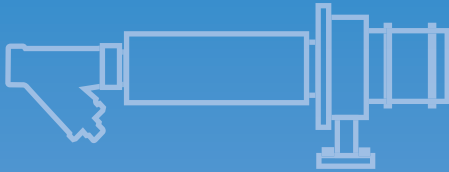


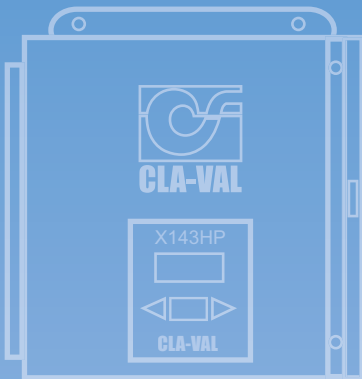
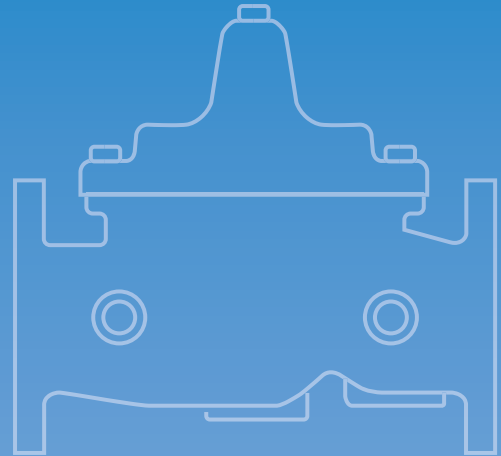


X143HP Hydro Powered Generator

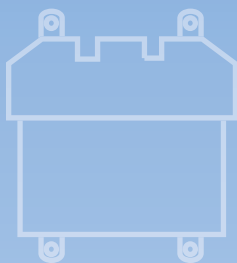
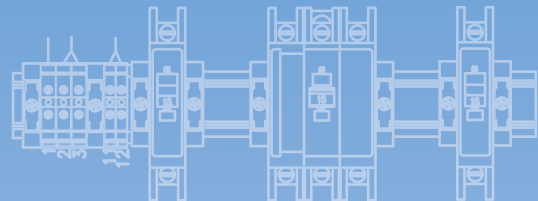
Installation • Operation • Maintenance



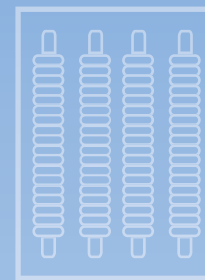
Power Generator Unit



DC Charge Controller Display



Battery Housing



Diversion Load

CLA-POWER

X143HP Installation, Operation and Maintenance Manual

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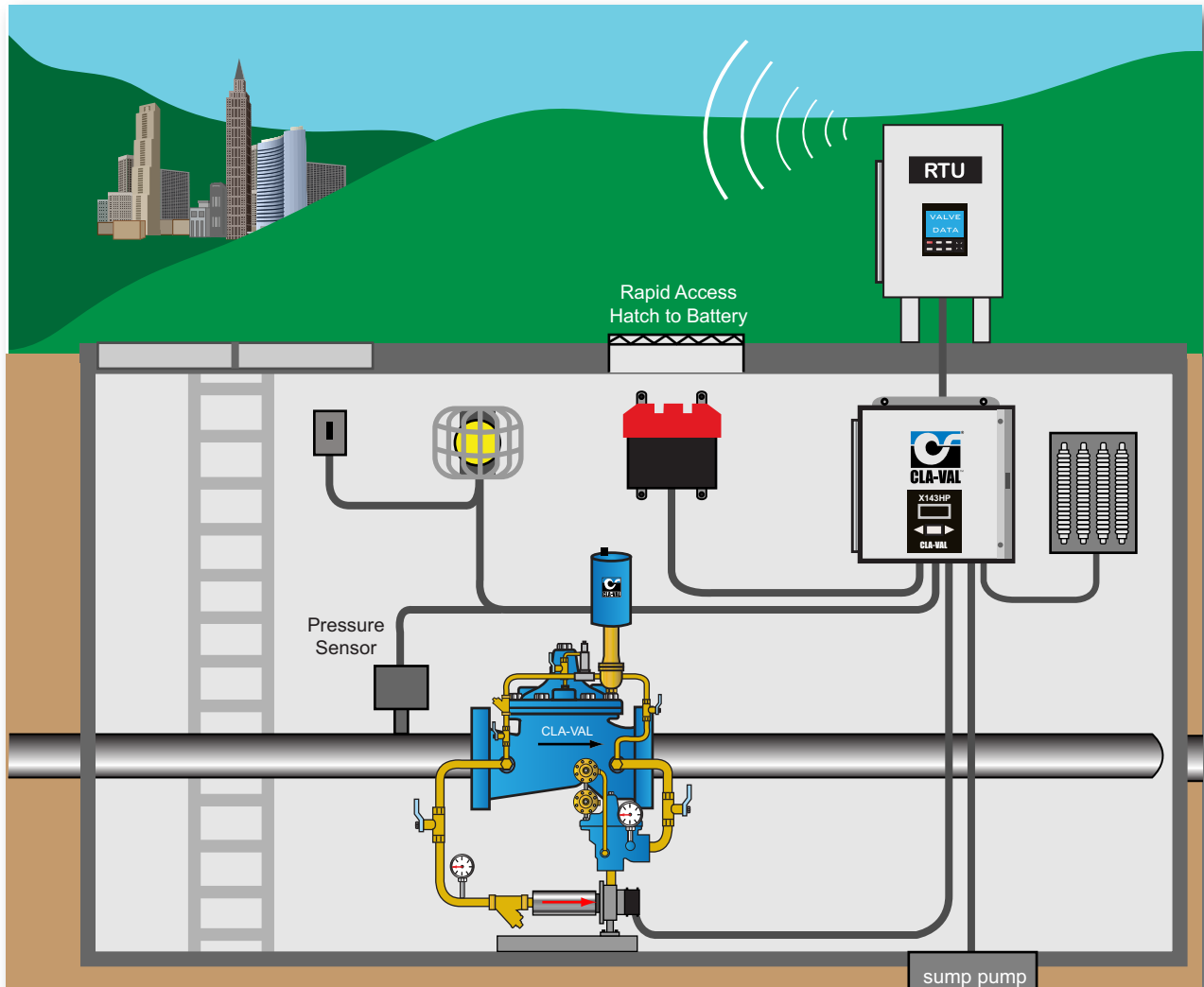
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INTRODUCTION

The X143HP is a water-driven power generation and storage system designed to power electrical devices inside a standard water- system vault. Applications include powering Remote Terminal Units (RTU), monitoring equipment, sump pumps, lighting, blowers, fans, and pressure management devices. As opposed to solar-panel applications, the X143HP operates efficiently in any kind of weather. This allows the use of smaller energy storage components and helps keep costs down.

This manual will help you install, operate, maintain and repair the X143HP Power Generation System.



Important Safety Information

The following safety notices are used in this manual:

- **CAUTION:** indicates that minor personal injury product or property damage may occur if the notice is ignored.
- **NOTE:** indicates special instructions that are important but are not related to hazards.

