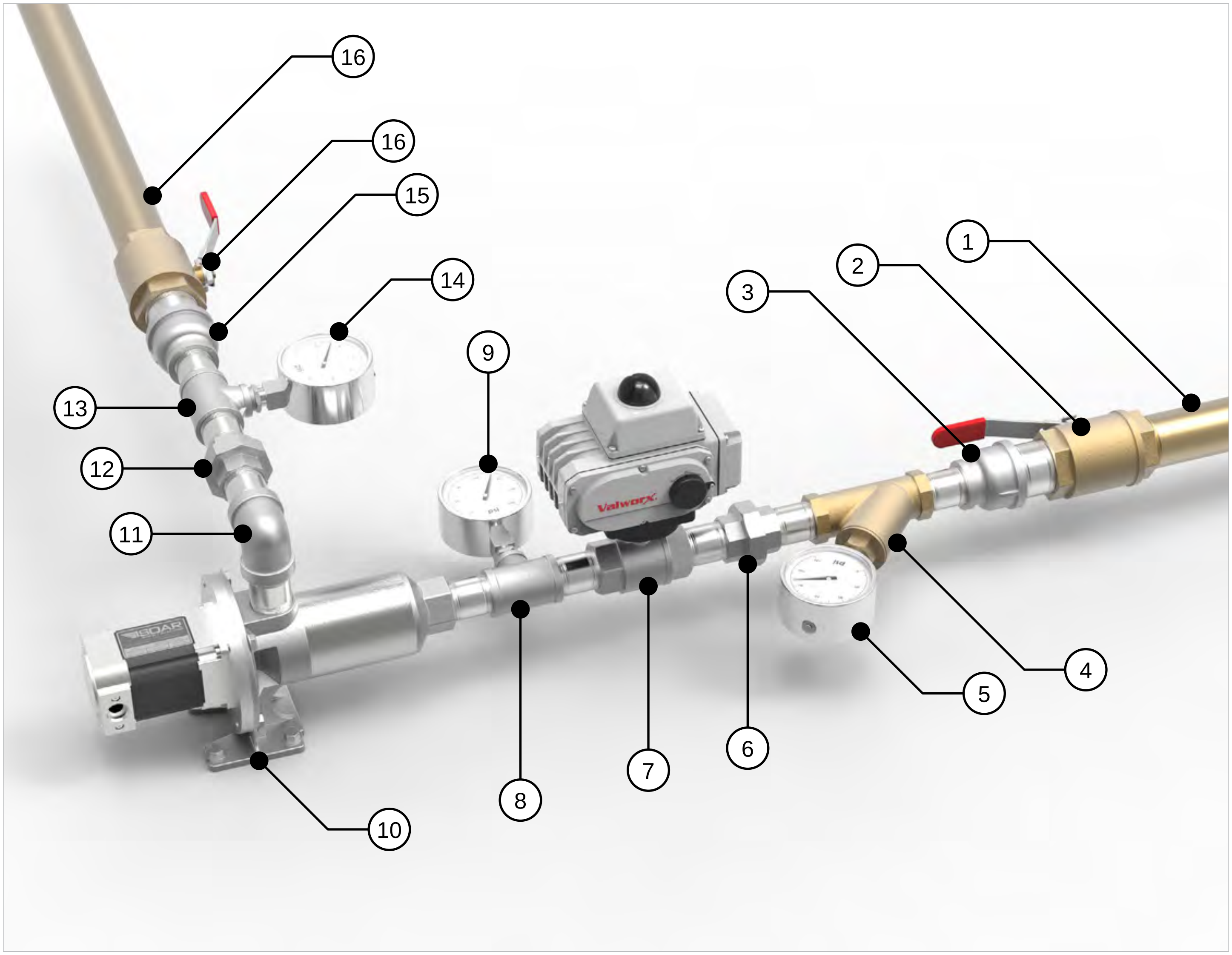
Default factory settings have the low-voltage disconnect disabled.

4.5 M300-30 Recommended System Layout



1. 2” Upstream Piping
2. Isolation Ball Valve, Full Port, 2” NPT
3. Reducer, 2” x 1.25” NPT
4. Y-Strainer, 1.25” NPT
5. Upstream Pressure Gauge, 0-100 PSI
6. Pipe Union, 1.25” NPT
7. Electronic Motorized Valve, 1.25” NPT
8. Tee, 1.25 x 1.25 x 0.75” NPT
9. Inlet Pressure Gauge, 0-100 PSI
10. M300-30 Turbine Generator Assembly
11. Bushing, 1.5 x 1.25” NPT
12. Pipe Union, 1.25” NPT
13. Tee, 1.25 x 1.25 x 0.75” NPT
14. Downstream Pressure Gauge, 0-100 PSI
15. Reducer, 2” x 1.25” NPT
16. Isolation Ball Valve, Full Port, 2” NPT
17. 2” Downstream Piping

4.6 M300-60 Recommended System Layout



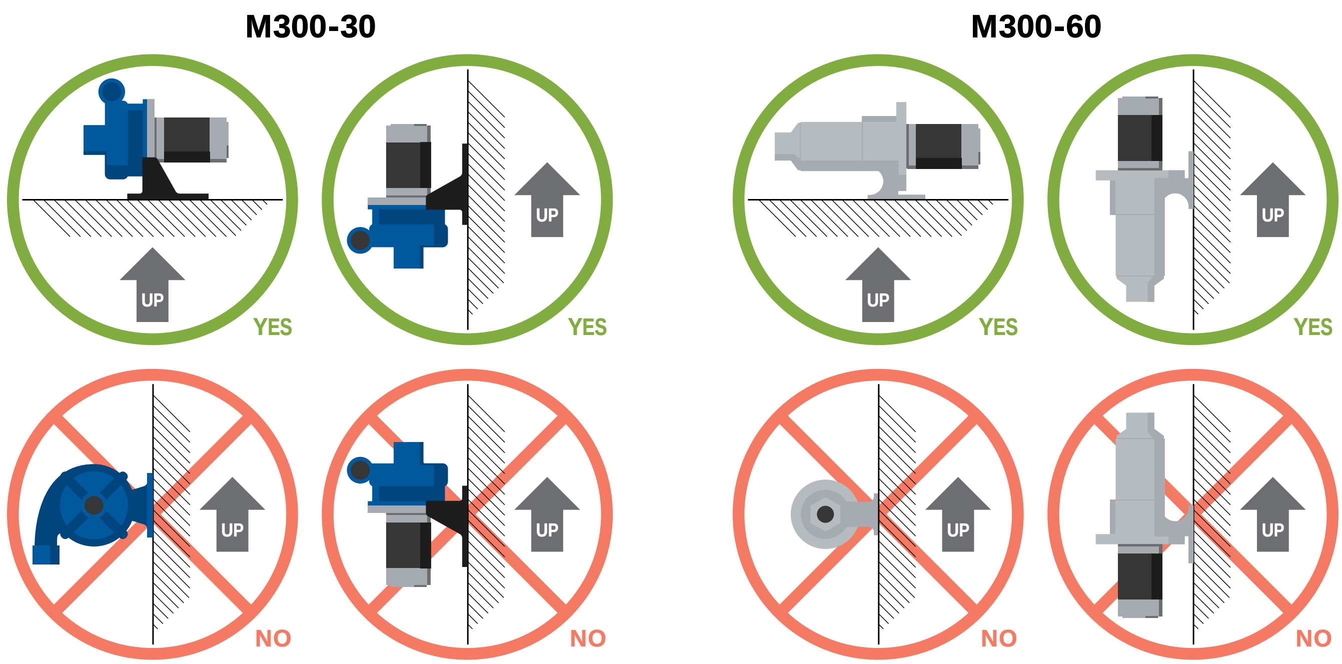
1	2” Upstream Piping	10	M300-60 Turbine Generator Assembly
2	Isolation Ball Valve, Full Port, 2” NPT	11	90 Degree Elbow, 1.25” NPT
3	Reducer, 2” x 1.25” NPT	12	Pipe Union, 1.25” NPT
4	Y-Strainer, 1.25” NPT	13	Tee, 1.25 x 1.25 x 0.75” NPT
5	Upstream Pressure Gauge, 0-100 PSI	14	Downstream Pressure Gauge, 0-100 PSI
6	Pipe Union, 1.25” NPT	15	Reducer, 2” x 1.25” NPT
7	Electronic Motorized Valve, 1.25” NPT	16	Isolation Ball Valve, Full Port, 2” NPT
8	Tee, 1.25 x 1.25 x 0.75” NPT	17	2” Downstream Piping
9	Inlet Pressure Gauge, 0-100 PSI		

4.7 Installation Procedure

CAUTION: In all cases, installation should be done by a qualified mechanical or electrical personnel. Do NOT attempt to operate the turbine-generator assembly without a complete installation. Operating the turbine-generator without a fully installed system can be DANGEROUS and potentially DAMAGE the equipment.

