



# INSTALLATION MANUAL

## General Information

Introduction .....	1
Danger, Warning, Caution, and Note Boxes.....	1

## Aqua-Hot Hydronic Heating System

Technical Information.....	2
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## Section 1: Aqua-Hot Installation

Installing the Mounting Tray and the Aqua-Hot.....	5
Installing the Expansion Tank.....	9

## Section 2: Hydronic Heating System

Location and Clearances .....	10
Mounting Requirements.....	10
Mounting the Heat Exchangers .....	11
Wiring the Heat Exchangers.....	13
Plumbing Requirements .....	14
Plumbing the Hydronic Heating System .....	15

## Section 3: Thermostats

Fresh Water Tank Thermostat Location .....	17
Fresh Water Tank Thermostat Mounting.....	17
Fresh Water Tank Thermostat Wiring .....	17
Room Thermostat Location.....	18
Room Thermostat Mounting .....	18
Room Thermostat Wiring.....	18

## Section 4: Domestic Water System

Domestic Water System Requirements .....	19
Domestic Water System Plumbing.....	19

## Section 5: Switch Panel

Switch Panel Location .....	21
Switch Panel Mounting.....	21
Switch Panel Wiring .....	22

## **Section 6: Fuel System**

Fuel System Location .....	23
Fuel System Requirements .....	23
Fuel System Installation .....	24

## **Section 7: Engine Preheat and Motoraide System**

Engine Preheat System Location .....	26
Engine Preheat System Plumbing Requirements .....	26
Engine Preheat System Plumbing Installation.....	26

## **Section 8: Exhaust System**

Exhaust System Requirements .....	29
Installing the Exhaust System .....	30

## **Section 9: Electronic Controller Wiring**

Electronic Controller Wiring.....	31
Wiring Harness Connection .....	32
Connecting the 12 Volt-DC Power .....	33

## **Section 10: Purging the Systems**

Purging the Hydronic Heating System.....	34
Purging the System by Grounding Zone Pumps .....	35
Purging the Domestic Water System.....	36

## **Section 11: Initial Start-Up**

Activating the Aqua-Hot.....	36
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## **Appendices:**

Appendix A: Wiring Diagram .....	A-1
Appendix B: Wire Gauge Information.....	B-1
Appendix C: Electronic Controller Features .....	C-1
Appendix D: Antifreeze Types.....	D-1
Appendix E: Antifreeze Mixture Water Quality Recommendations.....	E-1
Appendix F: Antifreeze Terms and Mixture Ratio .....	F-1

## Introduction to the Aqua-Hot 450 DE/DM:

This Installation Manual is designed to aid in the installation process of the Aqua-Hot 450 Hydronic Heating System by a trained and experienced installer. The Aqua-Hot features a 12 Volt-DC powered diesel-burner and a 120 Volt-AC, 1650 Watt electric heating element. These two heating sources are used in conjunction with an FDA-approved “GRAS” (Generally Recognized As Safe) propylene glycol based boiler antifreeze and water heating solution in order to provide a continuous supply of domestic hot water, interior/fresh water tank heating, independent interior zone heating, and engine preheating, applicable for the 450-DE model only. Be sure to reference Figures 1 through 6 for a complete component overview.

Both the Aqua-Hot 450-DE and 450-DM heaters include a motoraide feature, which uses the circulation of the motorhome’s engine to transport the antifreeze and water heating solution from the Aqua-Hot’s boiler tank to the motorhome’s warm engine and back to the boiler tank. Through this process, the boiler tank is kept heated, which reduces the time required to bring the tank to operating temperature for interior heat and continuous domestic hot water.

The Aqua-Hot 450-DE also includes an engine preheat feature, which provides an easy engine startup whenever cool weather conditions are present. Engine preheating occurs when the motorhome’s cold engine coolant is circulated through the Aqua-Hot’s engine loop where it gains warmth to transfer to the engine while circulating.

Please note that all Danger, Warning, Caution, and Note boxes, appearing as needed throughout this manual, must be reviewed and adhered to during the installation procedure in order to avoid potential hazards, which could result in injury, death, product damage, or property damage.

Should additional assistance be needed, please contact the Product Application Department at 1-800-685-4298, Monday through Friday, between the hours of 8:00 AM and 5:00 PM Mountain Standard Time.

## Danger, Warning, Caution, and Note Boxes:

Danger, Warning, Caution, and Note boxes appear throughout this manual as a means of alerting the installer to important information.

### **⚠ DANGER! ⚠**

INDICATES THAT PERSONAL INJURY IS LIKELY OR IMMINENT.

### **WARNING!**

Indicates that serious damage to the heater will occur and personal injury is possible as well.

### **CAUTION:**

Indicates that damage to the heater is possible.

**NOTE:** Indicates information that requires special attention by the installer.

# Aqua-Hot Hydronic Heating System



Figure 1

Diesel-Burner, Heat Input (Firing Rate) . . . . .	45,000 BTU/hr
Diesel-Burner, Fuel Consumption (Continuous Operation) . . . . .	0.40 gal/hr
Heater, Voltage/Maximum Power Consumption . . . . .	12 Volt-DC/60 watts
Electric Heating Element specifications. . . . .	120 Volt-AC/1650 watts
Zone Heat Circulation Pump specifications. . . . .	(2) 12 Volt-DC/21 watts each
Number of Heating Zones . . . . .	maximum of 5, plus Engine Preheat
Domestic Water Heating Capacity. . . . .	continuous/on-demand
Dimensions . . . . .	12"H x 18.5"W x 30"L
Dry Weight. . . . .	approximately 127 lbs.
Wet Weight . . . . .	approximately 184 lbs.



**For installation only in a compartment that is completely closed off from living quarters and accessible only from the outdoors.**  
The Exhaust System **MUST NOT** terminate beneath the vehicle or under an openable window or vent.

Combustion Air **MUST BE** supplied from outside the vehicle.

**CAUTION: THIS APPLIANCE OPERATES ON BOTH AC AND DC POWER.**  
USE COPPER CONDUCTORS ONLY!

Use a 20-Amp fuse for over-current protection for the DC power supply.  
Use a circuit breaker that cuts power at 20-Amps maximum for over-current protection for the 120-VAC power supply.

Mount the Heater near a bay/storage door so that the Access Cover can be easily removed for service.

**WARNING: DO NOT OPERATE APPLIANCE WITH ACCESS COVERS REMOVED.**

Minimum Heater Clearances:  
Front - Open Access  
Back - 0 inches  
Top - 0 inches  
Sides - 0 inches

Install in strict compliance with local codes, NFPA 1192, and the manufacturer's instructions.

**Certified for use in a Recreational Vehicle ONLY!**

Direct Vent Appliance

0 PSI	174	1650
Maximum Tank Pressure	Watts (DC)	Watts (AC)
.35 / 60	12 VDC	120 VAC, 60 Hz
Nozzle Size/Angle	Volts	Volts
56,000 BTU / 16.4 kWh	145 PSI / 10.0 bar	Pump Pressure
Input Firing Rate		
WEBASTO		DIESEL
Diesel-Burner Model Number	Diesel-Burner Serial Number	Fuel Type
AHE-450		
Model Number	Serial Number	Manufactured Date