This manual is also available in digital format on line at
www.cla-val.com

SECTION 1: System Components and How They Work

1.1 - Theory of Operation

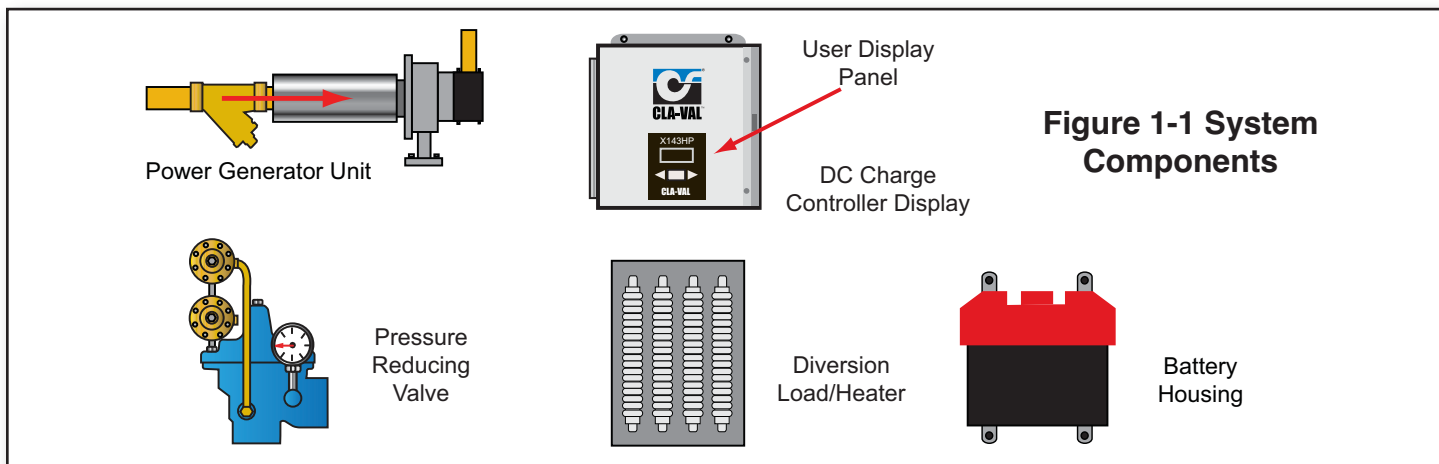


Figure 1-1 System Components

Piping from either side of the CLA-VAL **Pressure Reducing Valve** allows water to flow from the Main Line, through the **Power Generation Unit**, and back into the Main Line. The water flows through the X143HP's turbine which is connected by a shaft to the X143HP's generator. The generator converts the rotation of the turbine into electrical energy that powers connected devices and, when possible, charges the Battery Bank. The Battery Bank's stored power allows for uninterrupted operation of connected devices in times of diminished water flow, as well as permitting short term, high power consumption periods such as surge loads.

System monitoring and control is provided by components inside the Control Cabinet. The **DC Charge Controller** acts as a voltage regulator for the Battery Bank, varying charge voltage and current based on the amount of load, draw, and discharge level. It also dynamically modifies the float and acceptance points.



Fig. 1-2 X143HP Typical Application: Vault Installation

The **User Display Panel** provides information including battery current, battery temperature, voltage levels, generator current, and state of charge (bulk, acceptance, float or, for lead-acid batteries only, equalize). If necessary, this panel can be used to change control settings.

The **Diversion Load** converts excess energy, energy that is not required for operation of connected devices or for charging the Battery Bank, to heat which can be used to heat the space where the system resides. The Low Voltage Disconnect monitors the Battery Bank voltage and, when necessary, automatically disconnects the Battery Bank from the circuit to prevent deep discharge which shortens battery life.

The system automatically monitors and adjusts the shaft speed of the **Power Generation Unit** to ensure that it operates at its maximum point of power transfer for its current water flow and pressure conditions.

1.2 – Parts List



Figure 1-3 - Power Generation Unit with Y Strainer

X143HP Equipment - Supplied by Cla-Val

- Power Generator Unit
- Y-Strainer
- Diversion Load
- DC Charge Controller/Power Display
- Circuit Breaker
- Temperature Sensor



Figure 1-4 - DC Charge Controller Display with Low Voltage Disconnect and Circuit Breakers (Open and Closed Views)



Figure 1-5 - Diversion Load

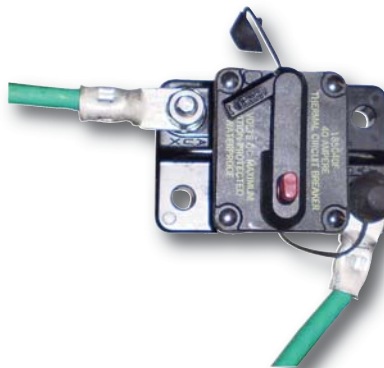


Figure 1-6 - Manual Disconnect Breaker



Figure 1-7 - Temperature Sensor

SECTION 1: System Components and How They Work

(continued)

1.2 – Parts List

The following parts are necessary for installation and operation **but not included** with the X143HP:

- Device to provide a pressure drop (such as an Automatic Control valve)
- Batteries
- Battery Housing
- Conduit
- Pipe and Fittings
- Mounting Hardware

Section 2: Installation of the X143HP Power Generation System

Materials Required for Installation

8AWG, 12AWG, and 14AWG wire

- Enough 8 AWG wire to connect battery bank to the Control Cabinet (2 wires)
- Enough 12 AWG wire to connect the diversion load (2 wires) to the Control Cabinet as well as enough 12AWG wire to connect user devices to the Control Cabinet.
- Enough 14 AWG wire to connect the Power Generation Unit to the Control Cabinet

Conduit

- Enough conduit to cover all the wires in and out of the control box

Batteries

- Quantity depends on your configuration. Refer to Appendix A to determine the size and quantity of batteries needed. The configuration **MUST** be determined before the unit can be installed
- You will also need the appropriate wire to connect the batteries to each other. See your local electrical specifications to determine the wire weight needed
- If using the **optional** Battery Housing supplied by Cla-Val, dimensions are as follows:
10.5" H x 10.5" W x 14" D
- Check the size of the battery that will be used to ensure that it will fit into the battery housing

Pipe and Fittings

Mounting Hardware

The connections to the power generator are 1.25 inch connections. When selecting fittings keep in mind that the less drop through the piping will result in the best possible power output.

Notes:

- The battery bank should be within 20 feet of the Control Panel or the Temperature Sensor will not reach

CAUTION:

- In all cases, installation should be done by qualified mechanical or electrical personnel

Section 2: Installation of the X143HP Power Generation System

(continued)

Sub-Section 2.1 - Mounting the Power Generation Unit

Mount the Power Generation Unit in a proper orientation as described in Figure 2-1. Consult Figure 2-2 for dimensional information for the Power Generation Unit, including mounting hole locations – dimensions “A” and “B”.

CAUTION:

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

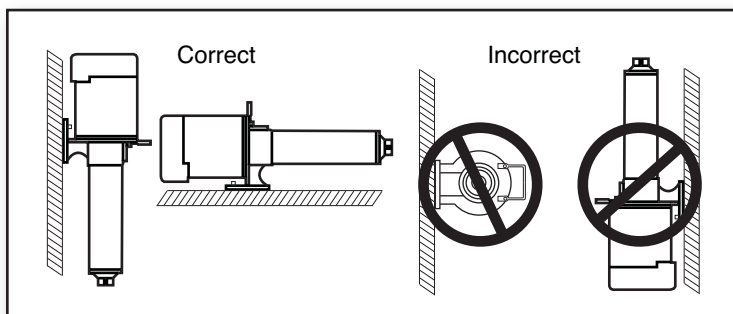


Figure 2-1 - Correct Mounting of the Power Generation Unit

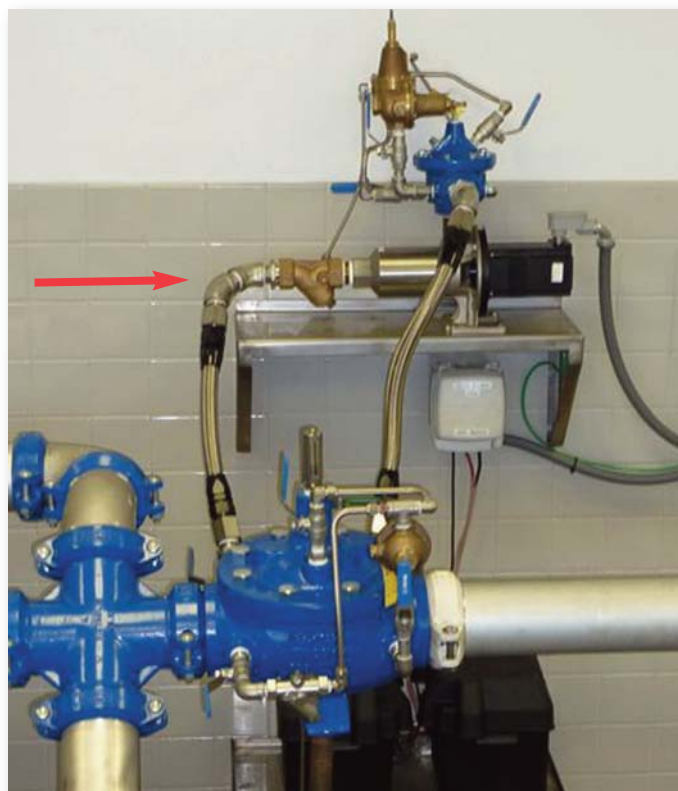


Figure 2-2 (at right) - Power Generation Unit Installation Mounted in horizontal direction