4.7.1 Mounting the M300 Turbine-Generator

Mount the M300 turbine-generator assembly in a proper orientation as described in the diagrams below.



The turbine-generator assembly can be mounted on either a horizontal or vertical surface. When mounted on a vertical surface the unit must be oriented so that the generator is above the turbine to avoid water entering the generator from leaking or condensation. The assembly must also be mounted correctly to prevent air from being trapped inside the unit.

CAUTION: Failure to install the unit correctly could result in faulty operation and/or damage to the unit.

4.7.2 Connecting the system to the Water Supply

Arrange the M300 system in the following order. Drawings of the recommended layouts including additional components can be found in the appendix.

1. The y-strainer should be the first item on the upstream supply line to the turbine. This is in place to filter any debris from passing through the system. The flow passages inside the turbine may become blocked if any debris enters the turbine resulting in reduced power output or total equipment failure.

2. Next in line should be the motorized valve. This is placed upstream of the turbine and modulates the system power output as needed.

3. Last in line is the turbine-generator assembly. Ensure the turbine-generator is securely mounted.

NOTE: All piping and fittings leading to and from the M300 System should be 2-inch or larger. Pipe between system components can be 1.25-inch for ease of installation permitted they are short lengths. For all plumbing avoid sharp bends and long runs of pipe to reduce pressure losses. All isolation valves used in series with the M300 system should be 2-inch full port valves or larger. This sizing ensures efficiency of operation by minimizing pressure losses before and after the turbine.

4.7.3 Mounting and Wiring the Control Panel

The control panel should be mounted in a location that will not flood and is protected from weather. The control panel should be located within a maximum 20-feet of the turbine-generator and 10-feet of the battery bank. Longer distances will result in the need for heavier gauge electrical wire. It is important that the control panel and battery bank be mounted in locations that will experience similar temperatures as the charge controller evaluates atmospheric conditions and adjusts charge rates as needed.

NOTE: All electrical work should be completed by a qualified technician.

1. Securely mount the control panel using hardware.

2. Install an electrical junction box near the turbine, close enough that the wires from the generator can reach inside with enough length for connections.

3. Run conduit between the control panel and turbine-generator junction box. To run wires inside the control panel, drill or punch holes through the bottom of the cabinet. This will reduce the chance of water entering the cabinet.

4. Run a short length of flex conduit between the generator and junction box. Flex conduit is recommended to ease installation and facilitates removal of the turbine for service.

5. Run a separate conduit between the control panel and motorized valve. A separate conduit is advised to minimize the chance of electrical interference.

6. Run conduit between the control panel and battery bank. If a manual battery disconnect is to be used be sure to account for it's inclusion.

7. Run conduit from the battery bank to the control panel and then to any connected devices for circuits which may use the low voltage disconnect option.

All wire must be properly sized for each circuit. It is recommended using red wire for + connections and black wire for GND connections unless otherwise noted. Suggested wire sizes are listed in the materials required section of this manual.

Refer to the control panel wiring diagram for field wiring and terminal locations for each circucit.

8. Pull wire for each circuit through the conduit and terminate it at the proper locations.

4.7.4 Installing and Connecting the Battery Bank

The MHC2500 Control Panel is designed to be used wtih both 12 Volt DC and 24 Volt DC battery banks. Battery voltage is evaluated and setpoints are adjusted as needed. Any setpoints within the menu system for 12 volt will automatically double for 24 volt systems. ***At the time of installation batteries must be fully charged for the controller to sense the appropriate voltage*.** For 12 volt battery bank operation an optional power supply must be included to supply the factory supplied motorized valve with the proper 24 vdc power.

It is recommended to install a manual disconnect switch between the battery bank and the control panel to easily cut power when needed.

NOTE: Always follow manufacturer's recommendations for safe handling and storage of batteries.

A determination about the size and set up of your battery bank must have been made in advance of installation based upon the worksheets provided in the Appendix. Follow your local electrical codes for selecting the wire size when connecting multiple batteries. Be certain to have the information therein available before proceeding.

When setting up a battery bank there are two options for wiring the batteries together, in series or in parallel. Consult the battery bank sizing worksheet for different arrangements.

1. Once the batteries are wired together inside the enclosure, connect a wire from the (Battery +) terminal in the control panel to the battery's positive (+) terminal.

2. Connect a wire from the control panel's (Battery -) terminal to the manual Disconnect Switch. Make sure that the disconnect switch is in the 'off' position and connect a wire from the remaining terminal on the Disconnect Switch to the battery's negative (-) terminal.

4.7.5 Operation

Your M300 Pico Hydro System should now be fully installed and ready to operate. Proceed to the System Operation section of this manual for detailed start-up, operation, and shut-down procedures.

CAUTION: DO NOT RUN WATER THROUGH THE TURBINE-GENERATOR ASSEMBLY WITHOUT A FULLY INSTALLED SYSTEM AND CONNECTED BATTERY BANK. DOING SO CAN RESULT IN DAMAGE TO THE EQUIPMENT AND PERSONAL INJURY. READ THE SYSTEM OPERATION SECTION CAREFULLY AND FULLY BEFORE ATTEMPTING TO OPERATE THE SYSTEM.

5. System Operation

5.1 Initial System Startup

The following procedure should be followed the first time the system is brought online or when changes have been made to the system.

CAUTION: The control panel must be connected to the turbine and fully powered up before running water through the turbine-generator assembly. Failure to do so can result in DAMAGE to the control panel.

5.1.1 Recommended Tools

The following tools or equipment can be useful or necessary to perform a successful startup of an installed M300 Pico Hydro system.

- Digital Multimeter
- Upstream Pressure Gauge
- Turbine Inlet Pressure Gauge
- Downstream Pressure Gauge

5.1.2 Ensure All Wiring is Properly Connected

1. Check that the battery bank is properly wired
2. Check that the turbine-generator is properly wired
3. Check that the motorized valve is properly wired
4. Check that any connected devices are properly wired

5.1.3 Connect the Control Panel to the Battery Bank

Close the manual disconnect switch between the battery bank and the control panel. Check that the display on the control panel is powered up. <u>The control panel must be powered on to continue with system startup.</u>

5.1.4 Control Panel Screen Navigation

The MHC2500 control panel is the brain of the M300 Pico Hydro system. The display on the front of the control panel displays information on current operating parameters and allows for the viewing and editing of system set points. A complete list of system menus and options with explanations is listed in the appendix.

- To navigate through the screens, press the up and down arrows.
- To select a submenu or confirm an entry, press enter.
- To return exit out of a submenu press the minus (-) button.
- To return to the main menu press the minus (-) button multiple times.
- To clear an existing value use the clear (CLR) button.
- To enter a value use the number keys. Confirm an entry by pressing enter.

For most systems, the default options can be left as supplied from the factory. It is possible to reset all system setpoints to default if needed through the menus.

5.1.5 Check Motorized Valve Operation

The control panel can be used to verify the motorized valve is operating properly. To do so log on to edit system setpoints and manually open/close the valve. Water supply to the system should be turned off during this process.

1. Log on to the control panel to manually control the motorized valve

   Main Menu > 3LOGON

2. Enter code to edit the set points (1234) then press enter

3. Navigate to the valve operations menu

   Main Menu > 2SP > Valve C/-/O 123

4. Manually close the motorized valve by setting the 'Valve C/-/O 123' to 1 then press enter

5. Verify that the motorized valve is closed by checking the visual indicator located on the valve.

6. Manually open the motorized valve by setting the 'Valve C/-/O 123' to 3 then press enter

7. Verify that the motorized valve is open by checking the visual indicator located on the valve.

8. If the valve is operating properly, set the motorized valve operation back to automatic by setting the ‘Valve C/-/O 123’ to 2 then press enter and continue with system startup. If the valve is not operating properly, check all system wiring and verify any settings located on the valve are properly configured.