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Figure 2

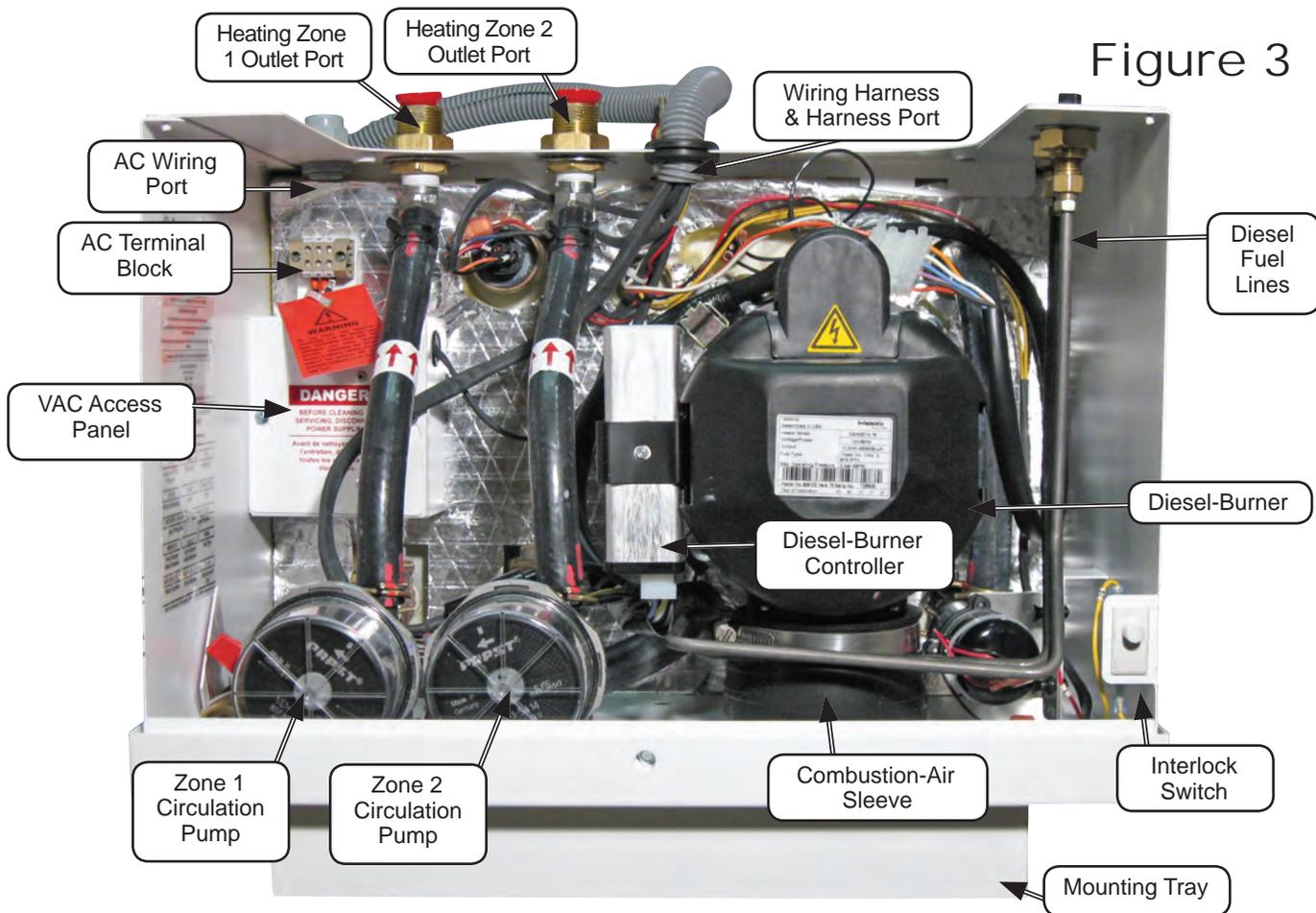


Figure 3

# Aqua-Hot Hydronic Heating System

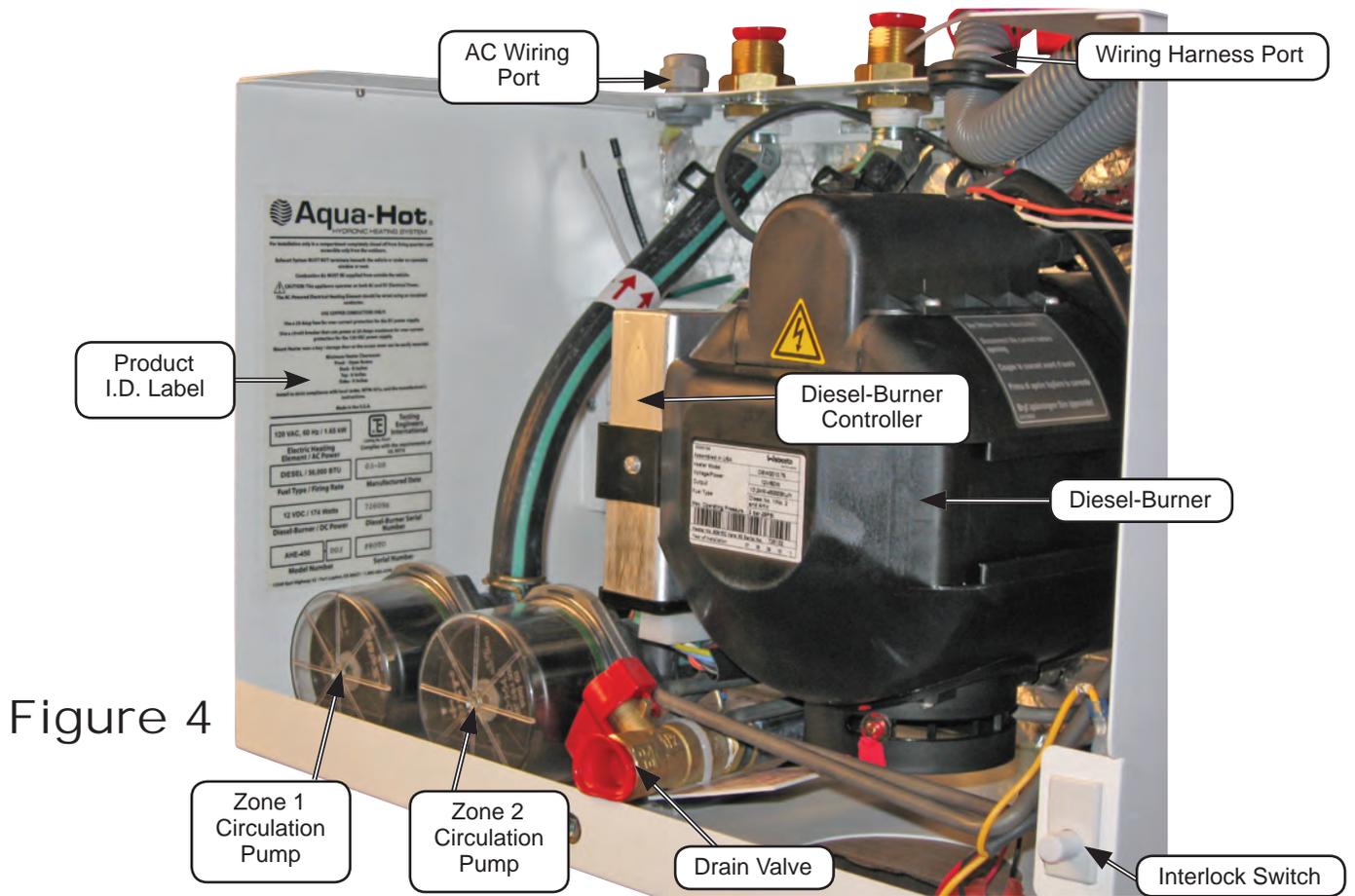


Figure 4

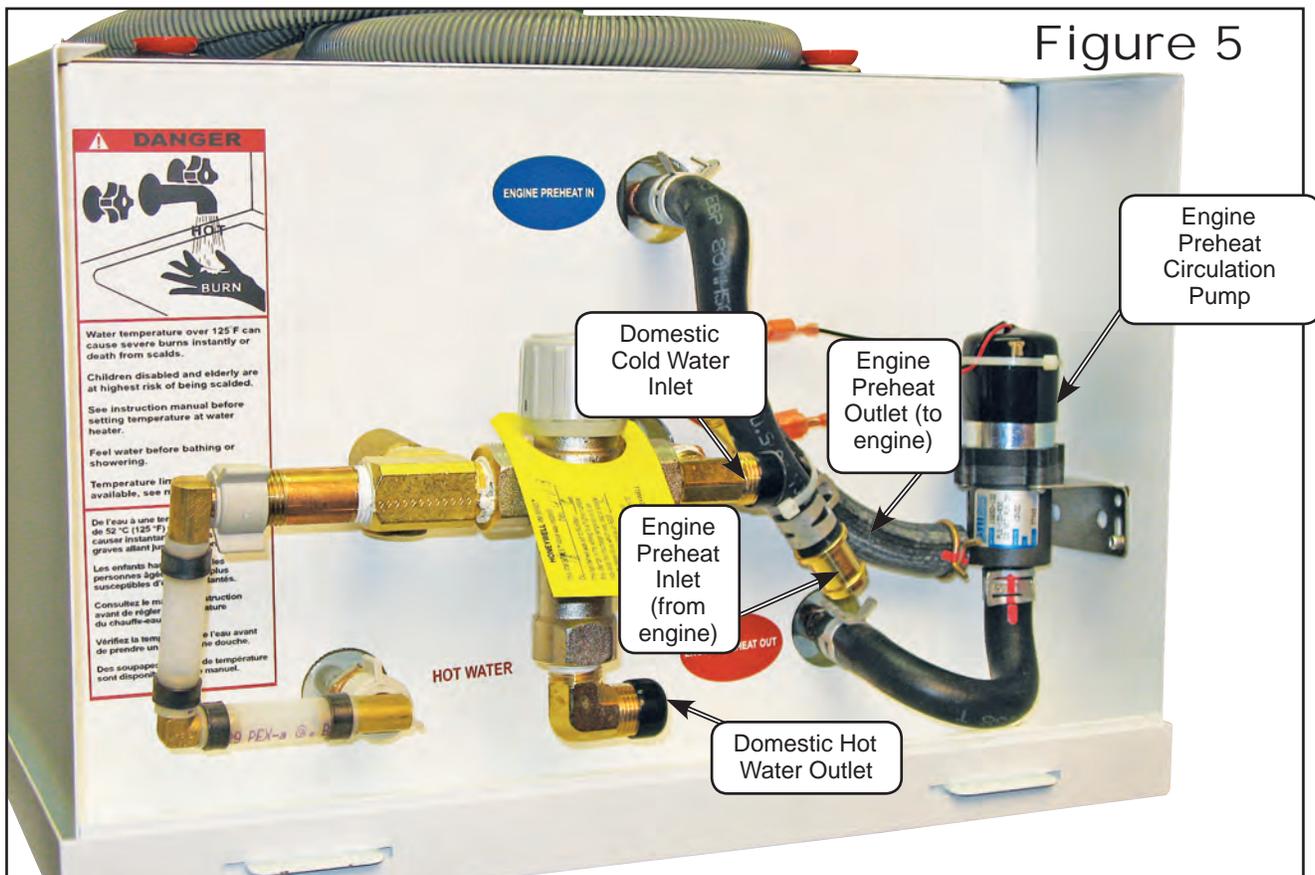


Figure 5

Back of Unit

# Aqua-Hot Hydronic Heating System

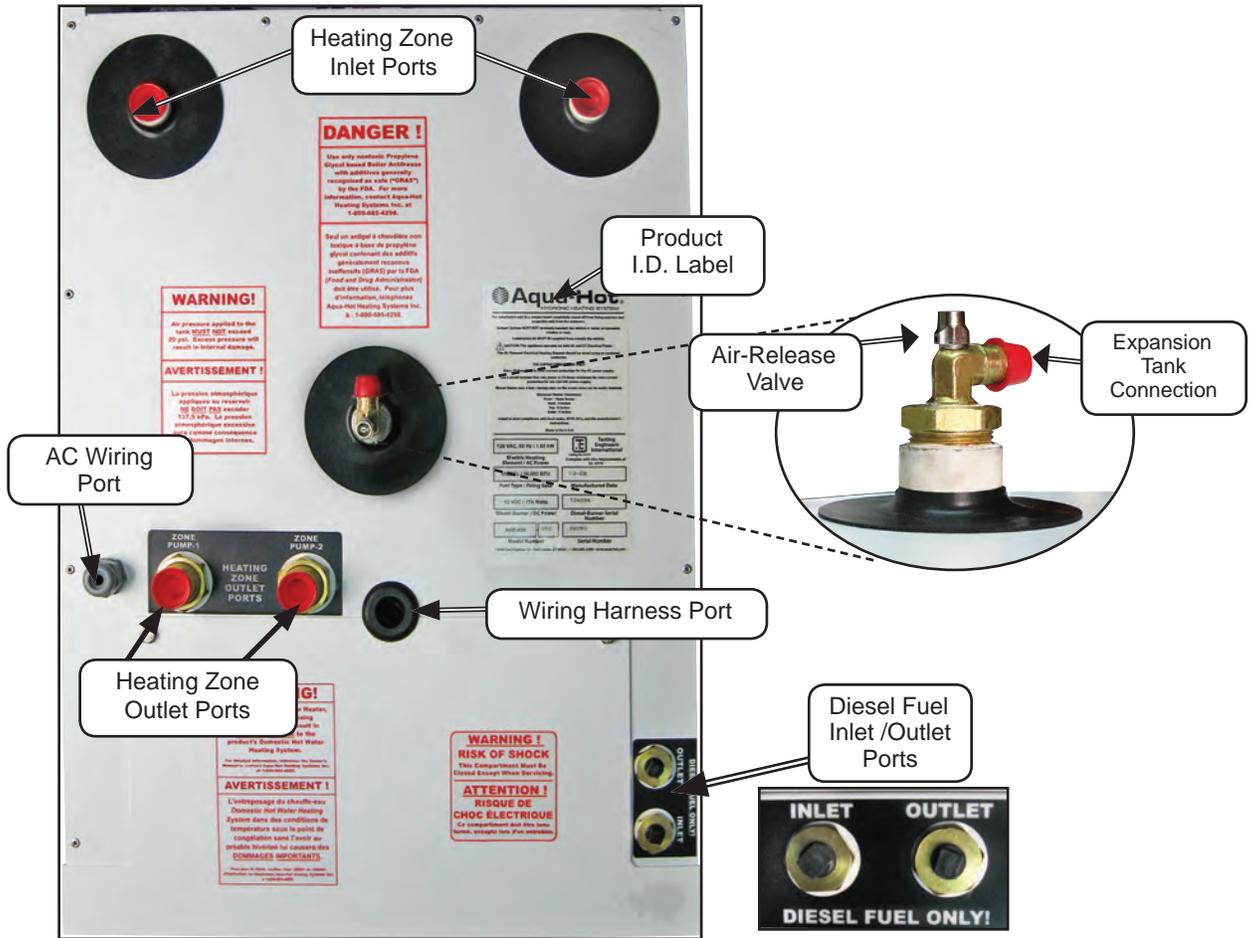


Figure 6

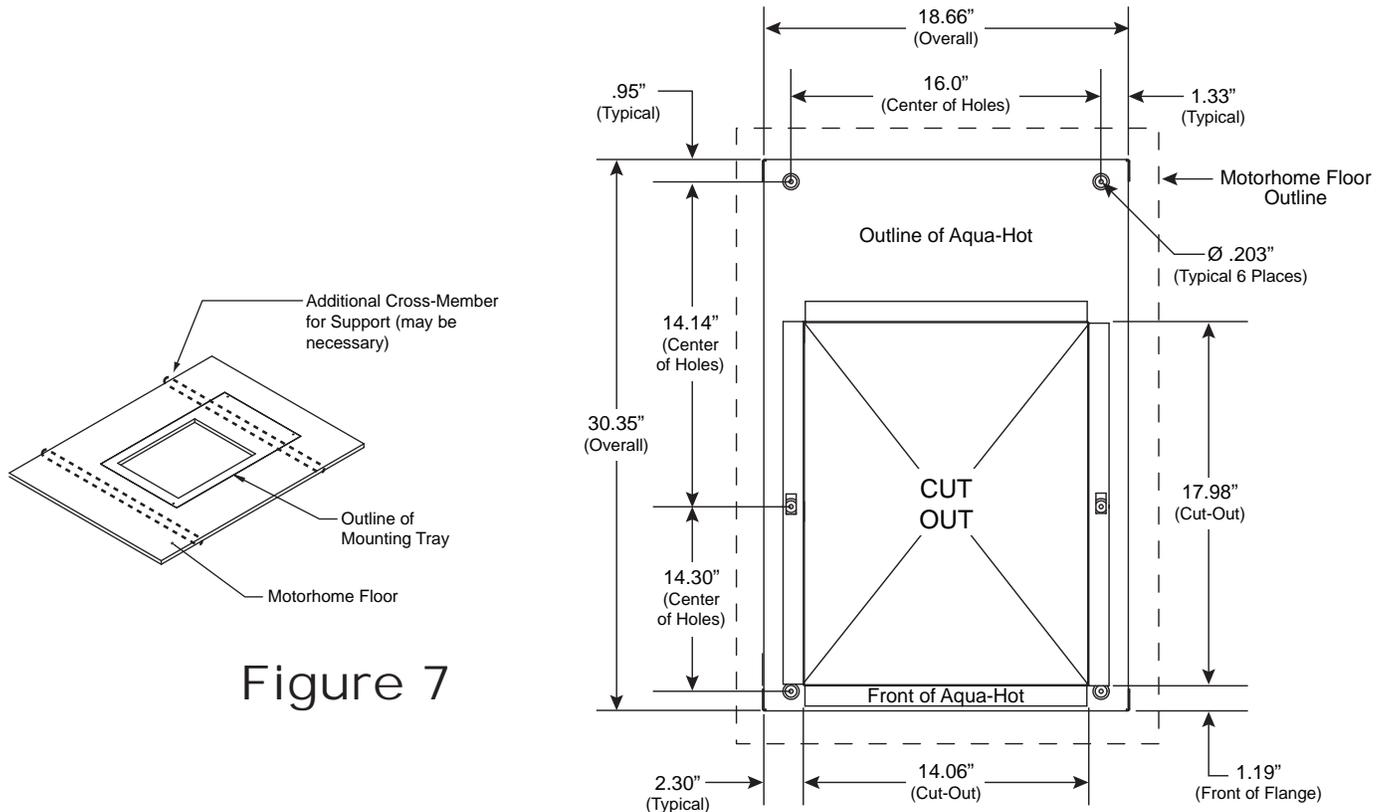


Figure 7

# Section 1: Aqua-Hot Installation

## Installing the Mounting Tray and the Aqua-Hot:

1. Reference the following illustrations for mounting information:
  - Overall Aqua-Hot dimensions - Figure 10
  - Mounting tray information - Figure 7
  - I.D. Label noting the “Open Access” clearance requirement for the front of the heater - Figure 2
  - Service access clearances - Figure 8
2. Cut out the required mounting tray opening. Reference Figure 7.
3. Install the mounting tray flange into the cut-out opening. Reference Figure 7.

**NOTE:** Be sure to secure the mounting tray into place prior to installing the Aqua-Hot.

Be sure to mount the Aqua-Hot securely into the mounting tray to ensure that the unit does not move or shift under normal operating conditions.

Be sure the access cover fastener is removed from the Aqua-Hot prior to placement into the installed mounting tray.