X143HP Power Generation Unit Dimensional Data

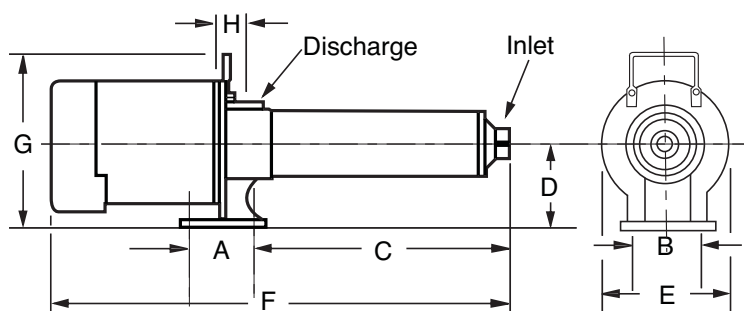


Figure 2-3 - Power Generation Unit Dimensions

| Dimensions | Value |
|------------|--------|
| A | 3.375" |
| B | 3.75" |
| C | 7.00" |
| D | 3.875" |
| E | 6.5" |
| F | 15.25" |
| G | 7" |

Section 2: Installation of the X143HP Power Generation System

(continued)

Sub-Section 2.2 - Connecting the Power Generation Unit to the Water Supply

All piping and fittings should be 1.25", where possible, with full-port valves to minimize pressure losses before and after the X143HP.

Step-by-Step Instructions

1. With Figure 2-4 as a guide, first install a strainer and coupling to the inlet side of the Power Generation Unit.

2. Next, connect the high-pressure side of the Main Line Pressure Reducing Valve to the strainer using 1.25" piping and a 1.25" full-port shut-off valve. See Figure 2-5 for an example.

NOTE: Avoid restrictions caused by sharp bends and long pipelines; unwanted pressure drops may result, reducing turbine performance and generator output.

3. Install the secondary CLA-VAL Pressure Reducing/Differential Limiting Valve to the outlet side of the Power Generation Unit as shown in Figure 2-5. (Note: This valve installation may not be required in all applications.)

4. If installing a secondary Pressure Reducing Valve, connect the outlet from the secondary valve to the low pressure side of the primary/main line Pressure Reducing Valve.

Otherwise, connect the water supply directly to the power generation unit.



Figure 2-4
Water Supply Connection

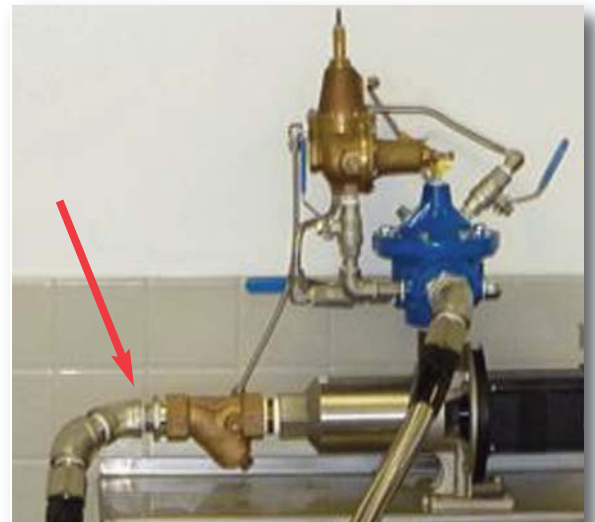


Figure 2-5
Water Supply Connection

Section 2: Installation of the X143HP (continued)

2.3 - Mounting and Wiring the Control Cabinet

1. To wire the the Control Cabinet See Figure 2-6), drill or punch holes through the bottom of the cabinet. This will reduce the chance of water entering the control cabinet.
2. Determine where you will mount the Diversion Load and Battery Bank. Use appropriate lengths of conduit and wire to reach each external device.
3. Refer to Figure 2-7 to locate the proper terminal for each connection. Use only the appropriate wire gauge called for by this manual (e.g. 12 AWG). The 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. User wiring connects to the top of the terminal blocks and breakers located in the upper portion of the Control Cabinet.



**Figure 2-6
DC Charge Controller
Display**

Fig 2-8 below shows and example of the user wiring. Remove the cover of the wire duct for installing the wire. The wire duct on the top and right side of the Control Cabinet is for user wiring.

Figure 2-9 below shows the required wiring connections and associated recommended wire size.

USER CONNECTION SIDE

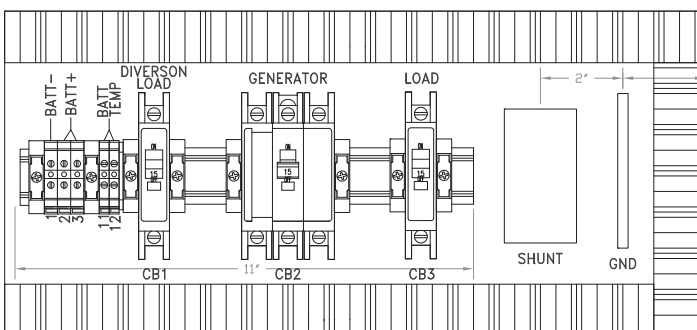


Figure 2-7 Wiring Details

Control Cabinet User Wiring Connections/Parameters



Figure 2-8 User Connection Wiring

| Item | Minimum Wire Size |
|--|---|
| Diversion Load | 12AWG |
| Battery Bank and Manual Disconnect | 8AWG to connect the Manual Disconnect and Control Cabinet |
| User devices meant to be powered by the System | 12AWG |
| Connecting power from the Power Generation Unit to the Control Cabinet | 14 AWG |

**Figure 2-9 Required Connections and
Recommended Wire Size**

Section 2: Installation of the X143HP (continued)

2.4 - Mounting and Wiring the Diversion Load

1. Mount Diversion Load to wall using appropriate fasteners. The Diversion Load converts excess energy created by the system to heat, so take care when locating it. The Diversion Load (as shown in **Figures 2-10 and 2-11**), unlike the control cabinet, is not water tight so care should be taken to place in a location where it will stay relatively dry.

CAUTION: The diversion load will become hot during normal operation. Do not mount the diversion load beneath heat sensitive equipment. Do not mount the diversion load underneath the Control Cabinet. This could damage the Control Cabinet and/or cause a system malfunction.

2. The diversion load needs to be configured for 12 or 24 Volts. The voltage for your system should have been pre-determined in advance using Appendix A as a guide. **If the circuitry is going to be configured for 24V the diversion load needs to be set to 3ohms. If the circuit is going to be configured for 12V the diversion load needs to be set to .75 ohms.** Instructions on how to configure the diversion load are on the instruction sheet that was included in the box with the diversion load.

3. There are two wires that need to run between the diversion load and control cabinet. One wire should be run from the + terminal in the diversion load to CB1, the other should be run from the – terminal in the diversion load to the Ground.



Figure 2-10
Diversion Load Exterior



Figure 2-11
Diversion Load Interior

2.5 – Installing and Connecting the Battery Bank and Manual Disconnect

Safety Tips for Working With Batteries

- Keep sparks and flames away from the battery. Inspect the battery in natural light.
- Remove wrist watches, which might make electrical contact and create sparks.
- Wear safety goggles or a face shield when inspecting or cleaning the battery.
- If acid does enter the eye, immediately flood with running water for at least 30 minutes.
- See a doctor as soon as possible.
- If acid contacts the skin, wash the affected area immediately with plenty of water.
- Avoid chemical burns by not rubbing eyes or skin while working with the battery.
- Wash your hands immediately after completing the job.
- Clean up all acid spills and flush clothing with a water and baking soda solution.
- Vent caps should be tight and level. Placing a damp cloth over vent caps when charging may act as a flame arrester.
- Smoking or open flames should never be present in a battery area, and ventilation is important.
- Store batteries in a cool, dry place. Storage temperature should be between 80°F and 32°F.
- Don't make live connection directly to the battery. Explosive gases can be set off by a match, incorrect connection of battery cables, and careless use of tools around the battery.
- Use proper lifting techniques when moving batteries, as they are heavy and awkward to lift.
- Follow your local building codes when working with batteries.