5.1.6 Pressure Test the System and Plumbing

This section only pertains If isolation valves are used, otherwise proceed to the following section.

1. Ensure the downstream isolation valve is in the closed position

2. Slowly open the upstream isolation valve, pressurizing the system

3. Check all plumbing for leaks and address as needed

5.1.7 Verify System Pressure Differential

Verify that the pressure differential across the system is within the expected range. This is the differential from before the motorized valve to after the turbine discharge. Do NOT exceed the following limitations for pressure differential.

Turbine-Generator Model	Maximum Pressure Differential
M300-30	32 PSI MAX
M300-60	73 PSI MAX

CAUTION: If excessive pressure differential is present in the system a small pressure reducing valve must be installed to reduce differential to acceptable levels. Exceeding the rated levels can result in over-generation and DAMAGE the equipment. See the appendix for adding a pressure reduction valve.

5.1.8 Flow Water Through the System

Once proper wiring is verified, the control panel is energized, motorized valve operation is verified and system pressure differential is verified proceed wth the following:

1. Slowly open any valves downstream of the system.

2. Slowly open any valves upstream of the system, allowing water to flow through

3. Check the system for leaks and address as needed

5.1.9 Check System Output

1. Use the display on the control panel to navigate to the display operation menu

   Main Menu > 1DSP > Operation

2. Check the Power(W) value to see current power output

3. Check the pressure differential across the turbine by evaluating the pressure at the turbine inlet and discharge. Note that the pressure at the turbine inlet can differ from the pressure upstream of the motorized valve if the valve is partially closed.

4. Consult the turbine-generator performance chart in the appendix to verify that power output matches expected output.

At this point the M300 Pico Hydro system should be fully set up and operational. The control panel will automatically evaluate charge status and loads, modulating generator output with the motorized valve.

<u>Extreme caution is advised when changing any setpoints.</u>

5.2 System Shutdown

The following procedure should be followed any time the M300 Pico Hydro system is to be brought offline.

1. Slowly close any isolation valves and shut off water supply to the system.

2. Disconnect the battery bank from the control panel, de-energizing the system.

5.3 System Startup

The following procedure should be followed any time the system is to be brought online after a temporary shut down. For first-time startups or startups after any system changes follow the procedure specified in the Initial System Startup.

5.3.1 Connect the Control Panel to the Battery Bank

Close the manual disconnect switch between the battery bank and the control panel to bring the system online. Check that the display on the control panel is powered up. The control panel must be powered on to continue with system startup and commence generation.

5.3.2 Flow Water Through the System

1. Slowly open any valves downstream off the system.

2. Slowly open any valves upstream of the system, allowing water to flow through

At this point the M300 Pico Hydro system should be fully set up and operational. The control panel will automatically evaluate charge status and loads, modulating generator output through opening and closing of the motorized valve.

6. Maintenance

6.1 System Maintenance

6.1.1 Regular Maintenance

The M300 Pico Hydro System does not require routine maintenance operations beyond periodic inspections. A visual inspection of the system should be performed once a month. The following list is a guide to check for possible system issues.

- Inspect the turbine-generator assembly for any leaks
- Inspect the system piping for any leaks
- Inspect for excessive noise or vibration of the turbine-generator
- Verify the power output of the generator is as expected. This is done by comparing the power output displayed on the control panel to the expected turbine output indicated on the turbine performance chart. Turbine inlet and discharge pressures must be known to do this.
- Verify that the motorized valve is operating as expected

6.1.2 Troubleshooting Guide

Should any issue be found during an inspection corrective actions should be taken. Below are a list of possible symptoms, causes and corrective actions.

Symptom	Possible Causes	Corrective Action
Turbine-Generator Leaking Water	Worn Seal	Factory Service by Canyon Hydro
	Worn O-Rings or Gasket	
Low Power Output	Clogged Y-Strainer	Clean Y-Strainer
	Air in Turbine/Piping	Bleed Air / Remount Turbine Correctly
	Debris Inside Turbine	Remove Debris from Turbine
	Loose Turbine Components	Remove, clean and reinstall loose components
Excessive Generator Noise	Worn Bearings in Generator	Factory Service by Canyon Hydro

6.1.3 Factory Service and Repair

It is recommended to send the turbine-generator assembly to the Canyon Hydro for any dissasembly or repair operations to ensure proper performance. All factory repairs will include performance testing and certification.

6.1.4 Spare Parts

If downtime is a concern it can be advantageous to keep a spare turbine-generator assembly on hand to change out and return the defective unit for factory service or repair.

7. Appendix

7.1 Planning Your System

7.1.1 Determining the Generator Power Output

The generator's power output is determined by the pressure differential across the system. To estimate power output first record the inlet and discharge pressures the M300 system will operate under, then calculate the net head.

Inlet Pressure		Discharge Pressure		Net Head
	-		=	
(PSI)		(PSI)		(Inlet-Discharge) (PSI)

The M300-30 turbine operates under a net head from 15-32 psi while the M300-60 turbine's range is 30-72 psi. Refer to the turbine performance chart to find the flow rate required. In standard applications excess flow will be passed by the parallel PRV so the flow rate indicated on the performance chart is a minimum requirement.

Required Flow		Available Flow
	<	
(GPM)		(GPM)

Use the performance chart to estimate the generator's power output in watts. Divide this by the system voltage (12V or 24V) to calculate the amps available. In most cases 24 volt systems are preferred however voltage will depend on what equipment is being run off the M300 power generation system.

Power Output		System Voltage		Generated Current
	/		=	
(Watts)		(12 or 24) (Volts)		(Amps)

Multiply this by the total possible hours per day the turbine will run to calculate the total daily amp-hours generated by the hydroelectric turbine. In most cases the daily runtime will be 24 hours.

Generated Current		Daily Runtime		Daily Supplied Amp-Hours
	x		=	
(Amps)		(Hours)		(Amp-Hours, Ah)

7.1.2 Calculating Equipment Power Draw

It is necessary to make sure that the total system power draw does not exceed the turbine's generational capacity. To do this, make a list of all devices that the generator will power and calculate the total required power draw. For each device it will be necessary to determine the required power.

Additionally, it will be necessary to determine each device's operating time - the total number of hours per day that the device is typically operating. Using the chart and equations provided below calculate the total daily power draw.

Device	Current Draw (amps)	Required Voltage (volts)	Required Power = Amps x Volts (watts)	Daily Runtime (hours)	Daily Power Draw = Watts x Hours (watt-hours)
Total Daily Power Draw of all devices: = Sum of all device daily power draws (watt-hours)					
Daily Required Amp-Hours: = Total Daily Power Draw / System Voltage (amp-hours)					

Compare the daily required amp-hours to the previously calculated daily supplied amp-hours. The daily requirements must not exceed the daily supply or the generator will not be able to keep the battery bank charged.

7.1.3 Determining Battery Bank Capacity

The minimum recommended battery bank size is 100 Amp-Hours. this should work for most applications not expecting significant surge loads. The battery bank serves as a system ballast and enables the possibility of temporary loads which exceed the turbine's power output. Having a battery bank is required in all applications, operating the system without one will immediately damage the control panel.

To size the battery bank for surge load applications it is necessary to know the surge load power draw and the expected duration.

Surge Load Power		Surge Load Duration		Surge Load Capacity
	X		=	
(Watts)		(Hours)		(Watt-Hours)

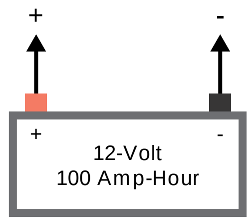
Surge Load Capacity		System Voltage		Ideal Battery Bank Capacity
	/		=	
(Watt-Hours)		(12 or 24) (Volts)		(Amp-Hours)

To ensure longevity it is important that batteries are not fully discharged. To prevent damage from occuring the battery bank capacity calculated above should be oversized by a minimum 15%.