Be sure to provide an adequate support system for the mounting tray; if adequate support is not present, a cross-member will need to be installed. Reference Figure 7.

Inspect the area beneath the mounting location to insure no structural members will interfere with the cut-out for the mounting tray.

4. Insert a #10 machine screw into each of the embossed holes in the mounting tray (total of six required) and tighten to secure the mounting tray to the motorhome. Reference Figure 7.
5. Place the Aqua-Hot into the mounting tray. Reference Figure 11.
6. Install the combustion-air sleeve onto the diesel-burner's air intake. Reference Figure 9.
  - A) Slide the end of the combustion-air sleeve with the clamp up through the mounting tray and underside of the Aqua-Hot 450-D.
  - B) Loosen the adjustable clamp and slide over the diesel-burner's air intake.
  - C) Tighten the clamp to secure the sleeve to the diesel-burner.
7. Re-install the access cover fastener and tighten once the total installation procedure is complete.



Figure 9

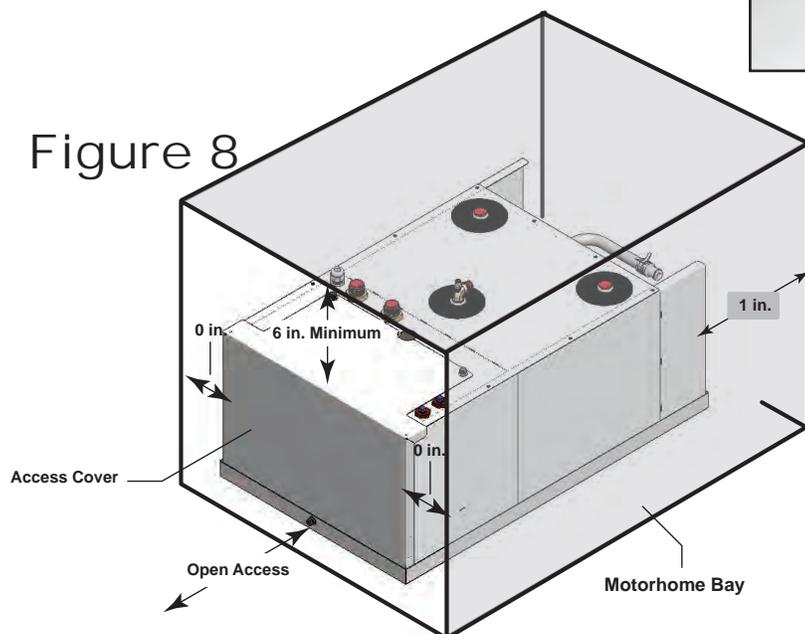


Figure 8

# Section 1: Aqua-Hot Installation

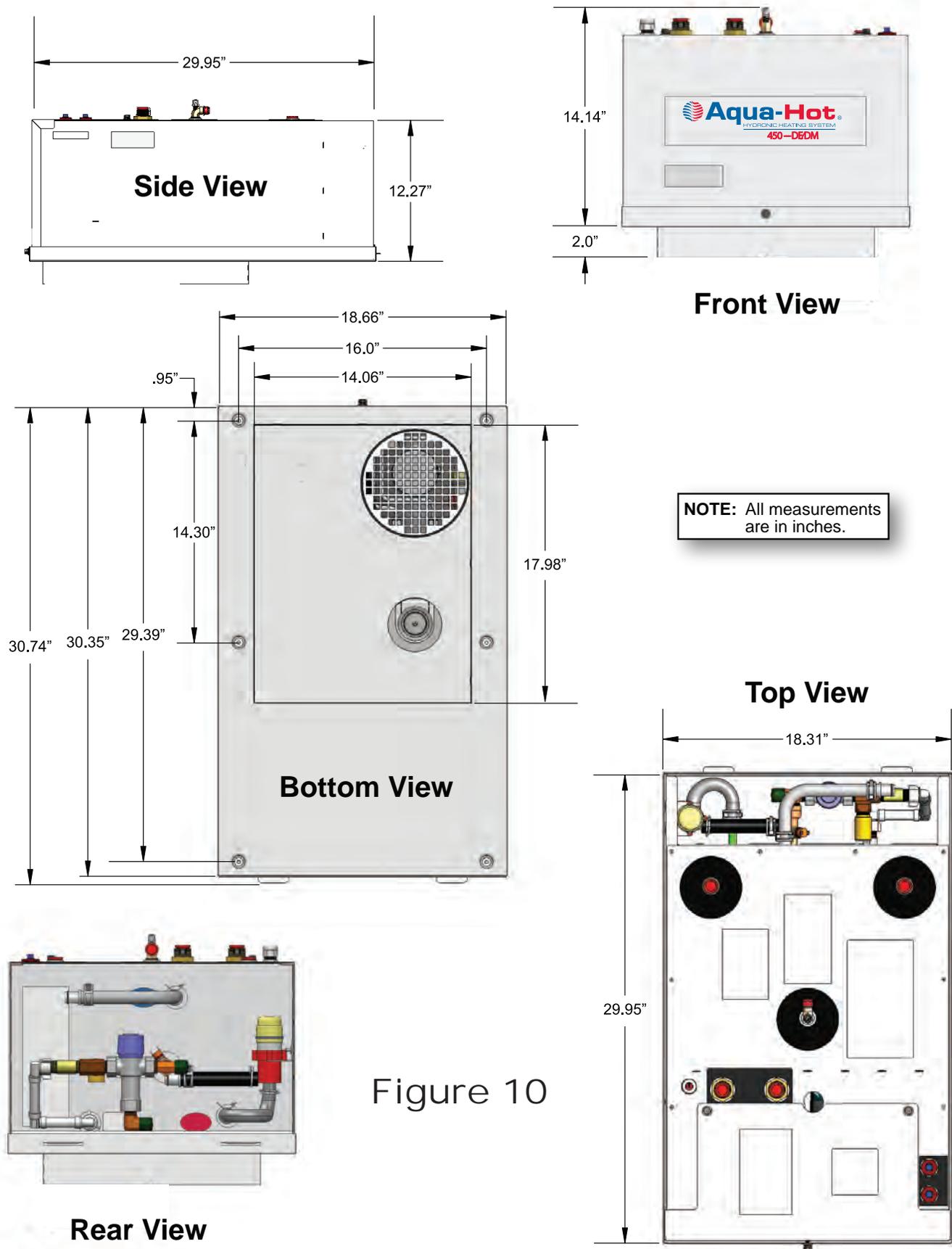


Figure 10

# Section 1: Aqua-Hot Installation

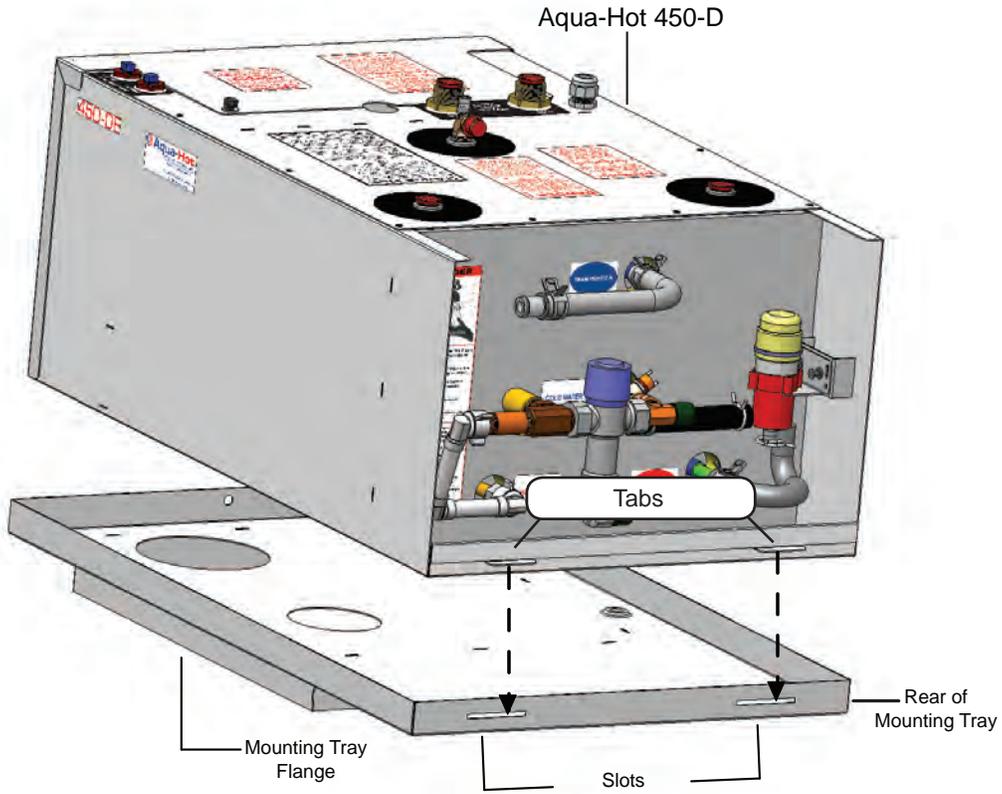
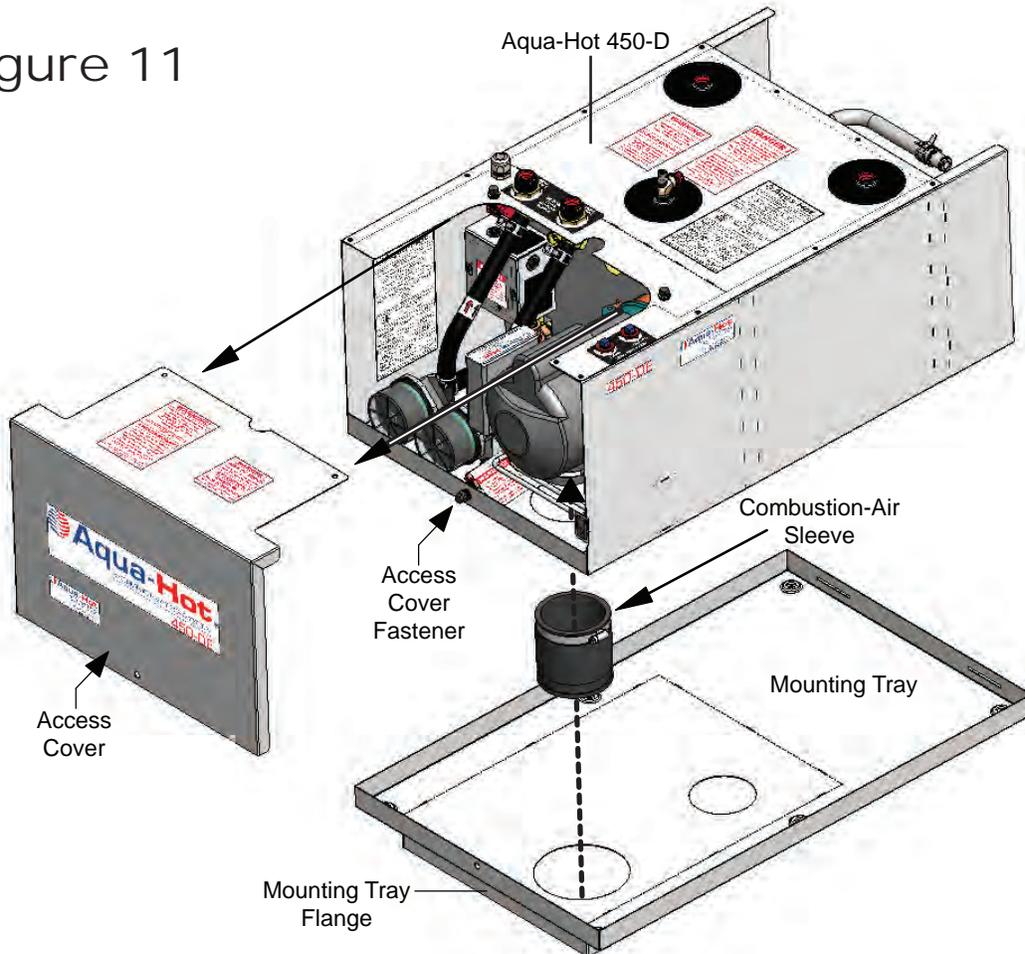