Section 2: Installation of the X143HP (continued)

2.5 – Installing and Connecting the Battery Bank and Manual Disconnect

A determination about the size and set up of your Battery Bank will have been made in advance of installation based upon the worksheets provided in Appendix A. Follow your local electrical codes for selecting the wire size when connecting multiple batteries. Be certain to have the information therein available before proceeding with the following steps. There is a section for each of the different battery configurations below. Find the appropriate section for your setup and follow the instructions in that section.

1. Connect a 8AWG wire coming from the battery (BATTERY -) connection in the Control Cabinet to the battery's negative ("-") terminal.
2. Use 8AWG wire to connect the battery's positive ("+") terminal to the Manual Disconnect.
3. Connect a 10AWG wire coming into the battery (BATTERY +) connection in the Control Cabinet to the remaining terminal on the Manual Disconnect

When setting up a battery bank, there are two options for wiring the batteries together:

- In series or
- In parallel

For a battery bank wired in SERIES, see Figure 2-13:

1. Connect a 8AWG wire coming from the battery's negative (BATTERY -) connection in the Control Cabinet to the first battery's negative ("-") terminal.
2. Use 8 AWG to connect the first battery's positive ("+") terminal the second battery's negative ("-") terminal.
3. Repeat step 2 until all batteries are connected in this manner.
4. Again using 8AWG, connect the positive ("+") terminal of the last battery to a terminal on the Manual Disconnect.
5. Connect 8AWG wire coming from the battery's (BATTERY +) connection in the Control Cabinet to the remaining terminal on the Manual Disconnect.

SINGLE BATTERY

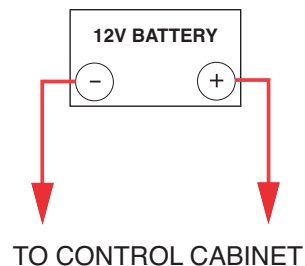
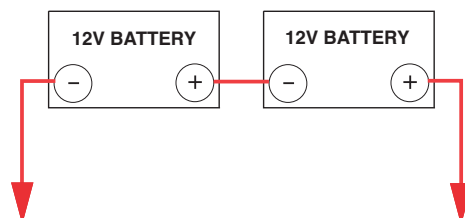


Figure 2-12

BATTERY BANK WIRED SERIES



TO CONTROL CABINET
Figure 2-13



Section 2: Installation of the X143HP (continued)

For a battery bank wired in **PARALLEL**, see **Figures 2-14A and B**:

1. Connect a 8AWG wire coming from the battery (BATTERY -) connection in the Control Cabinet to the first battery's negative ("-") terminal.
2. Connect a 8AWG wire coming from battery ("BATTERY +) connection in the Control Cabinet to a terminal on the Manual Disconnect.
3. Using 8AWG wire, connect the remaining terminal of the Manual Disconnect to the positive ("+") terminal on the same battery that is already connected to the Control Cabinet.
4. Using 8AWG wire, connect the negative ("-") terminal of the first battery to the negative ("-") terminal of the next battery in the bank.
5. Using 8AWG wire, connect the positive ("+") terminal of the first battery to the positive ("+") terminal of the next battery in the bank.
6. Repeat steps 4 and 5, connecting each remaining battery to the one before it until all batteries are connected.

BATTERY BANK WIRED IN PARALLEL FOR 12 VOLTS

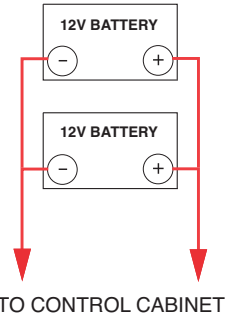


Figure 2-14A



Figure 2-14B

For a battery bank wired in **PARALLEL and SERIES**, see **Figure 2-15**:

1. Connect the 8AWG wire coming from the "BATTERY-" connection in the Control Cabinet to the first battery's "-" terminal.
2. Connect the 8AWG wire coming from "BATTERY+" connection in the Control Cabinet to a terminal on the Manual Disconnect.
3. Using 8AWG wire, connect the remaining terminal of the Manual Disconnect to the "+" terminal on the same battery that is already connected to the Control Cabinet.
4. Using 8AWG wire, connect the "-" terminal of the first battery to the "-" terminal of the next battery in the bank.
5. Using 8AWG wire, connect the "+" terminal of the first battery to the "+" terminal of the next battery in the bank.
6. Repeat steps 4 and 5, connecting each remaining battery to the one before it until all batteries are connected.

BATTERY BANK WIRED IN PARALLEL FOR 24 VOLTS

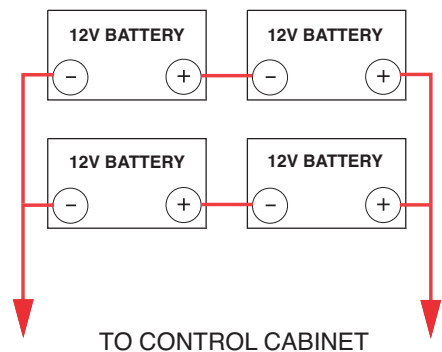


Figure 2-15



Section 2: Installation of the X143HP (continued)

2.6 – Connecting the Temperature Sensor

The temperature sensor should, at time of first unpacking, be in a clearly labeled manila envelope with the control cabinet. Connect the end with the connector to one of the battery terminals, which one is not important, and connect the wires on the other end to “BATTERY TEMP”.



Figure 2-16 Temperature Sensor

2.7 – Connecting the X143HP Power Generation Unit to the Control Cabinet

Use 14AWG wire to connect the Power Generation Unit to the Control Cabinet. There are four separate wires which need to be connected. The red black and white wires coming out of the Power Generation Unit connect to CB2 (Order doesn't matter). The green wire coming out of the Power Generation Unit connects to GND.

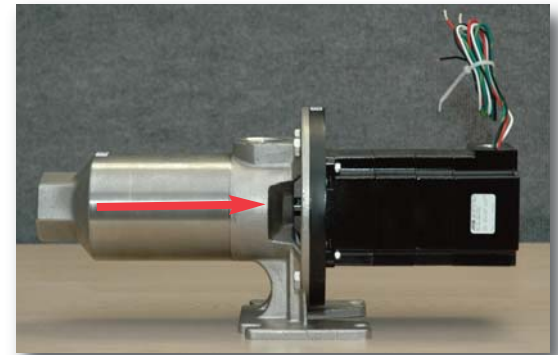


Figure 2-17 Connection Wires

2.8 – Adding Customer Devices

Use appropriate wire gauge to connect the devices the Power Generation Unit will drive to the Control Cabinet. The Customer's devices (as shown in example - Figure 2-19) should be connected CB3 for + and GND for -.

If there are multiple devices requiring power, it is possible to add additional circuit breakers, run multiple leads to 'CB3' or to use an external power distribution arrangement and connect that to 'CB3'. See Figure 2-18.

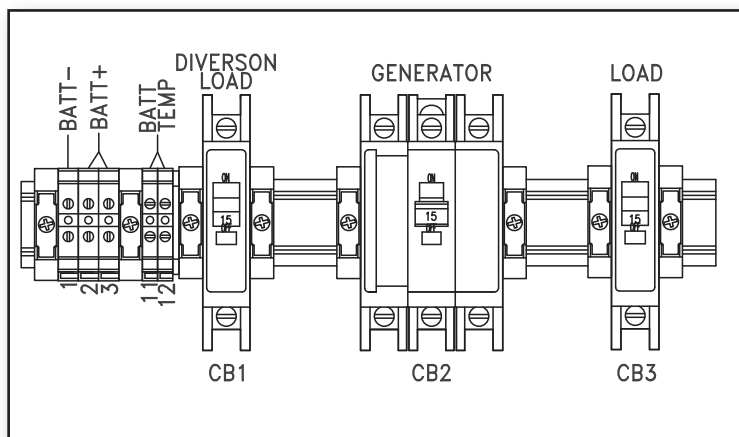


Figure 2-18 External Power Distribution Arrangement



Figure 2-19 Typical Customer Devices

Section 2: Installation of the X143HP (continued)

2.9 – Circuit Schematic

The schematic shown at right describes the wiring of a completed X143HP installation.