7.1.4 Battery Bank Configurations

For some applications a single battery will be able to provide the required voltage and capacity however most applications will require the use of multiple batteries. When connecting multiple batteries they can be wired either in series or in parallel. Batteries wired in parallel will have the capacities added together while batteries wired in series will have their voltages added together. In both cases, all batteries should be identical and of the same age. Several common battery bank configurations are shown below.

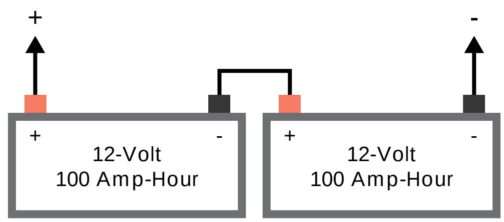
Single Battery



Supplied Voltage
12 Volts

Supplied Capacity
100 Amp-Hours

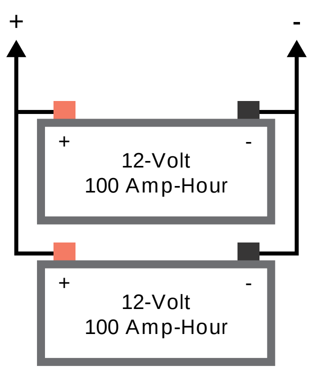
Dual Batteries
(wired in series)



Supplied Voltage
24 Volts

Supplied Capacity
100 Amp-Hours

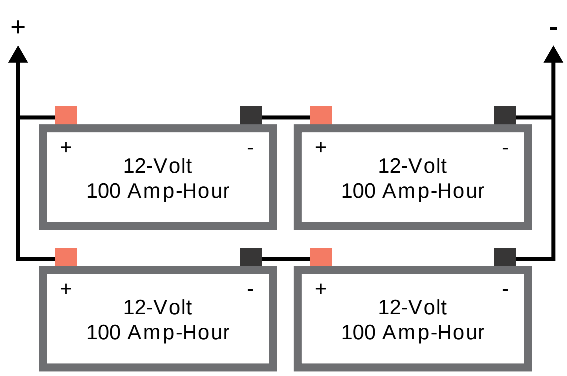
Dual Batteries
(wired in parallel)



Supplied Voltage
12 Volts

Supplied Capacity
200 Amp-Hours

Quad Batteries
(series and parallel)



Supplied Voltage
24 Volts

Supplied Capacity
200 Amp-Hours

7.2 MHC2500 Control Panel Charge Theory

The MHC2500 Control Panel is an advanced fully automatic 3-stage charge control system. Because of this, the charge system provides enhanced battery performance with less mainenance.

7.2.1 Multi-Stage Charge Control

Bulk Charge

- Bulk charge begins when battery voltage drops below the turbine start voltage setpoint. The system remains in bulk charge while battery voltage is below the acceptance charge voltage setpoint. While in bulk mode maximum power generation will be targeted.

Acceptance Charge

- When the battery recovers sufficient charge for voltage to rise to the acceptance charge voltage setpoint current is reduced as necessary to control at the acceptance voltage. The charge controller remains in acceptance for a set time as specified by the acceptance time setpoint.

Float Charge

- Once the battery is fully charged a somewhat lower float voltage is applied to maintain the battery in a fully charged state. In float charge the control panel will modulate turbine output to maintain charge level until the battery bank no longer accepts additional charging.

Equalize

In addition to the 3-stage charging a manual equalize function is included to periodically condition lead-acid batteries. Periodic equalization improves battery performance and life by bringing all battery cells up to the same specific gravity and eliminating electrolyte stratification. Equalization voltage is set by the system setpoint and duration is set by the equalization time setpoint.

Charge Mode	Approximate Charge Level
STOP	
BULK	<70% FULL
ACCEPTANCE	75% TO 95% FULL
FLOAT	FULLY CHARGED
EQUALIZE	----------------

7.2.2 Automatic Current Limit

The control panel has an automatic built in current limit to prevent damaging the internal wiring and components. Automatic current limit is set by the current setpoint. Current from the generator is limited through modulation of the electronic motorized valve.

7.2.3 Optional Temperature Compensation

The optional battery temperature compensation automatically adjusts charge voltage setpoints based on the atmospheric temperature of the control panel. If enabling this option it is imperative to have the battery bank and charge controller installed in the same atmospheric environment. The default compensation factor of is suitable for most lead-acid chemistry batteries. To disable temperature compensation set the setpoint to zero.

7.2.4 Automatic Voltage Sensing

The MHC2500 charge controller automatically detects 12 volt or 24 volt battery bank nominal voltage. Upon initial startup battery banks must be fully charged so that the controller senses the appropriate range. All setpoints in the system menus are automatically doubled for 24 VDC operation.

7.2.5 Battery Voltage to Customer SCADA

Wiring terminals are included in the control panel to send a battery charge level signal to a SCADA or similar system. To use this circuit, the control panel must be supplied with a +24VDC power source on the (+) terminal. The control system then returns a 4-20 mA signal (0-100% charged) on the (-) terminal.

7.2.6 Specifications

Specifications	MHC2500
Output Current Rating	25A
Nominal Battery Voltage	12 / 24 VDC
Generator Input Voltage	0-60 VAC
Standby Power Consumption	Typical operating power consumption. 1-watts
Maximum Power Consumption	Temporary, during motorized valve modulation only. 45-watts
Charge Algorithm	3-Stage: Bulk/Acceptance/Float
Turbine Start Voltage	11.9 V (Range 10.0 to 16.5 V)
Acceptance Voltage	14.4 V (Range 12.0 to 16.5 V)
Float Voltage	13.2 V (Range 12.0 to 16.5 V)
Equalization Voltage	15.2 V (Range 12.0 to 16.5 V)
Acceptance Time	120 Minutes (Range 5 to 360 minutes)
Equalize Time	120 Minutes (Range 5 to 360 minutes)
Temperature Compensation	Optional compensation adjusts charge voltage setpoints based on atmospheric temperature of the charge controller. -4.00 mV/°C/cell correction factor (Range -0.00 to -5.00 mV/C/cell)

7.3 MHC2500 Control Panel Menus

The MHC2500 control panel is the brain of the M300 Pico Hydro system. The display on the front of the control panel displays information on current operating parameters and allows for the viewing and editing of system setpoints.

- To navigate through the screens, press the up and down arrows.
- To select a submenu or confirm an entry, press enter.
- To exit out of a submenu press the minus (-) button.
- To return to the main menu press the minus (-) button multiple times.
- To clear an existing value use the clear (CLR) button.
- To enter a value use the number keys. Confirm an entry by pressing enter.

With 24-volt system operation, all voltage setpoints will be automatically doubled from their shown value.