Figure 11



# Section 1: Aqua-Hot Installation

## Installing the Expansion Tank:

Select a mounting location that allows for easy access and clear visibility whenever the particular storage bay door is open.

**NOTE:** The top of the expansion tank should always be mounted at least 4 inches higher than the highest point on the Aqua-Hot. Reference Figure 12.

1. Mount the expansion tank as illustrated in Figure 12.
2. Connect and clamp the overflow tubing from the expansion tank to the Aqua-Hot's expansion tank connection. Reference Figure 12.

**NOTE:** Avoid any dips and bends in the overflow tubing from the Aqua-Hot to the expansion tank as air can become trapped in these dips and bends, preventing the expansion of the heating solution from properly depositing in the expansion tank.

3. Drill a hole in the bay floor and connect (secure with a clamp) a long enough piece of overflow tubing so that it can be connected to the top of the expansion tank and extend through the bay floor.

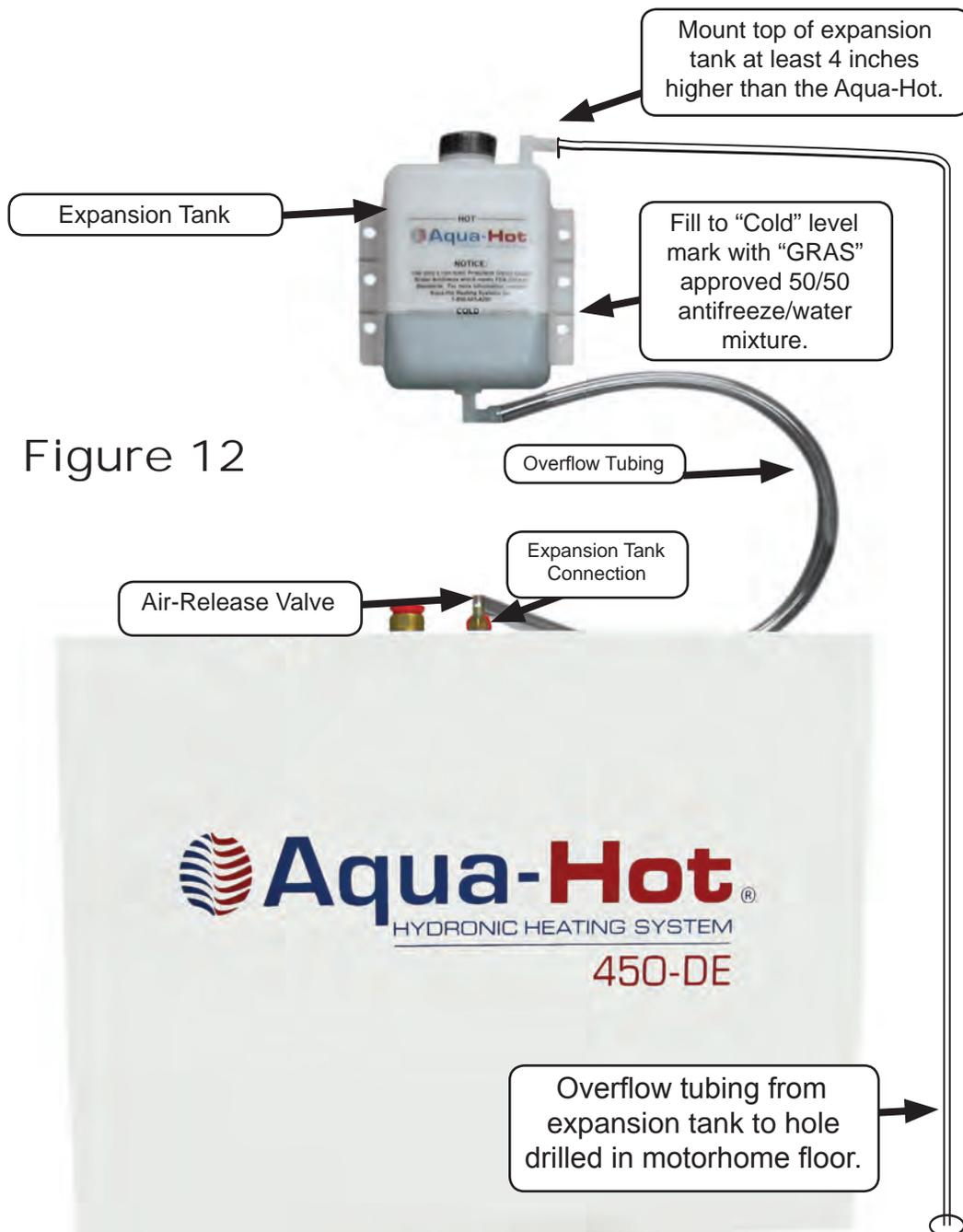


Figure 12

# Section 2: Hydronic Heating System

## Location and Clearances:

Place the heat exchangers so that even heat distribution will be felt throughout the interior of the motorhome. Reference Figures 13 through 20.

**NOTE:** For single slideout configurations, it is usually simplest to place a heat exchanger on the opposite side of the motorhome pointing towards the slideout.

Place the heat exchangers where they will be accessible for potential servicing and cleaning.

Centralize and position a heat exchanger in the fresh water storage tank plumbing bay.

**NOTE:** In order to achieve the best heating results, place the heat exchanger as close to the floor of the plumbing bay as possible (heat will naturally rise).

Reference Figures 15 and 18 for mounting location information.

Reference Figure 14 for clearance information.

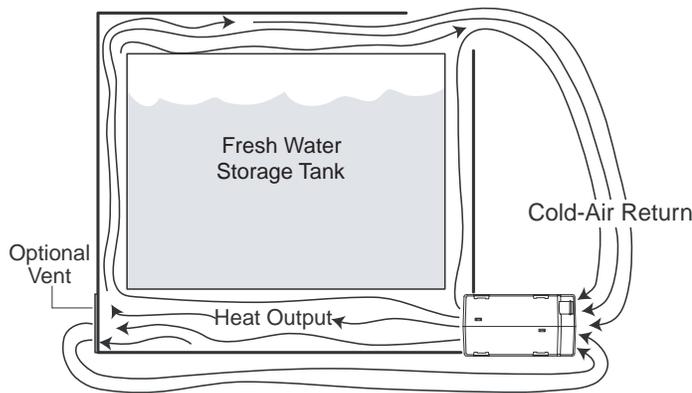


Figure 13

**NOTE:** An accessory device is available for the Cozy Heat Exchanger for the purpose of redirecting the airflow from the heat exchanger. Reference Figure 17.

## Mounting Requirements:

Sufficient ventilation (return-air) must be supplied to each interior heat exchanger. Reference Figures 15 and 16.

**NOTE:** Mounting the heat exchangers without sufficient ventilation will severely reduce their overall heating performance (heat output).

In order to provide sufficient ventilation, the return-air registers must be the same size, or larger, than the outlet-air registers.

Return-air must be supplied from the corresponding interior heating zones.

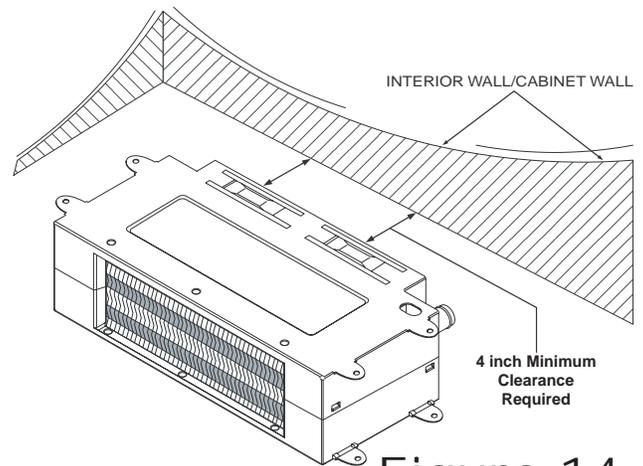


Figure 14

## Interior Zone Heating/Heat Exchanger Layout

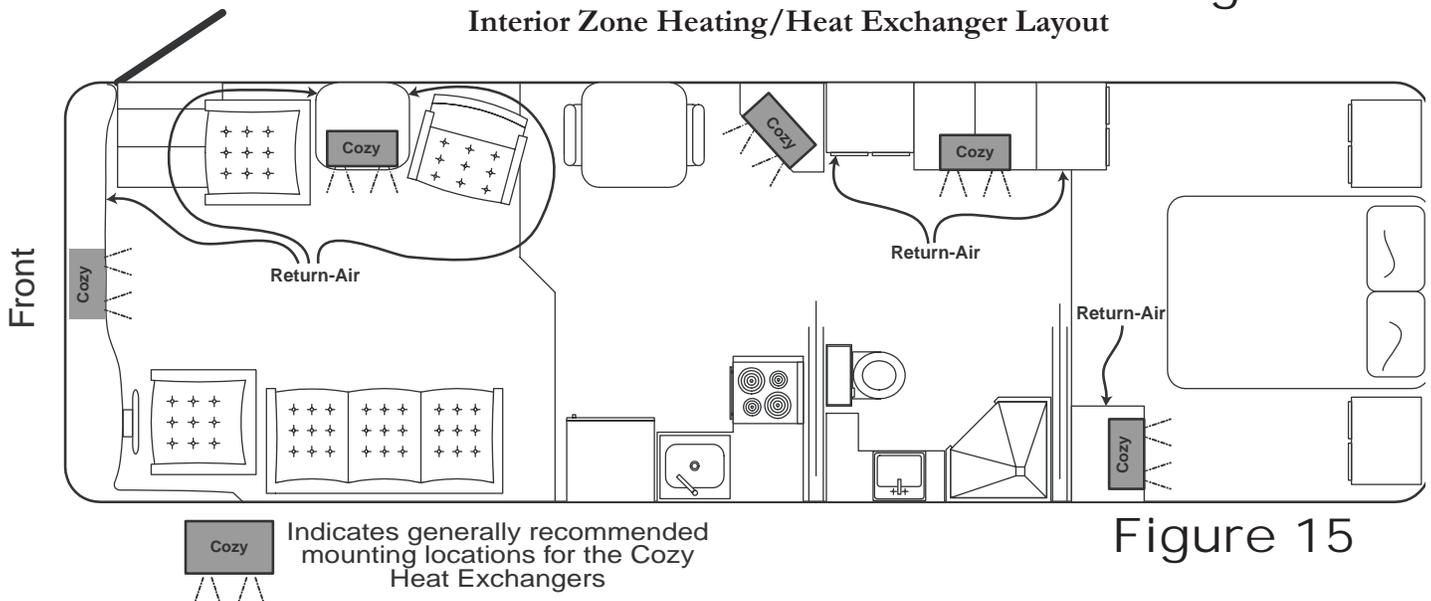


Figure 15

# Section 2: Hydronic Heating System

## Mounting the Heat Exchangers:

1. Cut out a 2.5 inch H x 10 inch W opening for each heat exchanger outlet and cold-air return register. Reference Figure 16.
2. Mount each heat exchanger permanently into place. Reference Figures 19 and 20.
3. Install the hot-air outlet and cold-air return registers. Reference Figure 16.