Figure 2-20 - DC Charge Controller Display with Low Voltage Disconnect and Circuit Breakers

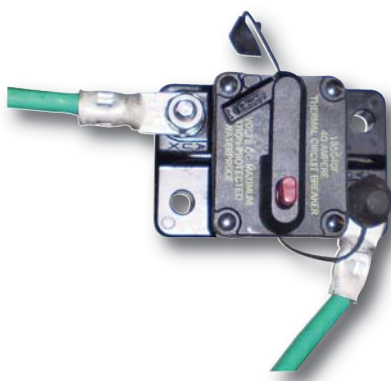
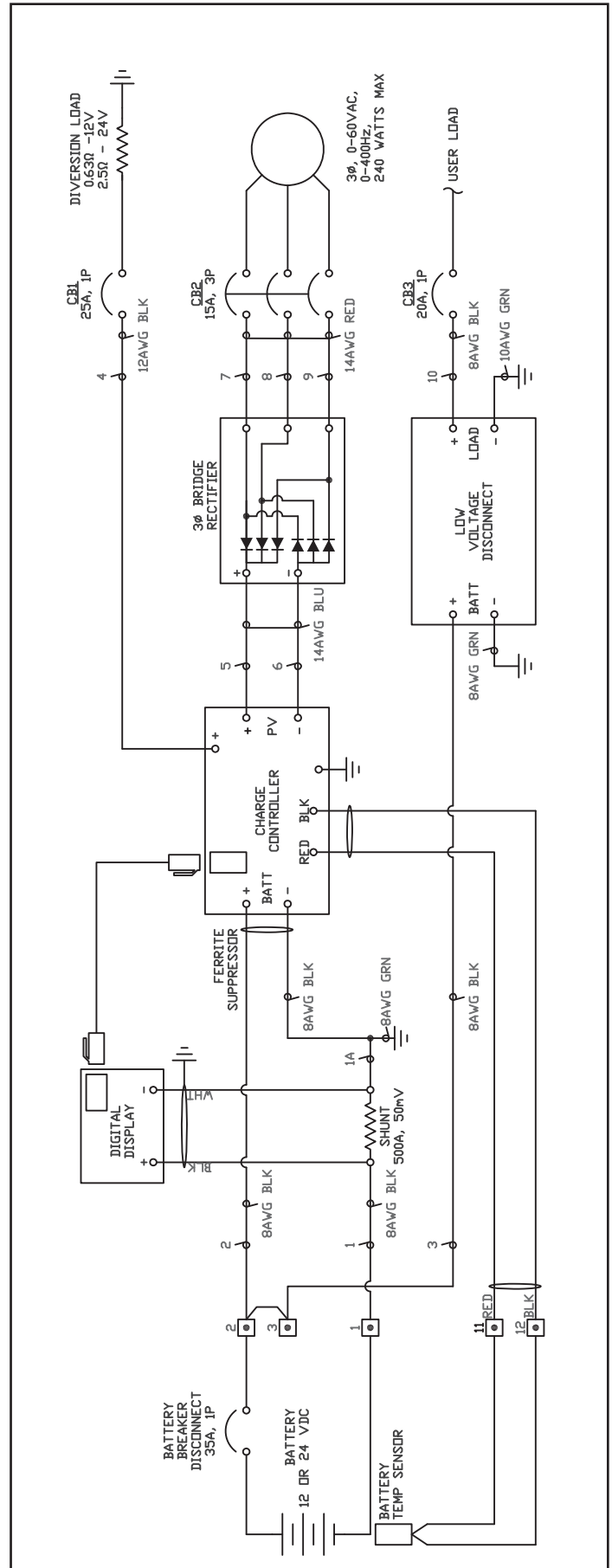


Figure 2-21 - Disconnect/Circuit Breaker (must be installed at battery bank)



SECTION 3: Control Cabinet Settings

The following parameters must be set for proper system operation. These settings effect battery charging and the information displayed on the User Display Panel (see Figure 3-1 below).

Before settings can be entered on the User Display Panel power must first be turned on to the User Display Panel. If the batteries are already charged, the manual disconnect breaker can be closed to power up the User Display Panel. If the batteries are not yet charged, or have little charge the unit must be started before configuration can continue. See section 4-1 for instructions on how to start the unit.

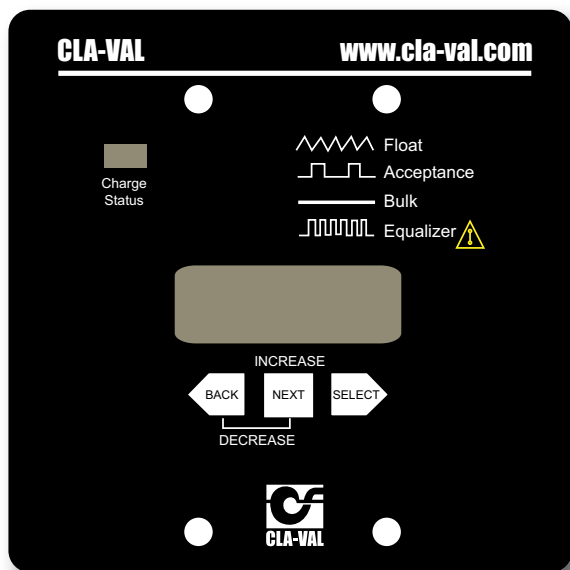


Figure 3-1 User Display Panel

NOTES

- The Low Voltage Disconnect must be configured by following the instructions in section 3-4 to your system voltage BEFORE the unit is started or the batteries may be damaged and there will be a HIGH RISK of electrical shock when configuring the Low Voltage Disconnect.
- Amp Hour Capacity should be based on a 20-hour discharge rate at 25° C. This information is normally found on the battery label. See Figure 3-2 below
- Amp Hour Capacity setting can only be set in increments of 10. Round down when setting the value.



Figure 3-2 Battery Label

3.1 – Setting Amp-Hour Capacity

1. Press the NEXT key repeatedly until ENTER ADVANCED DSPLY/SETUP appears.
2. Hold down the SELECT key for 3 seconds—you are now at the 1st advanced menu.
3. Press the next key until ENTER SETUP MENUS appears.
4. Hold down the SELECT key for 3 seconds—you are now at the 1st setup menu. The display should read SET BAT AMP-HRS
5. Hold down the SELECT key for 3 seconds. SETTING should now be flashing. Press the NEXT key to increase the Amp Hours. Hold down both the NEXT and BACK keys to decrease the Amp Hours.
6. When the Amp Hours are correct, hold down SELECT for 3 seconds. This sets and stores the new value.
7. For additional information, refer to the Charge Controller Manual provided with the X143HP.

SECTION 3: Control Cabinet Settings (continued)

3.2 – Setting Standard Battery Charge Parameters

Battery charge settings vary by manufacturer and battery type. Please contact your CLA-VAL Representative if you have questions about the proper settings for your installation. The default values are typically acceptable for most AGM(Absorbed Glass Mat) and Gel batteries (Contains acid that has been "gelled" by the addition of Silica Gel, making it impossible to spill acid even if they are broken).

The default values of the X143HP are:

- Acceptance Level: 14.4V
- Float Level: 13.2V
- Equalize Level: DISABLED
- Equalize Time: DISABLED

NOTE: Most installations are configured for a Battery Bank using Gel or AGM batteries which do not require equalization. The system is, therefore, shipped with equalization disabled. If you are using lead acid batteries, you will need to enable equalization and set the parameters as described at the end of this section.

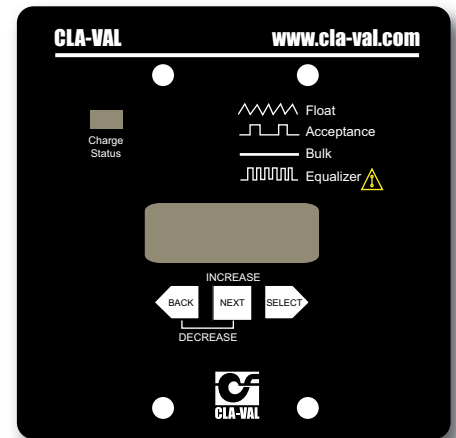


Figure 3-1 User Display Panel

To alter the default battery charging parameters, use the following procedure:

1. Press the NEXT key repeatedly until ENTER ADVANCED DSPLY/SETUP appears.
2. Hold down the SELECT key for 3 seconds—you are now at the first advanced menu.
3. Press the next key until ENTER SETUP MENU appears.
4. Hold down the SELECT key for 3 seconds—you are now at the first setup menu. The display should read SET BAT AMP-HRS
5. Press the NEXT key until SELECT BAT CHARGE PARAMETERS appears.
6. Hold down the SELECT key for 3 seconds. You should now be at the SET ACCEPT CHG screen.
7. Hold down the SELECT key for 3 seconds. SETTING should now be flashing.
8. Use the NEXT key to increase the acceptance charge level. Hold down both the NEXT and BACK keys to decrease the acceptance charge level.
9. When the acceptance charge level is correct, hold down SELECT for 3 seconds. This sets and stores the new value.
10. Press NEXT until SET FLOAT CHG appears.
11. Repeat steps 7) through 9) to set the float level. To return to the main menu, press BACK 3 times.