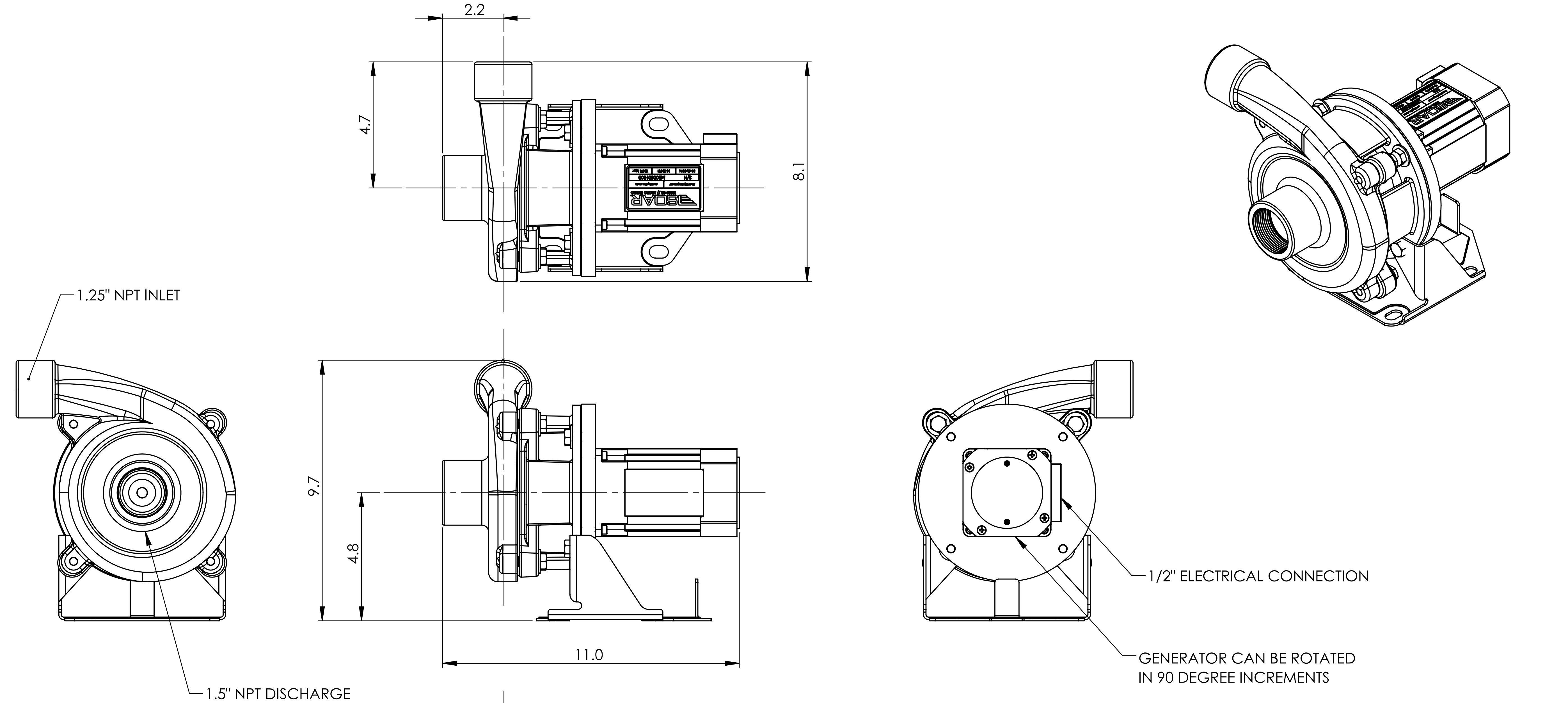
For most systems, the default options can be left as supplied from the factory. It is possible to reset all system setpoints to default if needed through the menus.

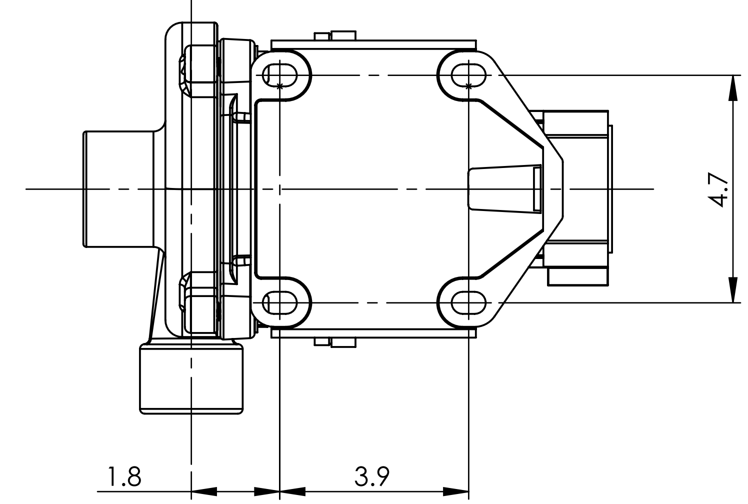
1 DSP	Displays the current operating paramaters and key setpoints
Operation	
Power(w)=	Displays the real-time generator output in watts
BattVolt(V)=	Displays the battery voltage
GenCurr(A)=	Displays the real-time generator output current in amps
State=	Displays the charge state (STOP, BULK/ACCEPTANCE, FLOAT or EQUALIZE)
Temp(F)=	Displays the control box atmospheric temperature in degrees F
Load1=	Displays the low voltage disconnect 1 circuit status (CONNECTED/DISCONNECTED)
Load2=	Displays the low voltage disconnect 2 circuit status (CONNECTED/DISCONNECTED)
Load3=	Displays the low voltage disconnect 3 circuit status (CONNECTED/DISCONNECTED)
OprReq(%)=	Displays the requested valve operating position (0% closed to 100% open)
Diagnostic	
Float(V)=	Displays the target float voltage setpoint in volts
Accept(V)=	Displays the target acceptance voltage setpoint
Equal(V)=	Displays the target equalize voltage setpoint
Disc(V)=	Displays the load 1,2&3 laod disconnect voltage setpoint (if disconnect is enabled)
Conn(V)=	Displays the load 1,2&3 load reconnect voltage setpoint (if disconnect is enabled)
Start(V)=	Displays the low voltage setpoint to commence generation
StartStop=	Displays if the control cabinet is allowed to start and stop the turbine (YES/NO)
OprReq(%)=	Displays the requested valve operating position (0% closed to 100% open)
OprPos(%)=	Displays the actual valve operating position (0% closed to 100% open)
About	Displays software version and contact information

2 SP	Displays (and allows modification when logged in) the control panel setpoints.
AcceptTime(Min)=	Time in minutes the acceptance voltage must be met before changing to float charge mode. Default=120
Accept(V) =	The acceptance voltage that must be met before changing to float charge mode. Default=14.4
BComp(mV/V/Vell)=	The battery temperature/charge voltage compensation set point. The compensation temperature is based on the control panel atmospheric temperature. If the control panel and battery bank experience differing temperatures set this to 0 (zero). Default=-5
Connect(V)=	The load 1,2&3 low voltage reconnect voltage. Default=12.6
Default(1/0)	Resets the factory defaults for all setpoints if set to 1.
DiscDly(Sec)=	The time in seconds the battery voltage must remain below the Disc(V) setpoint before disconnecting the low voltage disconnect circuits (if enabled). Default=300
Disconnect(V)=	The load 1,2&3 low voltage disconnect voltage (if enabled). Default=11.5
DiscDisab1(1/0)=	Disables or enables the low voltage disconnect for circuit #1. Default=1 (Disabled)
DiscDisab2(1/0)=	Disables or enables the low voltage disconnect for circuit #2. Default=1 (Disabled)
DiscDisab3(1/0)=	Disables or enables the low voltage disconnect for circuit #3. Default=1 (Disabled)
EqualTime(Min)=	The time in minutes to hold the equalize voltage (if started). Default=120
Equalize?(1/0)	If set to 1 this immediately starts the equalize process for the EqualTime(Min) setpoint duration at the Equal(V) setpoint voltage. ONLY FOR LEAD ACID BATTERIES.
Equal(V)=	The target voltage during equalize charge mode (if enabled). Default=15.2
Float(V)=	The target voltage during float charge mode. Default=13.2
ValveAnaGain=	The measured time for the motorized valve to change from fully open to fully closed. Value x 10 = time in seconds. Do not change unless using an alternate motorized valve than supplied from the factory. Default=0.6 (6 seconds)
ValveMinimumPos=	Sets the minimum allowable valve position (%). Default=0
CurrentSpt=	Sets the maximum allowable generator current. Default=25
TurbnOffDly(Min)	The time in minutes to hold float state voltage before closing the motorized valve to stop generation. Default=5
TurbnOnDly(Min)	The time in minutes the battery voltage must remain below the TurbineStart(V) setpoint before opening the motorized valve to start generation. Default=1
TurbnCntl?(1/0)	Disables or enables the controller's ability to adjust the motorized valve. Default=1 (Enabled)
TurbineStart(V)=	Low voltage set point at which the charge cycle begins. Default=11.9
Valve C/-/O 123=	Manually or automatically open and close the motorized valve. 1=closed, 2=automatic, 3=open. Default=2

3 LOGON	Log on to edit system setpoints. Enter code 1234-enter to edit the setpoints. Once a code has been entered the setpoints in '2 SP' can be edited. Always use caution when editing system setpoints.
5 CLK	Shows and allows editing of the internal system clock.
7 LCD	Allows contrast adjustment for the LCD display (1-255)
8 I/O	Shows the status of the input and output circuits for the control panel. A dot indicates an input/output not in use. A number indicates an input/output in use.