**NOTE:** Please note that a return air register may not be required; however, adequate return-air must be provided to each particular heat exchanger. This means that the total cross-sectional area of the return-air opening must be equal to or greater than the cross-sectional area of the hot-air outlet opening of the heat exchanger.

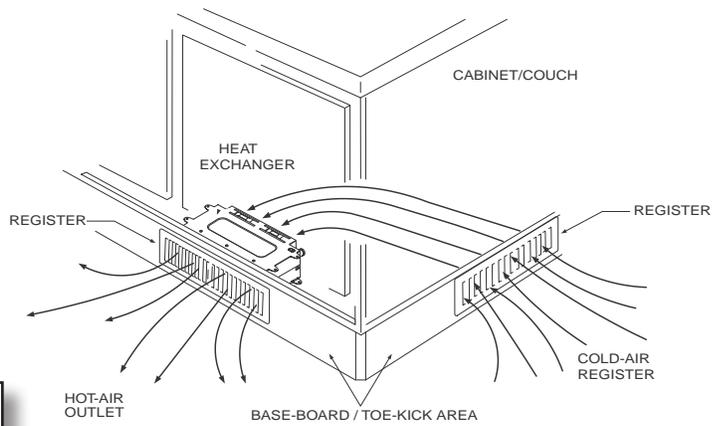


Figure 16

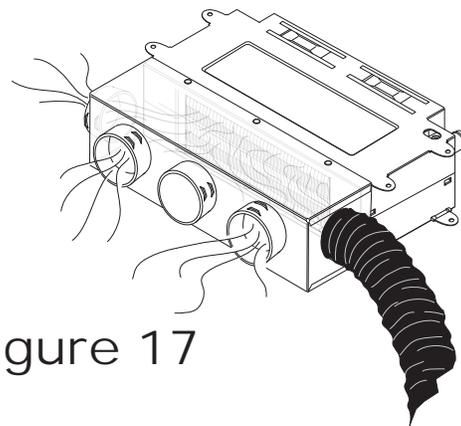


Figure 17

## Generalized Motorhome Heating System Floor Plan

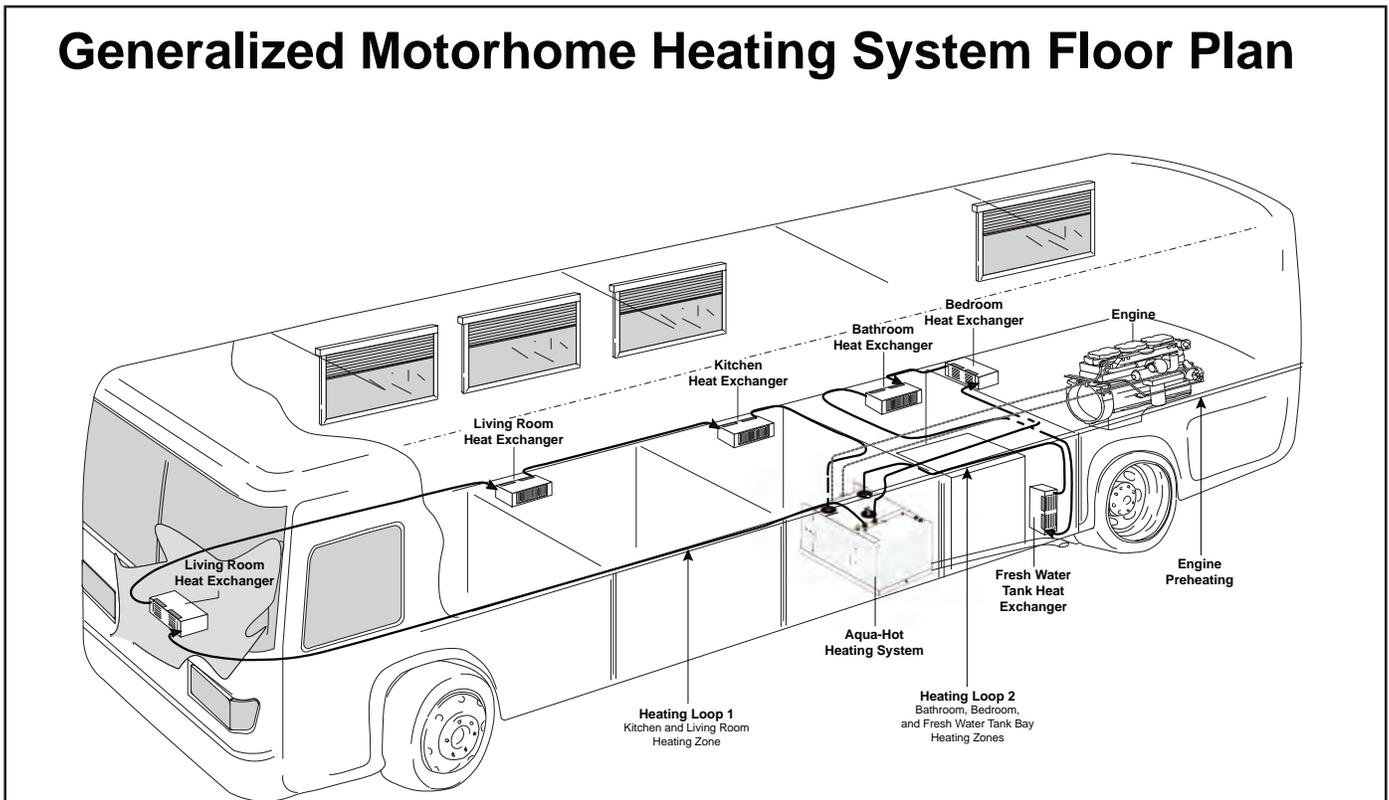


Figure 18

# Section 2: Hydronic Heating System

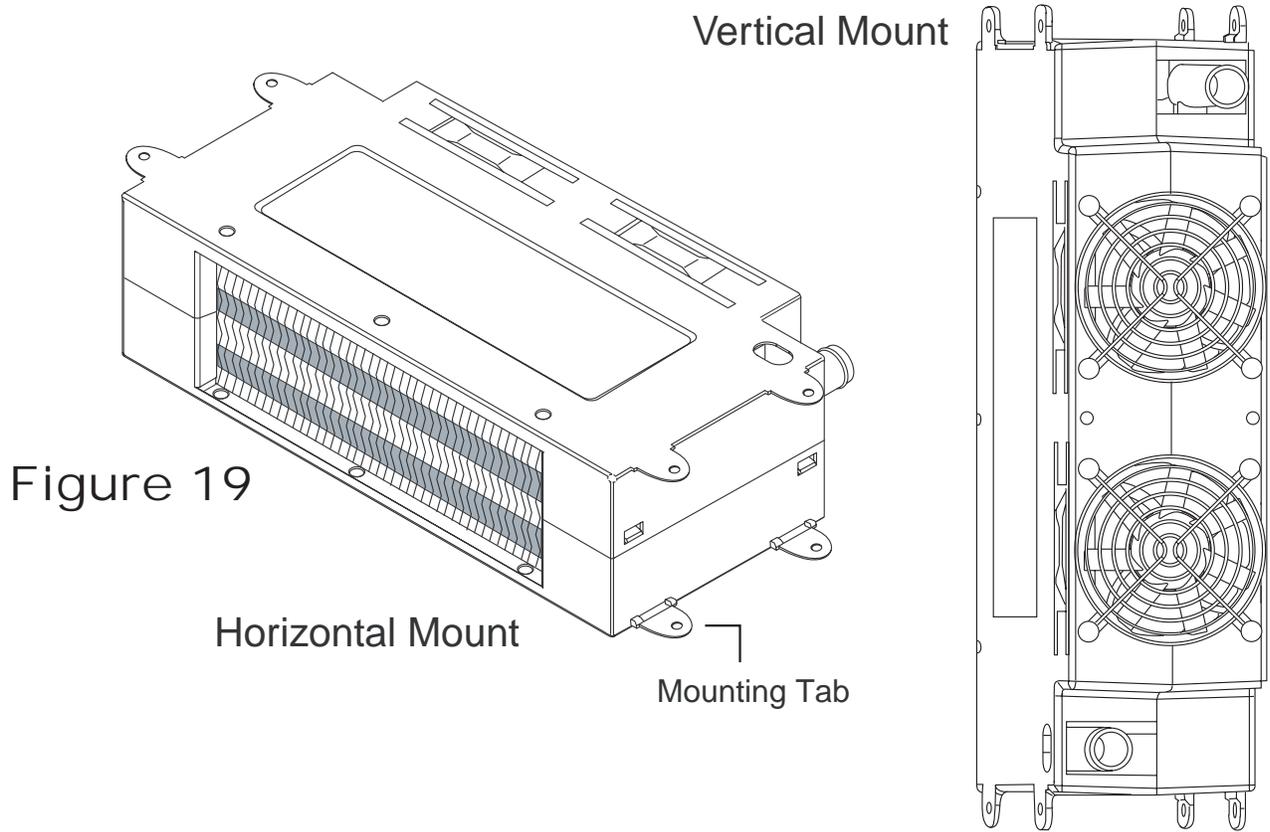


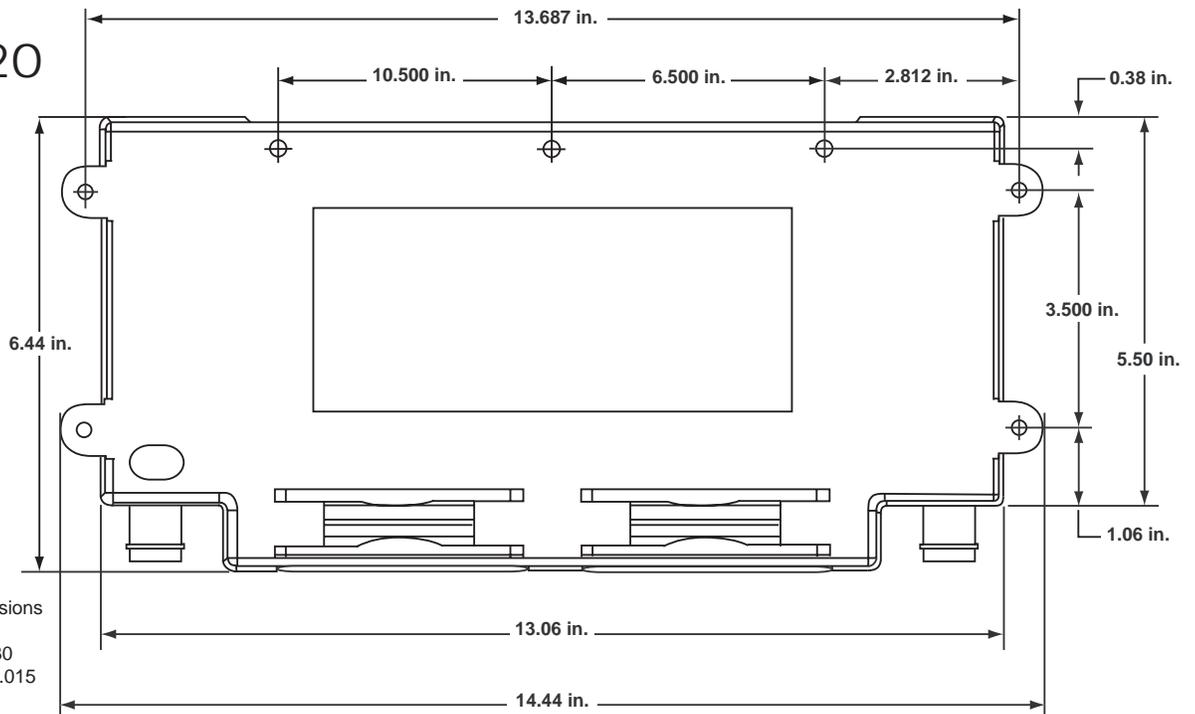
Figure 19

Horizontal Mount

Vertical Mount

Mounting Tab

Figure 20



**NOTE:**  
Tolerances on the dimensions shown are as follows:  
.XX (i.e., 6.44 in.) = ± .030  
.XXX (i.e., 6.500 in.) = ± .015

# Section 2: Hydronic Heating System

## Wiring the Heat Exchangers:

1. Run two 18-gauge wires, red for (+) and black for (-), from each particular heating zone's heat exchanger to the electronic controller. Reference Figure 22.
2. Label the wires indicating the heating zone they pertain to (e.g., Living Room, Bathroom, Bedroom, etc.).
3. Insert all heat exchanger wires into the appropriate terminal/heating zone location on the electronic controller. Reference Figure 21 and Appendix A.
4. Wire all heat exchangers in a zone in-series. Reference Figure 23 and Appendix A.
5. Connect all electronic controller wires to the positive and negative leads of the heat exchanger. Reference Figure 22.