SECTION 3: Control Cabinet Settings (continued)

3.3 – Setting Equalization Parameters (Lead-Acid Batteries ONLY)

1. Open the control cabinet by loosening the two screws on the right side.
2. Remove the Charge Controller Cover.
3. Locate the DIP switches on the top middle of the charge controller (Figure 3-3).
4. Turn ON the Number 5 Switch.
5. Reinstall the cover
6. Close the control cabinet.

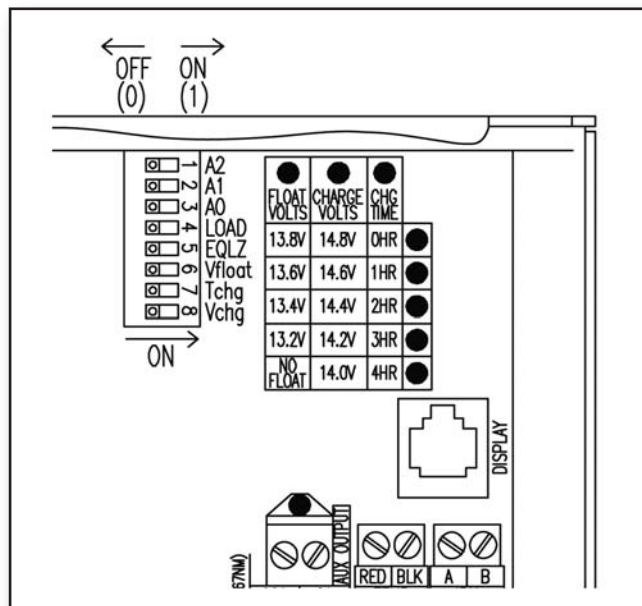


Figure 3-3, Charge Controller Switch Configuration

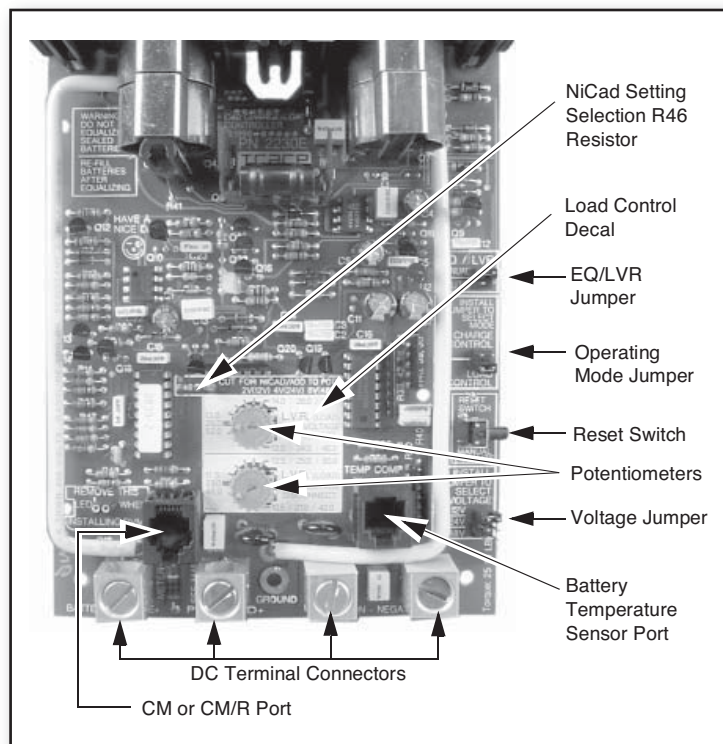
7. Press the NEXT key repeatedly until ENTER ADVANCED DSPLY/SETUP appears.
8. Hold down the SELECT key for 3 seconds you are now at the 1st advanced menu.
9. Press the next key until ENTER SETUP MENUS appears.
10. Hold down the SELECT key for 3 seconds—you are now at the 1st setup menu. The display should read SET BAT AMP-HRS.
11. Press the NEXT key until SELECT BAT CHARGE PARAMETERS appears.
12. Hold down the SELECT key for 3 seconds. You are now at the SET ACCEPT CHG screen.
13. Press the NEXT key until SET EQUALIZ CHG appears.
14. Hold down the SELECT key for 3 seconds. SETTING should now be flashing.
15. Use the NEXT key to increase the equalization charge level. Hold down both the NEXT and BACK keys to decrease the acceptance charge level.
16. Then the equalization charge level is correct, hold down SELECT for 3 seconds. This sets and stores the new value.
17. Press NEXT and scroll to the SET EQUALIZ TIME screen.
18. Repeat steps 12 through 14 to set the equalize time.
19. Press NEXT and scroll to the SET AUTO EQUALIZ menu.
20. Repeat steps 12 through 14 to set the number of days between automatic equalizations.
21. Press BACK 3 times to return to the main menu.

SECTION 3: Control Cabinet Settings (continued)

3.4 – Low Voltage Disconnect Configuration

The system's Low Voltage Disconnect protects the Battery Bank from damage by disconnecting the user load from the battery should the voltage fall below acceptable levels. It is set, by default, to accommodate a 12V Battery Bank. If the Low Voltage Disconnect must be configured for 24V operation, move the Voltage Jumper (refer to Figure 3-4 to locate it) from the 12V position to the 24V position. The different positions are written in text on the board next to the jumper location.

**Figure 3-4 (at right),
Low Voltage Disconnect Configuration**



SECTION 4: X143HP Operation

4.1 – Starting Operation

Follow this procedure when starting the installation for the first time or after shutting the system down for maintenance as per the instructions in Section 4.2.

1. Open the Disconnect/Circuit Breaker for the Generator, Diversion Load, Battery Bank and User Load/Devices.
2. Ensure all wiring is properly connected.
 - a. Check that Diversion Load is properly wired.
 - b. Check that Battery Bank is properly wired.
 - c. Check that the Disconnect/Circuit Breaker is properly wired.
 - d. Check that user devices are properly wired.
 - e. Check that temperature sensor is properly wired.
 - f. Check that generator is properly wired.
 - g. Check that the Low Voltage Disconnect is properly configured
3. Close the Diversion Load breaker.
4. Verify that the Disconnect/Circuit Breaker is closed and Battery Bank is connected to the circuit.
5. Close the Generator breaker.
6. Close the User Load breaker.
7. Open shut-off valves and allow water into the system.
8. Check the system for water leaks.
9. Check surrounding piping and auxiliary equipment for leaks.
10. Using gauges, measure the pressure differential across the Power Generation Unit. (See note below)

NOTE: Measure the pressure drop as close to the turbine as possible. Taking a reading in the connecting piping away from the turbine will provide a less accurate measure of pressure differential.

SECTION 4: X143HP Operation (continued)

4.1 – Starting Operation (continued)

- 11. Verify that the Temperature Sensor is operating correctly.
 - a. Press the NEXT key repeatedly until ENTER ADVANCED DSPLY/SETUP appears.
 - b. Hold down the SELECT key for 3 seconds—you are now at the first advanced menu.
 - c. Press the next key until BAT TEMPERATURE appears.
 - d. Verify that the temperature on the display matches the ambient temperature near the Battery Bank.
- 12. Verify generator output.
 - a. Record the voltage in the lower left-hand corner. Press NEXT and record the current in the lower right-hand corner of this screen.
 - b. Multiply the two values. This is the output power (in Watts) of the generator and should match the value calculated in Appendix A: Sizing the System of this manual.