7.4 Equipment Drawings and Performance Curves





M300 MICRO HYDRO

Canyon Hydro
5500 Blue Heron Lane
Deming, Washington 98244
(360) 592-5552
the water power division of Canyon Industries, Inc

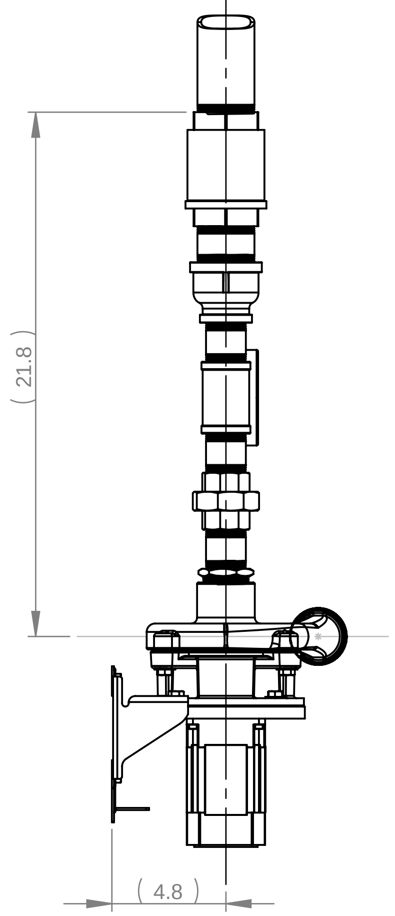
WEIGHT (lbs.)	
DRAWN BY:	RM
CHECKED BY:	

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE INCHES
TOLERANCES:
DECIMALS
.X± .03
.XX± .010
.XXX± .005
.XXXX± .0005
ANGULAR
±0.5°
FRACTION
±1/16
DO NOT SCALE DRAWING

REV	DESCRIPTION	DATE	APPROVED
0	Release for production	4/2/19	RM

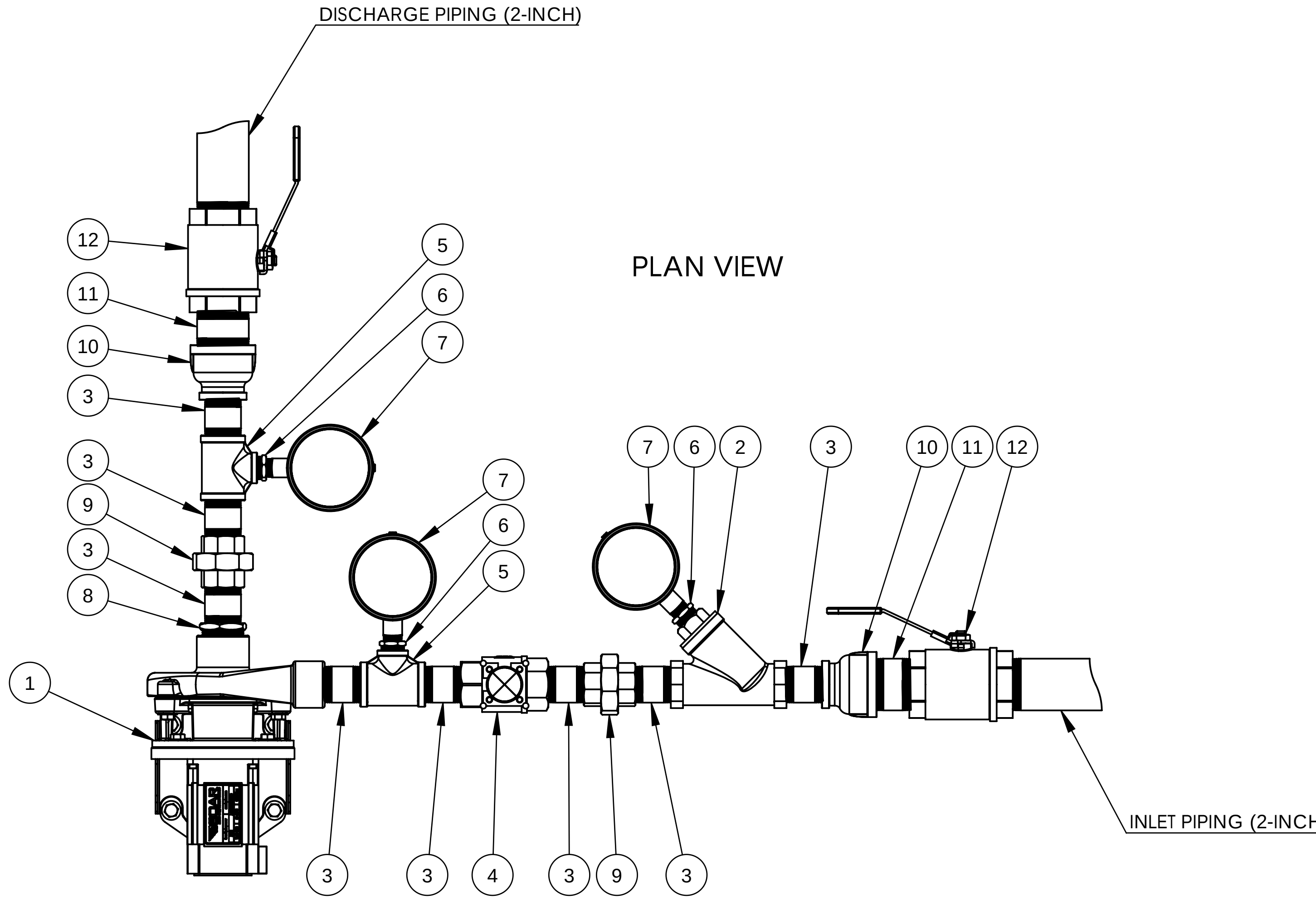
TITLE: M300-30 TURBINE/GENERATOR ASSY OVERVIEW			
DWG. NO. M300-2010	DATE: 4/2/2019		REV
SCALE: 1:4	SIZE: "B"	QBC:	0

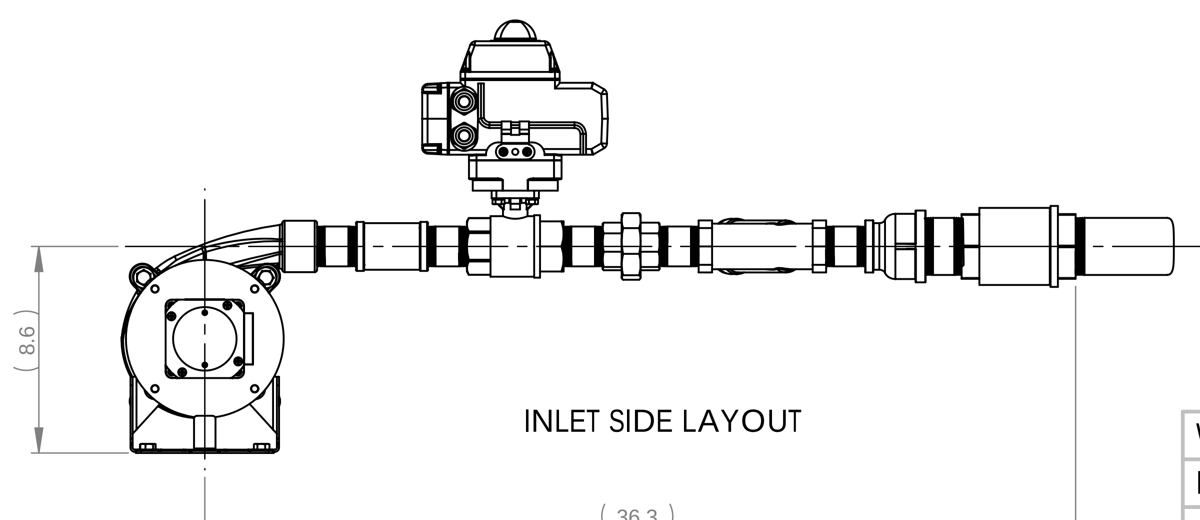
ITEM NO.	PART NUMBER	DESCRIPTION	M300-30 Std Layout/ QTY.
1	M300-201	M300-30 Turbine-Generator Assembly	1
2	M300-701	Y-Strainer, 1.25 NPT, 20-Mesh	1
3	M300-702	Connector Nipple, 1.25 NPT x 3"	8
4	M300-703	Electronic Motorized Valve, 1.25" NPT	1
5	M300-704	Tee, 1.25 x 1.25 x 0.75 NPT	2
6	M300-705	Bushing, 0.75 x 0.5 NPT	3
7	M300-706	Pressure Gauge, 0-100 PSI, 0.5 NPT	3
8	M300-707	Bushing, 1.5 x 1.25 NPT	1
9	M300-709	Union, 1.25 NPT	2
10	M300-710	Reducer, 2.0 NPT x 3.0"	2
11	M300-711	Connector Nipple, 2.0 NPT x 3"	2
12	M300-712	Isolation Ball Valve, 2.0 NPT	2



DISCHARGE SIDE LAYOUT

PLAN VIEW





INLET SIDE LAYOUT

NOTE: OVERALL ASSEMBLY LENGTHS AND HEIGHTS ARE FOR REFERENCE ONLY AS TOTAL ASSEMBLED LENGTH WILL DEPEND ON THREAD ENGAGEMENT OF EACH COMPONENT.