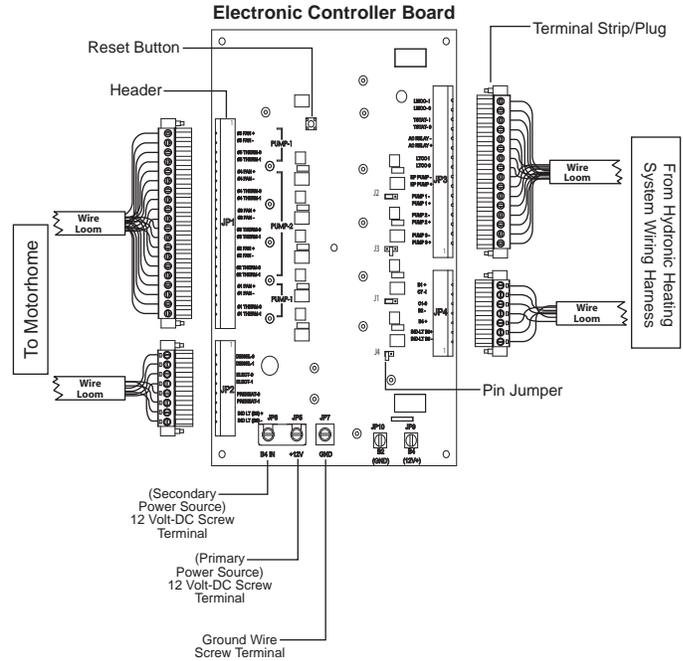


Figure 21

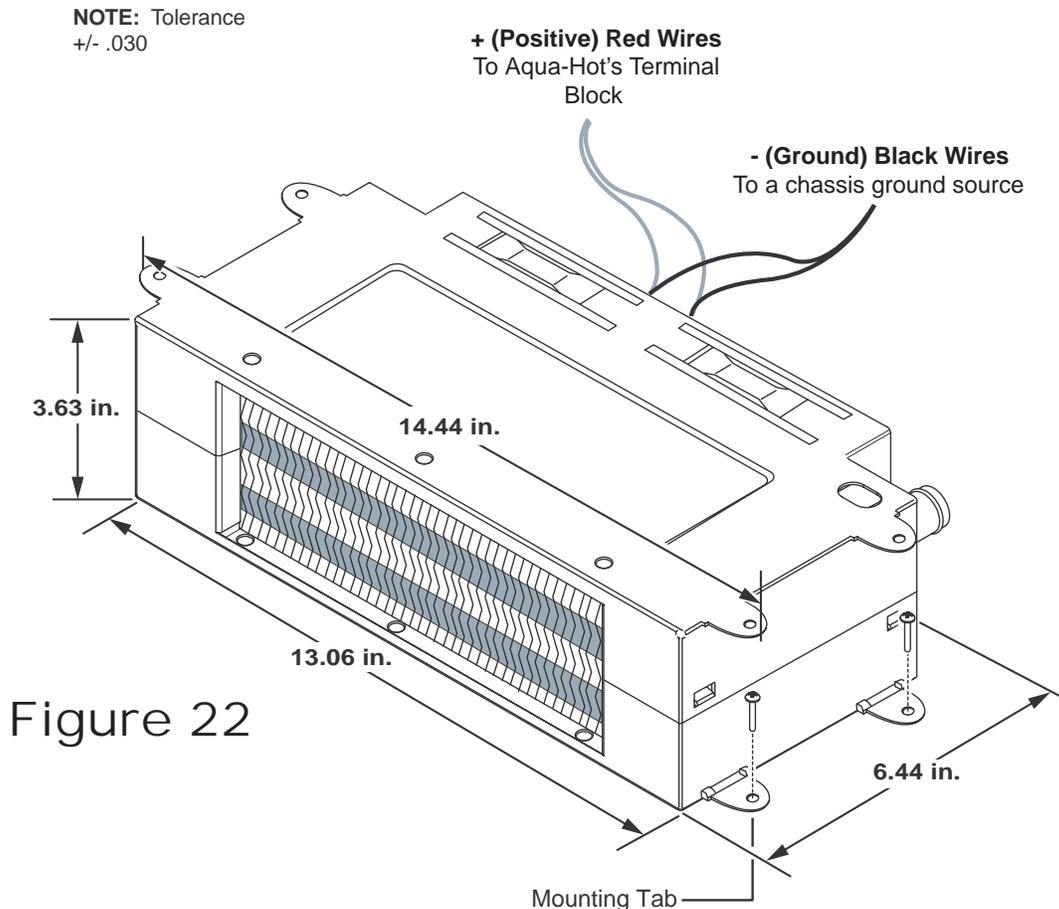


Figure 22

# Section 2: Hydronic Heating System

## Plumbing Requirements:

Once all heat exchangers have been mounted, formulate a plan for the routing of the plumbing lines from each heating zone to the Aqua-Hot.

All plumbing lines should be laid as flat as possible, and any extreme rises in height should be avoided to eliminate any potential air-traps.

The kitchen and living room heat exchangers (typically three) must be plumbed together **in-series** on “Heating Loop 1.” Reference Figures 23 and 24.

The fresh water tank, bedroom, and bathroom heat exchangers (typically 3) must be plumbed together **in-series** on “Heating Loop 2.” Reference Figures 23 and 24.

Use 3/8 inch I.D. (Inside Diameter) plumbing lines for both heating loops.

Use wide-sweeping elbows or “bend supports” whenever the plumbing lines may be susceptible to kinking (i.e., 90° bends).

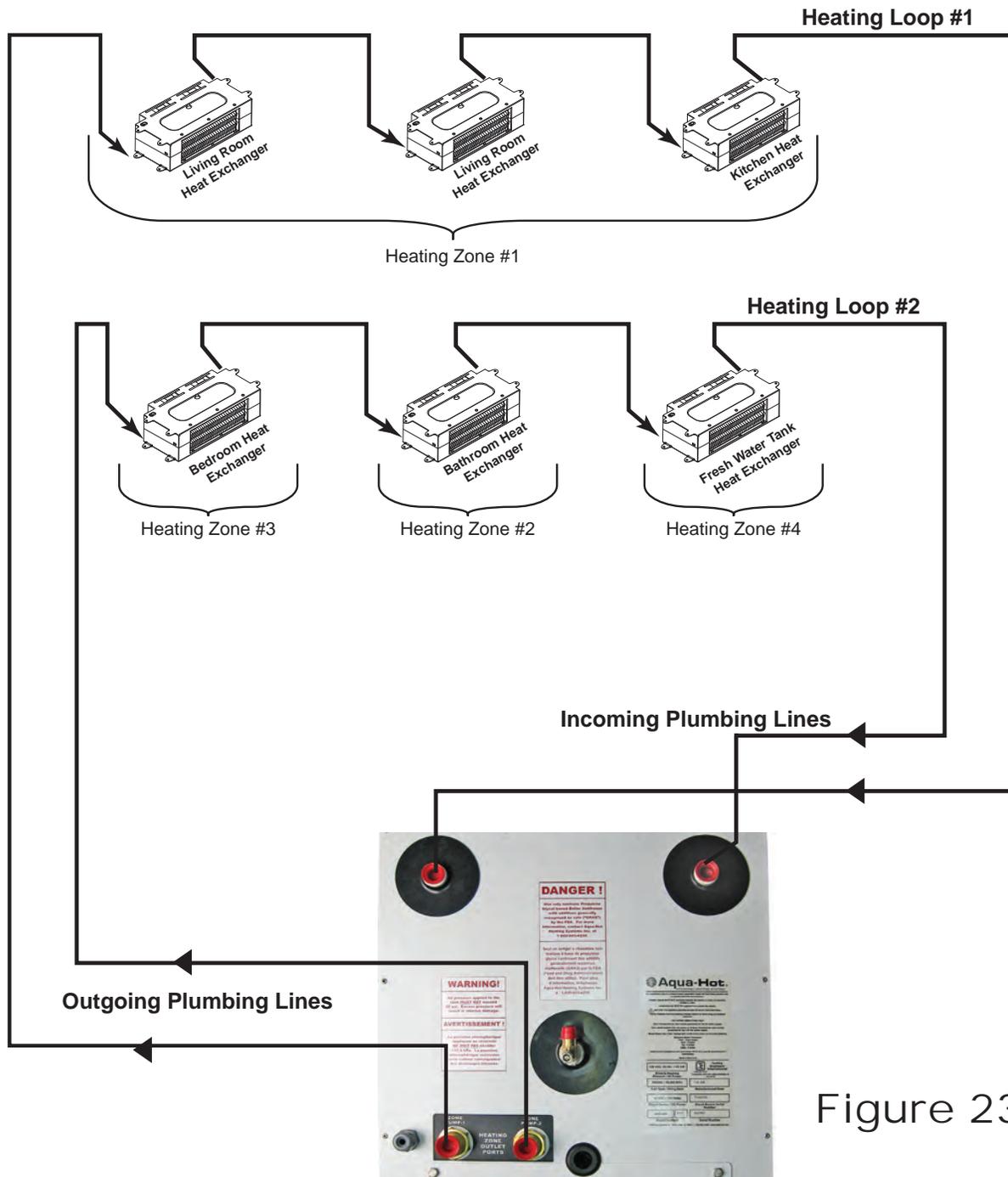


Figure 23

# Section 2: Hydronic Heating System

## Plumbing the Hydronic Heating System:

1. Lay out the plumbing lines for all heat exchangers.
2. Label each line with the heating loop number and designate as an inlet or an outlet line.

**NOTE:** Run all plumbing lines in areas where they cannot be pinched off or damaged under normal operating conditions.

Be sure to secure all lines where necessary and apply protective shielding in areas where chafing may occur.

Rubber Coated/Closed-Type clamps are recommended when securing the plumbing lines.

3. Connect and clamp the outlet line from the Aqua-Hot to the lowest port on the closest heat exchanger for both heating loops. Reference Figures 24 and 26. Then, connect each additional heat exchanger in the same arrangement (low to high). Reference Figure 23.
4. Connect and clamp the inlet line from the heater to the highest port on the last heat exchanger for both heating loops. Reference Figures 24 and 26.