- 13. Verify that the Battery Bank is charging properly.
 - a. Press NEXT until you are at the BATTERY VOLT/AMP screen—the top menu.
 - b. Using Figure 4-1 as a guide, observe the green Charge Status LED on the User Display Panel and confirm the charging mode. This information is also shown graphically on the User Display Panel. The Charge Status LED should turn on immediately upon starting the system.
 - c. If in bulk charge mode and the current reading is “-”, this indicates that the load is greater than the generator output and the Battery Bank is not charging. If the current reading is “+,” the Battery Bank is charging.

| Charge Status LED Behavior | Charge Mode | Approx. Charge Level |
|--------------------------------------|-------------------|----------------------|
| Off | Charge Off | N/A |
| Continuously on | Bulk Charge | <70% Full |
| Blinking, 1 Sec. On, 1 Sec. Off | Acceptance Charge | 70-95% Full |
| Blinking .2 Sec On, 1 Sec. Off | Float Charge | Fully Charged |
| Rapid Blinking .2 Sec On, .2 Sec Off | Equalize Charge | M/A |

Figure 4-1 Battery Charge Status

- 14. Verify the Temperature Sensor is working (value is in expected range).

4.2 – Stopping Operation

CAUTION: To avoid damage to critical electronic components, you must follow this procedure when stopping operation for any reason!

- 1. Close the shut-off valves to stop the flow of water.
- 2. Open generator breaker inside of Control Cabinet, disconnecting generator from the rest of the circuit.
- 3. Open the Manual Disconnect connecting the Battery Bank to the rest of the circuit.

SECTION 5: Maintenance and Repair

5.1 – Routine Maintenance

CAUTION: Always disconnect the power supply and depressurize the system before performing any maintenance or repair.

The system should be inspected routinely for leaks, worn components and failing sensors. An inspection should consist of the actions in steps 1-3 and 5 of the procedure outlined in section 4.1. It is recommended the equipment be turned off during inspection. In addition, the strainer attached to the input of the power generation unit should be removed and cleaned regularly to insure its ongoing functionality.

5.2 – Rotary Seal Replacement

If the shaft seal in the Power Generation Unit should become damaged or worn due to air pocketing or other causes, replace it by the following procedure. If it is worn or damaged, it will likely leak water.

Required Tools:

- Strap Wrench
- Pipe Wrench
- 6" Long, .25" diameter dowel
- Liquid soap solution – one drop of soap per teaspoon of water.

Procedure

1. Disassemble turbine.
 - a. Remove the strainer, coupling and inlet tubing from the Power Generation Unit.
 - b. Remove the pressure reducing valve (if used) and outflow tubing from the unit.
 - c. Disconnect all electrical connections from the unit.
 - d. Remove the unit from its mounting.
 - e. Referring to Figure 5-1, use a pipe wrench to remove the head from the unit by turning counter-clockwise (CCW).
 - f. Use a strap wrench to loosen the barrel, again turning CCW.
 - g. Position the unit so that the rear of the generator's black casing is sitting upon the ground.
 - h. Push a 6" long, .25" diameter dowel through the intake opening while sliding the barrel off of the impeller stack. This holds the stack in place.
 - i. Slide the impeller stack and any shim washers onto the dowel, keeping all parts in the proper order and orientation for reassembly. Set the impeller stack and dowel aside.
 - j. Through the opening the generator mounting frame, prevent the generator shaft from rotating with a 9/16" wrench.
 - k. Remove the shaft from the generator by turning a 3/8" wrench CCW on the hex-shaped shaft.



Figure 5-1 Rotary Seal Replacement

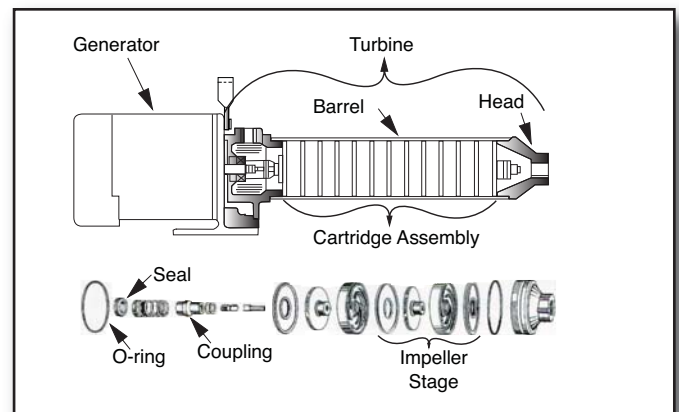


Figure 5-2 Turbine Parts

SECTION 5: Maintenance and Repair (continued)

5.2 – Rotary Seal Replacement (continued)

2. Remove the seal.

- a. Slide the rotary seal assembly, consisting of a carbon ring and Buna-N gasket off the end of the generator shaft.
- b. Using 2 flat-headed screwdrivers, pry the ceramic seal and rubber gasket from the recess of the mounting ring.

3. Replace the seal.

CAUTION: Always exercise extreme care to avoid damaging the replacement seals. Nicked scratched or dirty seal faces (especially ceramic or carbon) will result in improper operation and/or shorter seal life.

- a. Clean the seal cavity of the mounting ring and motor thoroughly.
- b. Wet the outer edge of the rubber cap on the ceramic seal with the liquid soap solution.
- c. Making sure the polished face of the ceramic seal faces outward, press it firmly and squarely into the seal cavity.
- d. If the seal does not reseat correctly, remove it. Place the seal face up away from the work area and re-clean the seal cavity.
- e. If the seal still does not seat, place a cardboard washer over the polished seal face and carefully press it into the cavity using a clean piece of standard 1-¼" pipe.
- f. Dispose of the cardboard washer and recheck that the seal cavity is free of dirt and, foreign particles, scratches and grease.
- g. Inspect the shaft to be sure that it is free of scratches.
- h. Apply one drop of the liquid soap solution to the inside diameter of the rubber rotating member.
- i. Slide the rotating seal member, carbon face toward the ceramic face, and spring over the shaft.

5.3 - Reassemble the Turbine.

1. Carefully inspect the components that make up the impeller assembly for damage, distortion or wear.
2. Reassemble the turbine
 - a. Position the unit so that the rear of the generator's black casing is sitting upon the ground.
 - b. Insert a 9/16" wrench into the opening on the generator mounting frame to prevent the generator shaft from rotating as you reattach the impeller shaft.
 - c. Using a 3/8" wrench, tighten the shaft back onto the generator by turning with a clockwise (CW) motion.
 - d. Transfer the impeller stack and shims from the dowel back onto the generator shaft.
Be certain to maintain the proper order and orientation of all components.
 - e. Insert the barrel over the impeller stack and generator shaft and retighten with a strap wrench by turning CW. If the barrel is made from stainless steel, use anti-seize compound on its threads.
 - f. Reattach the head onto the barrel by turning CW with a pipe wrench. If the head is made from stainless steel, use anti-seize compound on its threads.
 - g. Reattach the unit to its mounting.
 - h. Reconnect all electrical connections.
 - i. Reattach all tubing and fittings to the unit and check for leaks.

SECTION 5: Maintenance and Repair (continued)

5.4 – Generator Replacement

The generator does not require routine maintenance. Should it require replacement, remove the turbine and seal assembly as per the steps in Section 5.2 and then proceed as follows to remove and replace the generator.

1. Remove the 4 cap screws that connect the generator to the mounting ring and pull the generator straight away.
2. Insert the replacement generator into place and replace the 4 cap screws that you've just resumed.
3. Reassemble the turbine as described in Section 5.3.

5.5 – Troubleshooting

| Symptom | Possible Causes | Corrective Action |
|-------------------------------|---------------------------------------|---|
| Unit Leaking Water | Defective Seals | Replace Seal, See Section 5.1 |
| | Worn O-Rings | Disassemble Turbine and Replace, See Sections 5.1 and 5.3 |
| Low Power Output | Clogged Intake Filter | Remove, Clean and Reinstall, See Section 2.2 |
| | Loose Impeller Stages, Loose Barrel | Tighten Barrel to Correct Torque, See Section 5.3, Item (d) |
| | Air in Lines Due to Improper Mounting | Remount Correctly See Section 2.1 |
| Squeaky or Vibrating Bearings | Worn Bearings in Generator | Replace Generator, See Section 5.4 |

APPENDIX A: Sizing the System

To determine the size of the battery bank and inverter (if required), for your power generation system, use the following worksheets. An example is provided at the end of this section. You may also visit www.cla-val.com and click on the **Cla-Power Calculator** under **Software, Calculators & Guides**.