M300 MICRO HYDRO

Canyon Hydro

5500 Blue Heron Lane
Deming, Washington 98244
(360) 592-5552

the water power division of Canyon Industries, Inc

WEIGHT (lbs.)

DRAWN BY: RM

CHECKED BY:

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE INCHES
TOLERANCES:
DECIMALS
.X± .03
.XX± .010
.XXX± .005
.XXXX± .0005
ANGULAR
±0.5°
FRACTION
±1/16

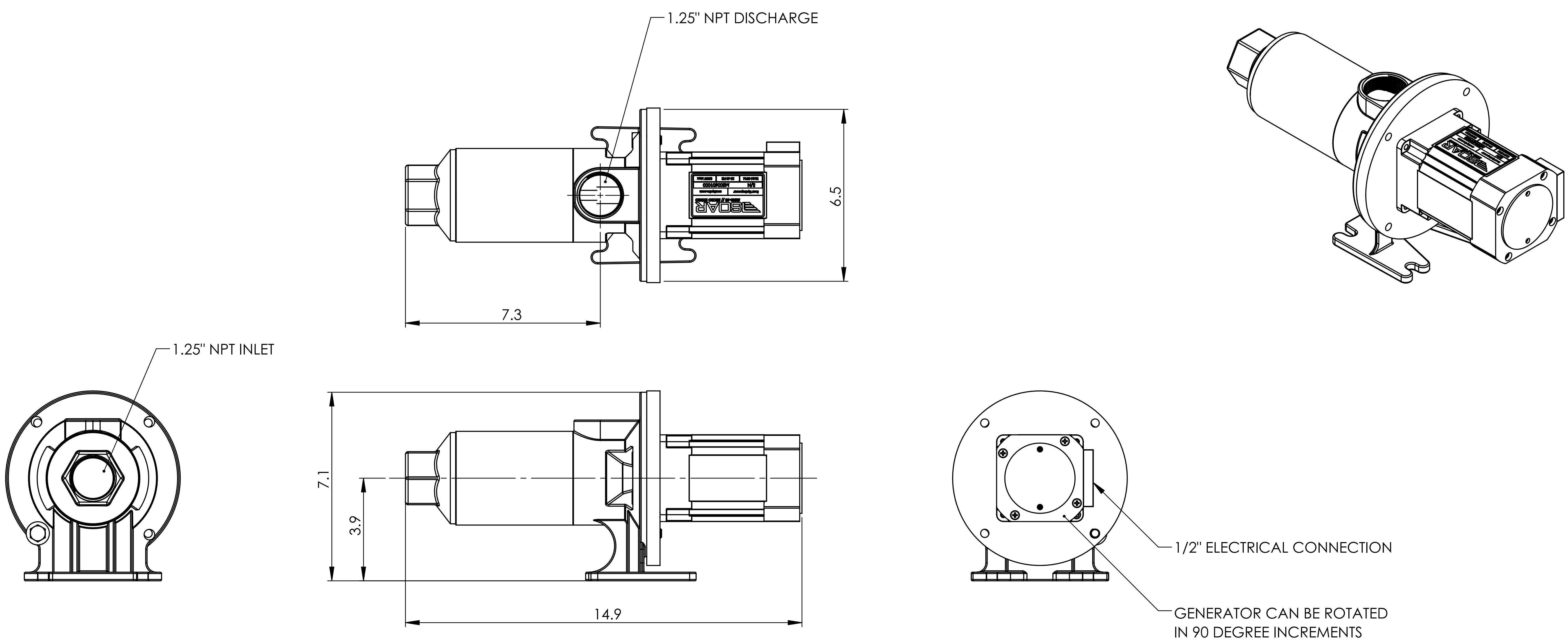
DO NOT SCALE DRAWING

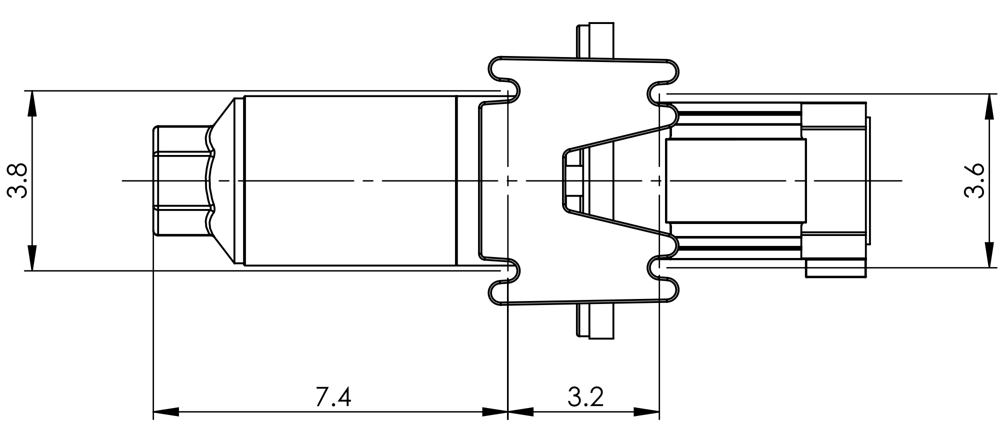
REV	DESCRIPTION	DATE	APPROVED
0	Release	11/27/18	RM

TITLE: M300-30 RECOMMENDED SYSTEM LAYOUT

DWG. NO. M300-2013 | DATE: 11/27/18 | REV 0

SCALE: 1:8 | SIZE: "B" | QBC:





M300 MICRO HYDRO

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5500 Blue Heron Lane
Deming, Washington 98244
(360) 592-5552

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WEIGHT (lbs.)	
DRAWN BY:	RM
CHECKED BY:	

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE INCHES
TOLERANCES:
DECIMALS
.X± .03
.XX± .010
.XXX± .005
.XXXX± .0005
ANGULAR
±0.5°
FRACTION
±1/16