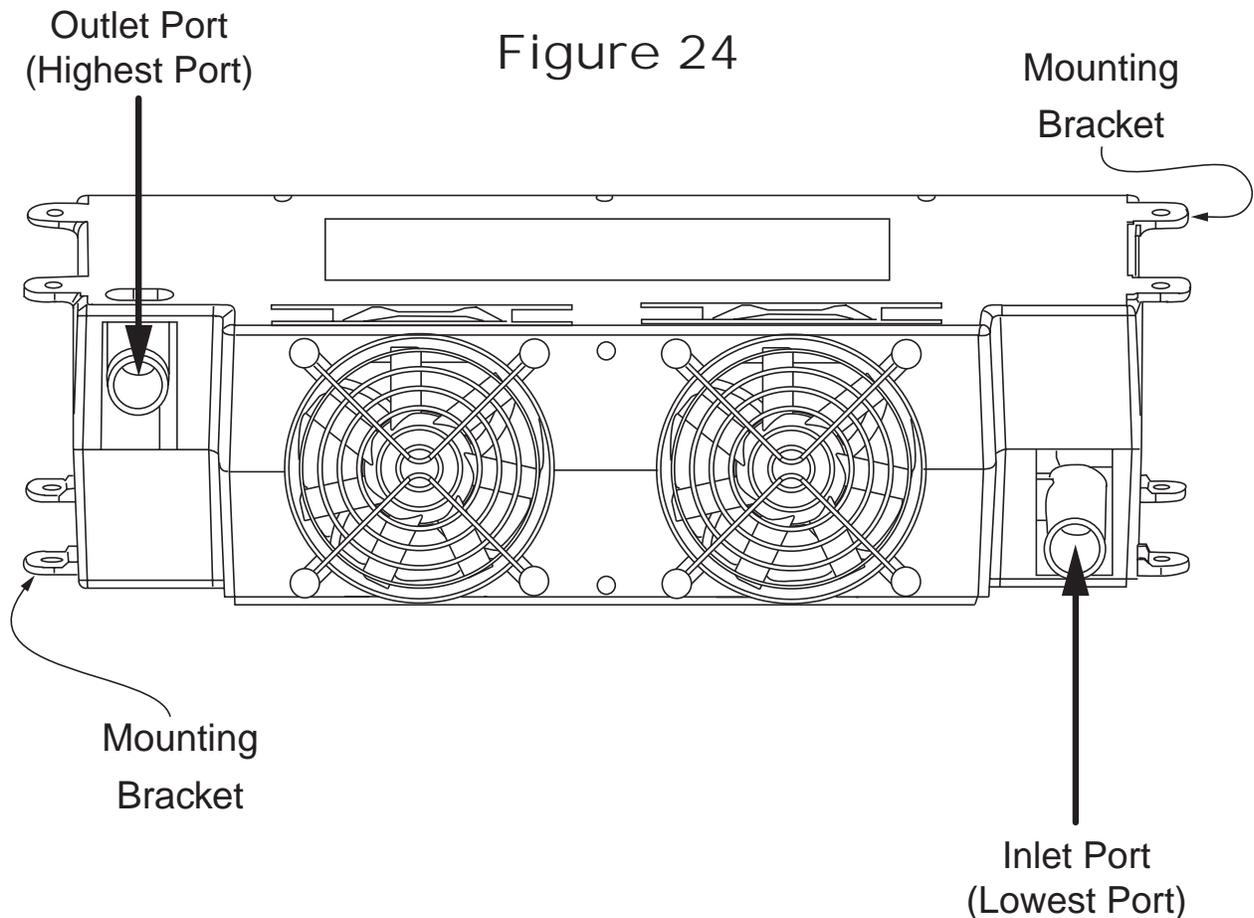
**NOTE:** Reference Figure 25 for visual instructions on connecting PEX-type tubing to each heat exchanger.

Plumbing heat exchangers in this manner will allow air to escape naturally. If air is trapped in any heat exchanger, it will significantly reduce the heat exchanger's overall heating performance (heat output).

5. Connect and tighten all interior plumbing lines, outlet and inlet, to the Aqua-Hot's appropriate heating loop ports. Reference Figures 23 and 26.

## Cozy Heat Exchanger (Rear View)

Figure 24



# Section 2: Hydronic Heating System

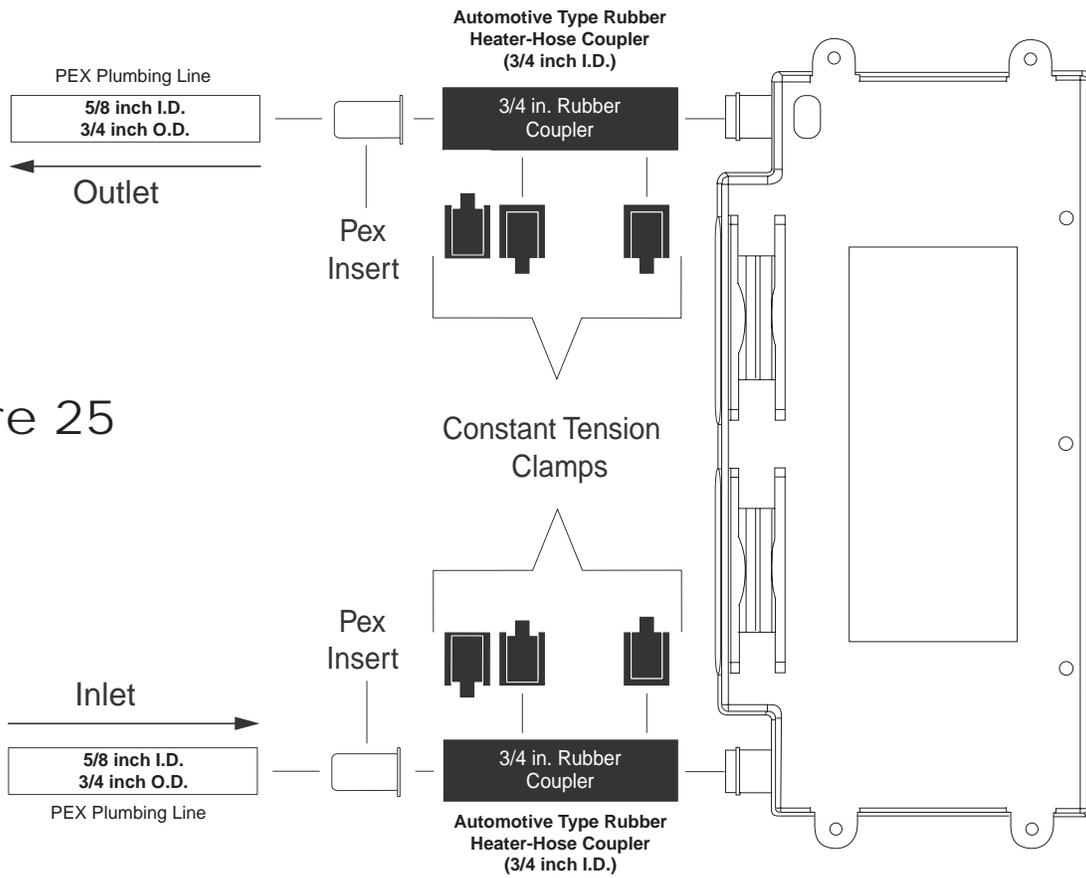
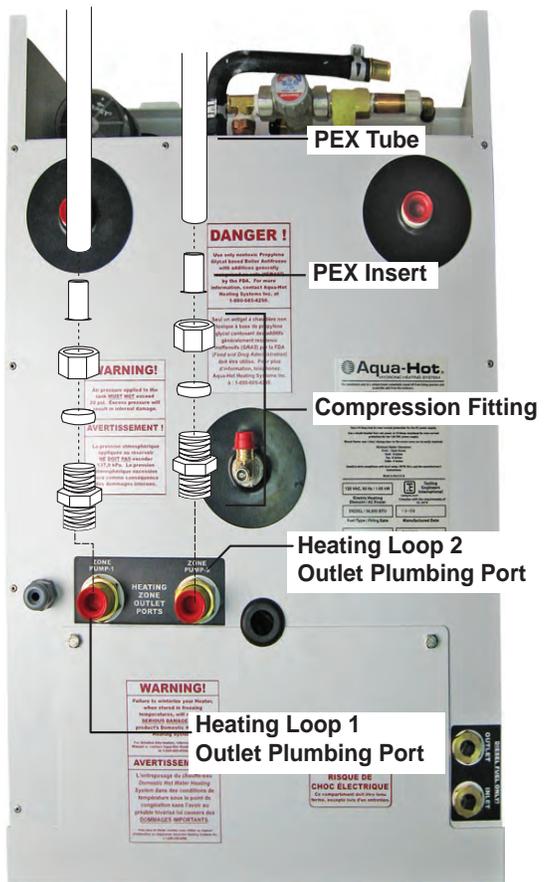


Figure 25

# Section 2: Hydronic Heating System

## Outlet Heating Loop Ports



## Inlet Heating Loop Ports

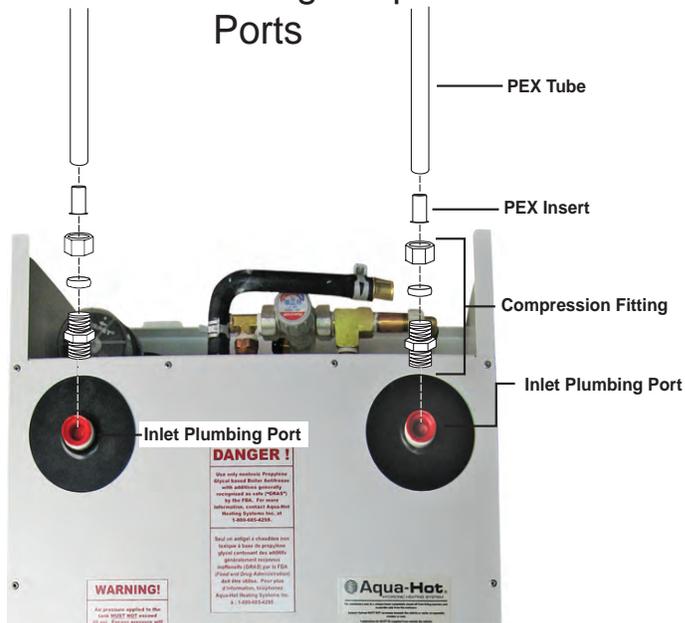
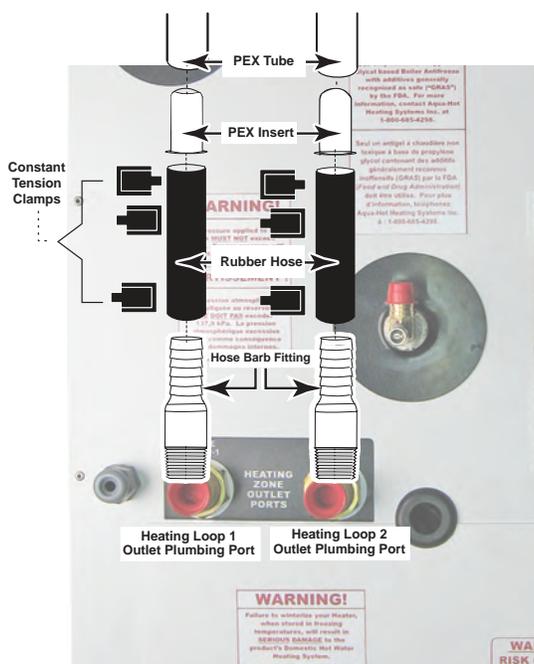
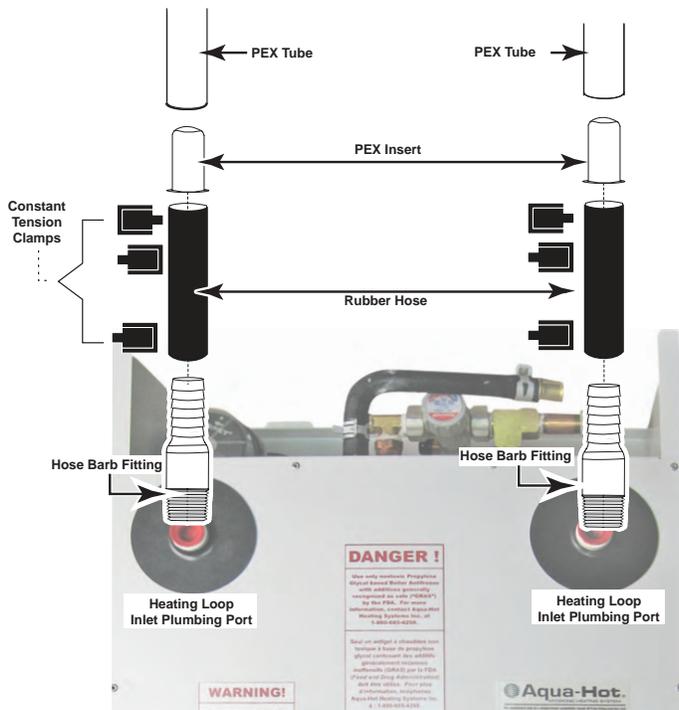


Figure 26

## Outlet Heating Loop Ports



## Inlet Heating Loop Ports



# Section 3: Thermostats

## Fresh Water Tank Thermostat Locations:

Select a location that will ensure even-heat distribution throughout the fresh water storage tank bay compartment in order to prevent the domestic water and plumbing system from freezing.