A.1 - Determining Generator Output

Before proceeding, record the battery voltage of the batteries comprising the battery bank. This is typically 12V or 24V and should be determined based on the operating requirements of the devices that will be powered by the X143HP.

A BATTERY VOLTAGE _____ V

The generator provides electrical power to your system components. The available power is determined by the flow rate and pressure that drives the generator's turbine within the Power Generation Unit and is measured in Watts (W).

Using the graph in Figure A-1, first determine the differential pressure through the Power Generation Unit which will give you the flow rate of water into the system. Remember to appropriately size all piping and fittings for the flow rate of your system. Adapting the CLA-VAL Pressure Reducing Valve's 1" fittings to 1 1/4" or larger is acceptable and recommended.

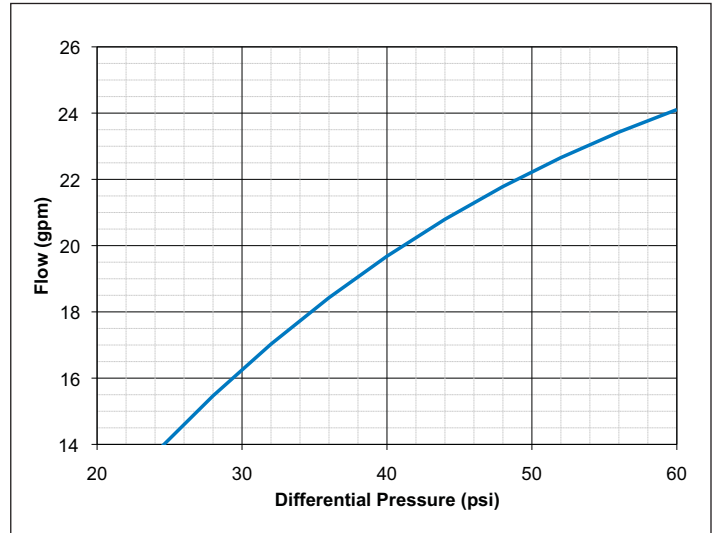


Figure A-1

B FLOW RATE _____ gal/min

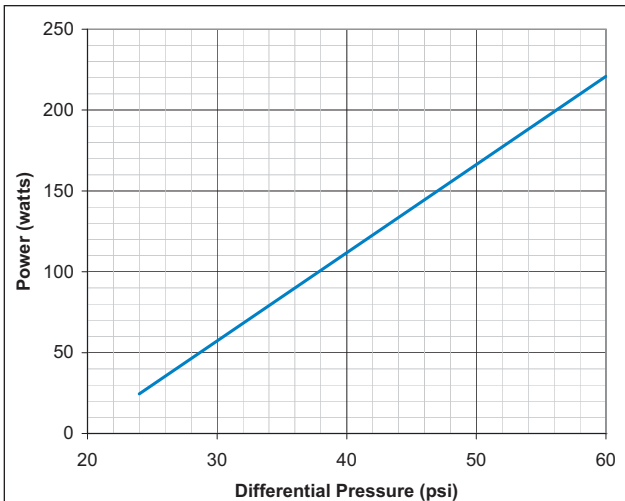


Figure A-2

C DIFFERENTIAL PRESSURE _____ psi

Using the graph in Figure A-2, input the differential pressure information from line C to determine the available power from the generator.

D AVAILABLE POWER _____ W

For example, Figure A-1 shows that a flow rate (B) of 22+ gpm produces a differential pressure (C) of 50 psi. Figure 2-2 shows that, with a pressure differential of 50 psi, the generator outputs 160+ watts of power (D). To determine the value of Amp-Hours supplied by the generator each day, solve the following:

$$(D / A) \times 24^* =$$

E SUPPLIED AMP-HOURS _____ Ah

**Multiplying by 24 presumes 24 hour operation of Power Generation Unit. Substitute for actual hours of operation per day as necessary.*

A.2 - Determining Equipment Power Draw

To size the battery bank, make a list of all devices that the generator must power. For each device, it will be necessary to determine at least two of the following three characteristics:

1. Required power — measured in Watts (W).
2. Current Draw — measured in Amps (A).
3. Required voltage — measured in Volts (V).

Additionally, determine each device's operating time — the total number of hours per day the device is typically operating. Also determine each device's autonomy period — the number of days they will continue operating should the Power Generation Unit's power output fall below expected levels. Record the available information in the following table and calculate the missing information based upon the equations provided.



| | | F | G | H | I | J | | | K | L | | | M | | | |
|--|--|-----------|-------------|----------|--------------------------|---|---|--|----------------|------------------------|---|--|-----------------|--|--|--|
| Device | | Power (W) | Voltage (V) | Amps (A) | Operating Time (Hrs/Day) | A / G | For each device, multiply the following values COLUMN (H) X COLUMN (I) X COLUMN (J) And record that value in COLUMN K. | | Amp-Hours (Ah) | Autonomy Period (Days) | For each device, multiply the following values COLUMN (F) X COLUMN (I) X COLUMN (L) And record that value in COLUMN M. | | Watt-Hours (Wh) | | | |
| 1 | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | |
| Power = Voltage x Amps Voltage = Power / Amps Amps = Power / Voltage | | | | | | N Total Required Amp-Hours | | O Total Required Watt-Hours | | | | | | | | |

A.3 - Determining Battery Capacity and Quantity

After determine total Amp-hour and Watt-hour requirements for typical operation, determine the type and quantity of batteries needed for the Battery Bank and how they will be wired to one another and to the Control Cabinet during installation.

First, determine the ideal Battery Bank capacity, measured in Amp-hours:

$$O / A = P$$

IDEAL BATTERY BANK CAPACITY _____ Ah

For batteries wired in series, each battery should be rated as equal to or greater than the practical capacity in Amp-hours. For batteries wired in parallel, the sum of the batteries' ratings for Amp-hours should be equal to or greater than the practical capacity. In both cases, all batteries should be the same.

NOTE: To ensure longevity it is important that batteries not be fully discharged. To prevent that from occurring you should oversize the Battery Bank capacity calculated in P by at least 15%

A.4 – Battery Bank Wiring Examples

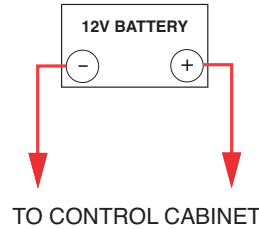
To achieve the desired voltage and amp-hour values, it may be necessary to wire multiple batteries together in series and parallel. The following four examples demonstrate how voltage and amp-hours are affected by each arrangement.

In a series circuit, the voltage sources within the circuit are summed – 2 12V batteries in series provide 24V. The amp-hours within the circuit are constant – 2 100Ah batteries in series provide 100Ah.

In parallel, the voltage is constant. 2 12V batteries produce 12V. The amp-hours are summed – 2 100Ah batteries provide 200Ah.

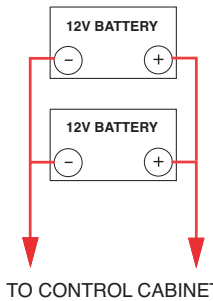
For each, assume that the battery is rated for 12V and 100Ah.

SINGLE BATTERY



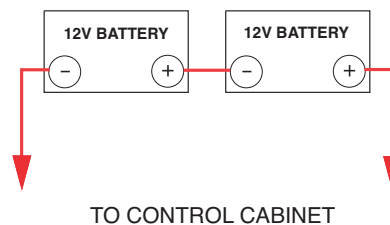
Total Voltage Supplied: 12V
Total Amp-Hours Supplied: 100Ah

BATTERY BANK WIRED IN PARALLEL FOR 12 VOLTS



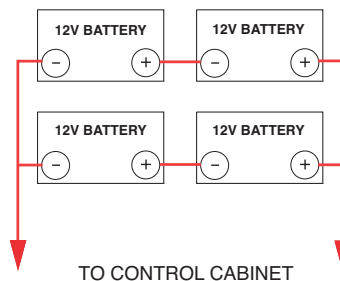
Total Voltage Supplied: 12V
Total Amp-Hours Supplied: 200Ah

BATTERY BANK WIRED SERIES



Total Voltage Supplied: 24V
Total Amp-Hours Supplied: 100Ah

BATTERY BANK WIRED IN PARALLEL FOR 24 VOLTS



Total Voltage Supplied: 24V
Total Amp-Hours Supplied: 200Ah





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