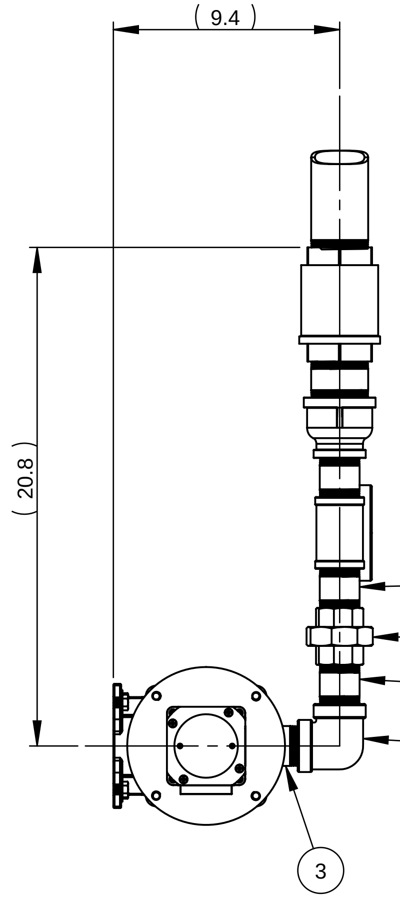
DO NOT SCALE DRAWING

REV	DESCRIPTION	DATE	APPROVED
0	Release for production	12/18/17	RM

TITLE: M300-60 TURBINE/GENERATOR ASSY OVERVIEW

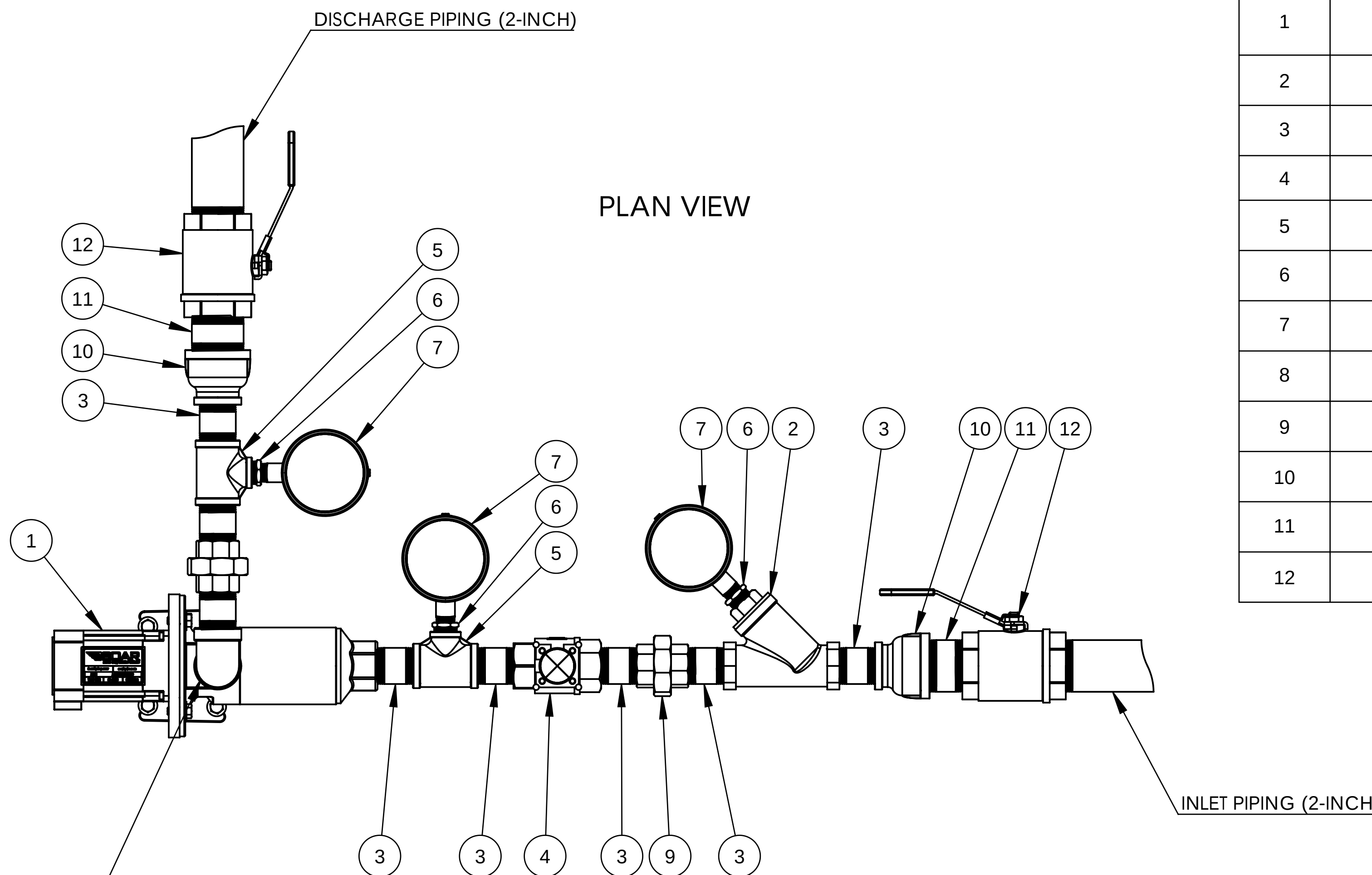
DWG. NO. M300-2020		DATE: 12/18/17	REV
SCALE: 1:4	SIZE: "B"	QBC:	0

ITEM NO.	PART NUMBER	DESCRIPTION	M300-60 Std Layout/QTY.
1	M300-202	M300-60 Turbine-Generator Assembly	1
2	M300-701	Y-Strainer, 1.25 NPT, 20-Mesh	1
3	M300-702	Connector Nipple, 1.25 NPT x 3"	9
4	M300-703	Electronic Motorized Valve, 1.25" NPT	1
5	M300-704	Tee, 1.25 x 1.25 x 0.75 NPT	2
6	M300-705	Bushing, 0.75 x 0.5 NPT	3
7	M300-706	Pressure Gauge, 0-100 PSI, 0.5 NPT	3
8	M300-708	Elbow, 90-degree, 1.25" NPT	1
9	M300-709	Union, 1.25 NPT	2
10	M300-710	Reducer, 2.0 NPT x 3.0"	2
11	M300-711	Connector Nipple, 2.0 NPT x 3"	2
12	M300-712	Isolation Ball Valve, 2.0 NPT	2



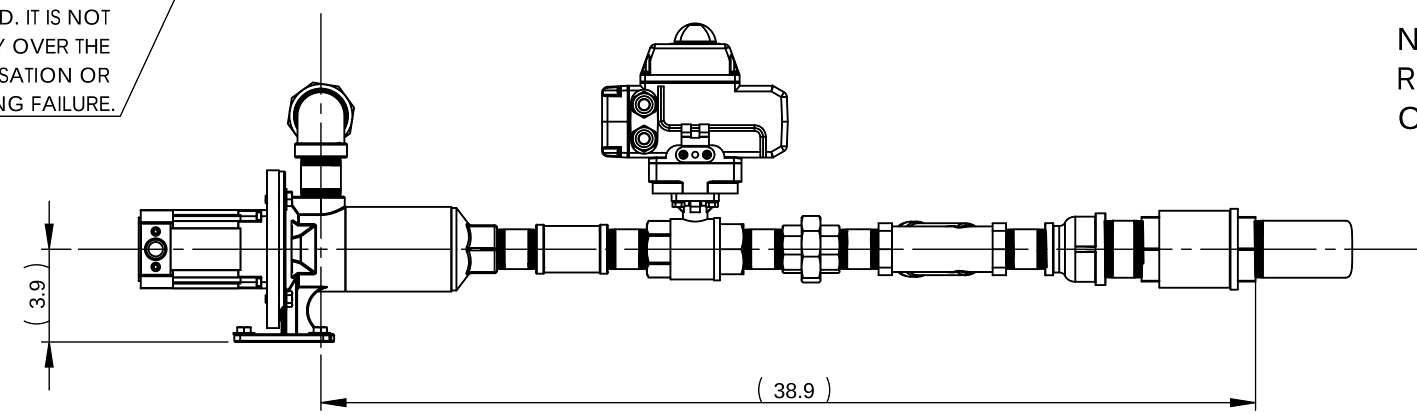
DISCHARGE LAYOUT

PLAN VIEW



DISCHARGE ELBOW CAN BE ROTATED AS NEEDED. IT IS NOT RECOMMENDED TO PASS DISCHARGE DIRECTLY OVER THE GENERATOR AS ANY DRIPS FROM CONDENSATION OR LEAKING ON TO GENERATOR CAN CAUSE BEARING FAILURE.

NOTE: OVERALL ASSEMBLY LENGTHS AND HEIGHTS ARE FOR REFERENCE ONLY AS TOTAL ASSEMBLED LENGTH WILL DEPEND ON THREAD ENGAGEMENT OF EACH COMPONENT.



INLET LAYOUT

M300 MICRO HYDRO

Canyon Hydro

5500 Blue Heron Lane
Deming, Washington 98244
(360) 592-5552

the water power division of Canyon Industries, Inc

WEIGHT (lbs.)	
DRAWN BY:	RM
CHECKED BY:	

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE INCHES
TOLERANCES:
DECIMALS .X± .03 .XX± .010 .XXX± .005 .XXXX± .0005
ANGULAR ±0.5°
FRACTION ±1/16
DO NOT SCALE DRAWING

REV	DESCRIPTION	DATE	APPROVED
0	Release	11/27/18	RM

TITLE: M300-60 RECOMMENDED SYSTEM LAYOUT

DWG. NO. M300-2023	DATE: 11/27/18		REV
SCALE: 1:8	SIZE: "B"	QBC:	0