Typically only the bulb of the thermostat needs to be physically mounted in the area requiring heat (usually in close proximity to the domestic water pump). Reference Figure 27.

Do not mount the thermostat bulb in a drafty area.

The selected mounting location should allow for easy operator access. Reference Figure 27.

Avoid mounting the fresh water tank thermostat's bulb too close to the bay heat exchanger.

## Fresh Water Tank Thermostat Mounting:

1. Determine a location for the thermostat based upon the previous location information.
2. Once the thermostat has been completely wired, permanently mount the thermostat in place. Reference Figure 27.

## Fresh Water Tank Thermostat Wiring:

1. Run two 18-gauge wires from the thermostat's mounting location to the Aqua-Hot's electronic controller.

**NOTE:** It is recommended that the wire numbers in Appendix A be used when installing the Aqua-Hot in order to assist with differentiating between the separate heating zones and to aid service personnel with troubleshooting.

2. Insert each thermostat wire into the appropriate terminal/heating zone location in the electronic controller. Reference Appendix A and Figure 28.
3. Connect both wires to the appropriate leads of the thermostat. Reference Figure 27.

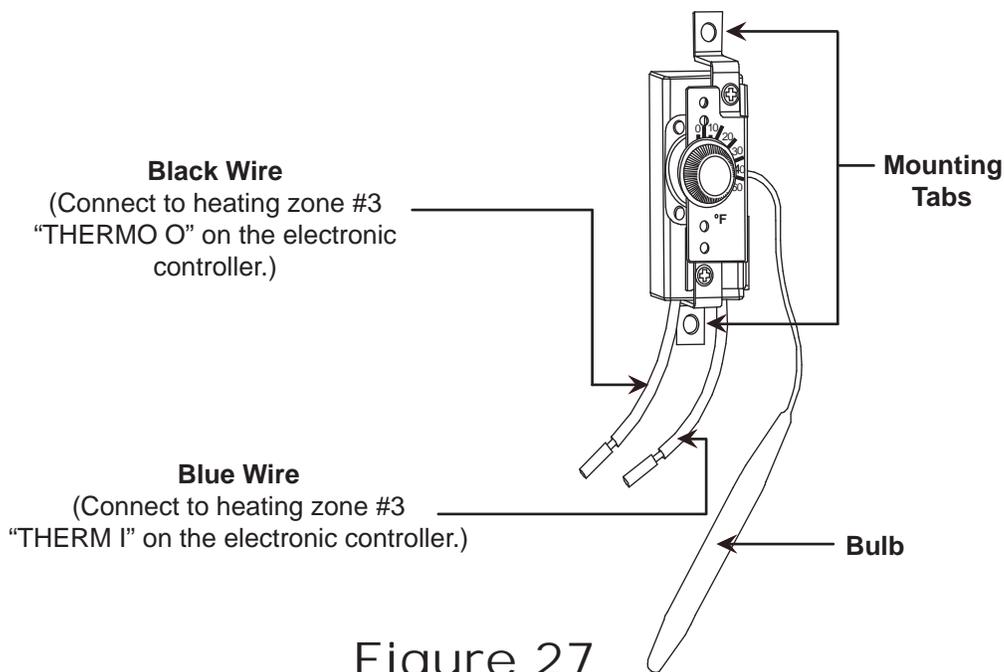


Figure 27

# Section 3: Thermostats

## Room Thermostat Locations:

Select a location that will ensure even-heat throughout each heating zone. The selected location should prevent the thermostat from being affected by:

- drafts or dead spots behind doors and in corners
- hot or cold air from ducts
- radiant heat from the sun or appliances
- heat from concealed pipes and chimneys
- unheated or uncooled areas such as an outside wall behind the thermostat

Locate each thermostat at approximately chest level, if applicable.

## Room Thermostat Mounting:

Once the room thermostat has been wired, permanently mount the thermostat in place.

Be sure to then turn **OFF** all interior room thermostats.

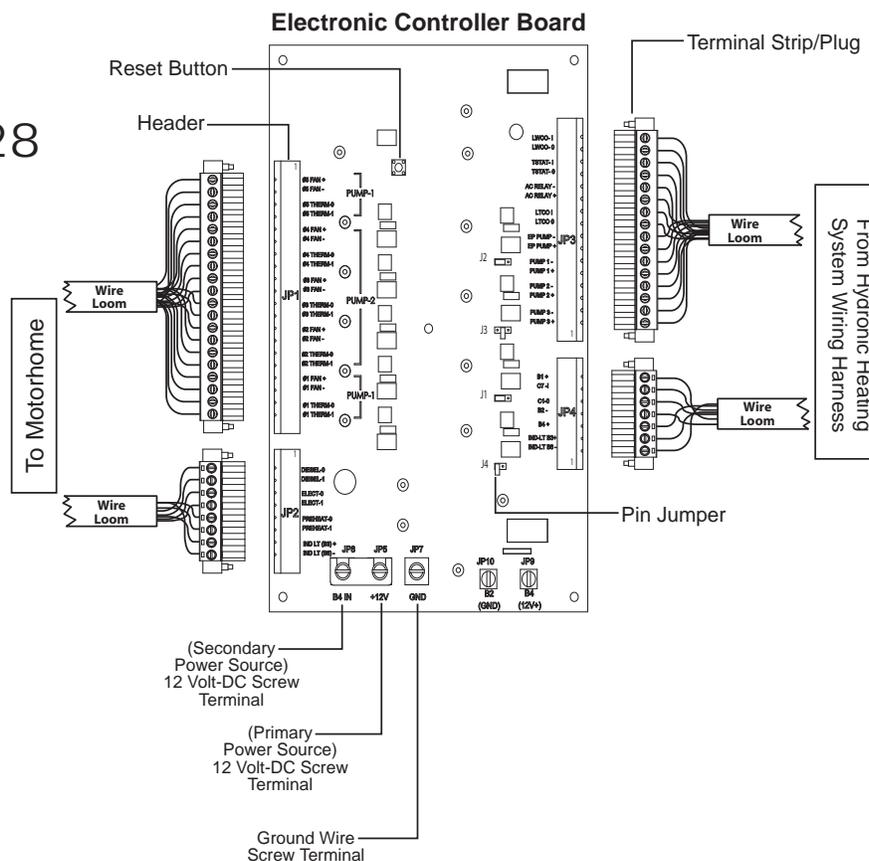
## Room Thermostat Wiring:

1. Run two 18 gauge wires from each room thermostat mounting location to the Aqua-Hot's electronic controller. Reference Appendix A.

**NOTE:** It is recommended that the wire numbers in Appendix A be used when installing the Aqua-Hot in order to assist with differentiating between the separate heating zones and to aid service personnel with troubleshooting.

2. Insert all room thermostat wires into the corresponding zone number location on the electronic controller. Reference Appendix A and Figure 28.
3. Connect all wires to the appropriate leads of each room thermostat.

Figure 28



# Section 4: Domestic Water System

## Domestic Water System Requirements:

**NOTE:** Please note that it may be necessary to utilize an accumulator tank within the domestic water system. Reference Figure 30. Although the Aqua-Hot is equipped with a pressure-relief valve, the use of an accumulator tank will help prevent excessive “weeping” of the valve. Manufacturers of pressure-relief valves indicate that excessive weeping of these valves will cause the “seat” in the valve to deteriorate, and, in turn, the valve will fail prematurely. For additional information regarding accumulator tanks, please be sure to reference the Recreational Vehicle Industry Association’s (RVIA) technical publication titled “Recreational Vehicle Plumbing Systems.” To obtain a copy of this particular publication, please contact RVIA at (703) 620-6003 or visit them online at [www.rvia.org](http://www.rvia.org).

Use the RVIA-provided table below in order to determine the proper sizing of pipe and tubing required to ensure maximum efficiency.

The size of water supply piping and branch line shall not be less than specified in the table below.

**NOTE:** A water heater or ice maker shall not be counted as a “water-using fixture” when computing pipe sizes.

**NOTE:** As stated directly from the ANSI A119.2/NFPA 501C Standard on Recreation Vehicles, 1993 Edition:

*“Piping Systems shall be sized to provide an adequate quantity of water to each Plumbing Fixture at a flow rate sufficient to keep the Fixture in a clean and sanitary condition without any danger of back-flow or siphoning.”*

**NOTE:** The Aqua-Hot is equipped with a pressure-relief valve, which releases excessive pressure in the domestic water system, as well as a tempering valve in order to regulate the temperature of the hot water.

## Domestic Water System Plumbing:

1. Connect a domestic water plumbing line from the domestic water demand pump/water manifold to the cold water inlet port on the Aqua-Hot. Reference Figures 29 and 30.
2. Connect a domestic water plumbing line from the Aqua-Hot’s hot water outlet port to the hot water system’s distribution lines/water manifold. Reference Figures 29 and 30.

Minimum Size Tubing and Pipe for Water Distribution Systems\* Table

Number of Fixtures	Tubing		Pipe
	Inner Dia. (inches)	Outer Dia. (inches)	Iron Pipe Size (inches)
1	1/4**	3/8**	3/8
2	1/4***	3/8***	3/8
3	3/8	1/2	1/2
4	3/8	1/2	1/2
5 or more	1/2	5/8	1/2

\* Minimum size for toilet water supply line shall not be less than the size recommended by the toilet manufacturer.

\*\* 12-feet (3.7 m) maximum length allowable only from water service connection to a single fixture.

\*\*\* 6-feet (1.8 m) maximum length.

# Section 4: Domestic Water System

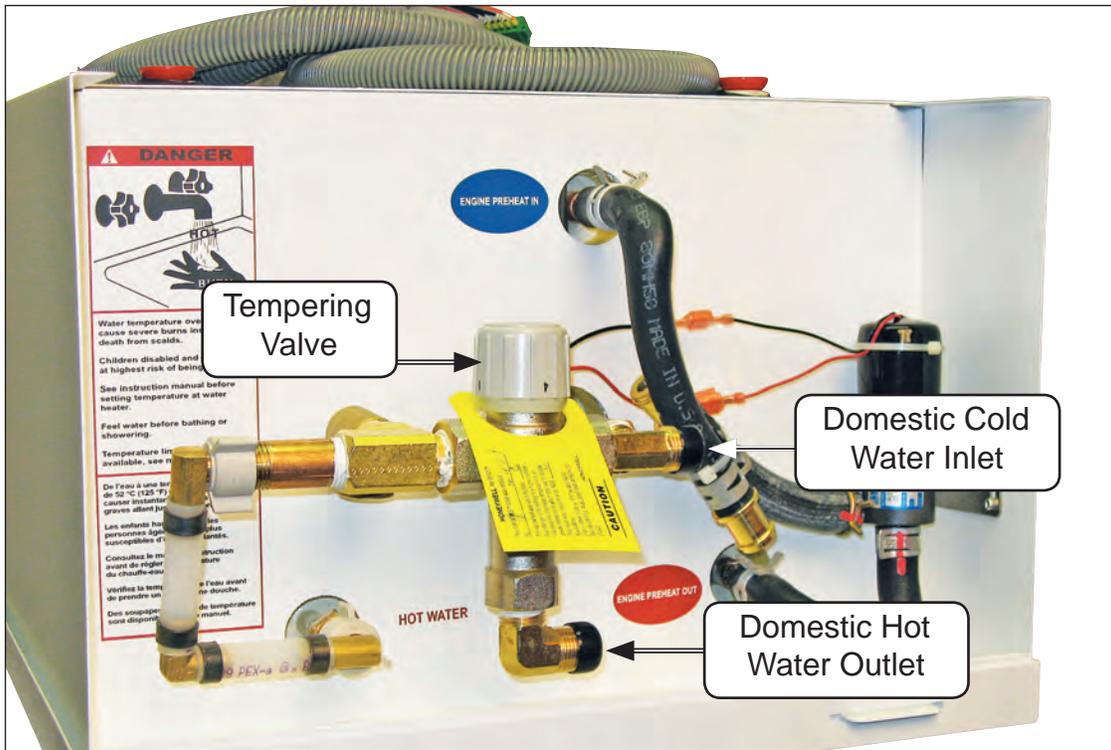


Figure 29

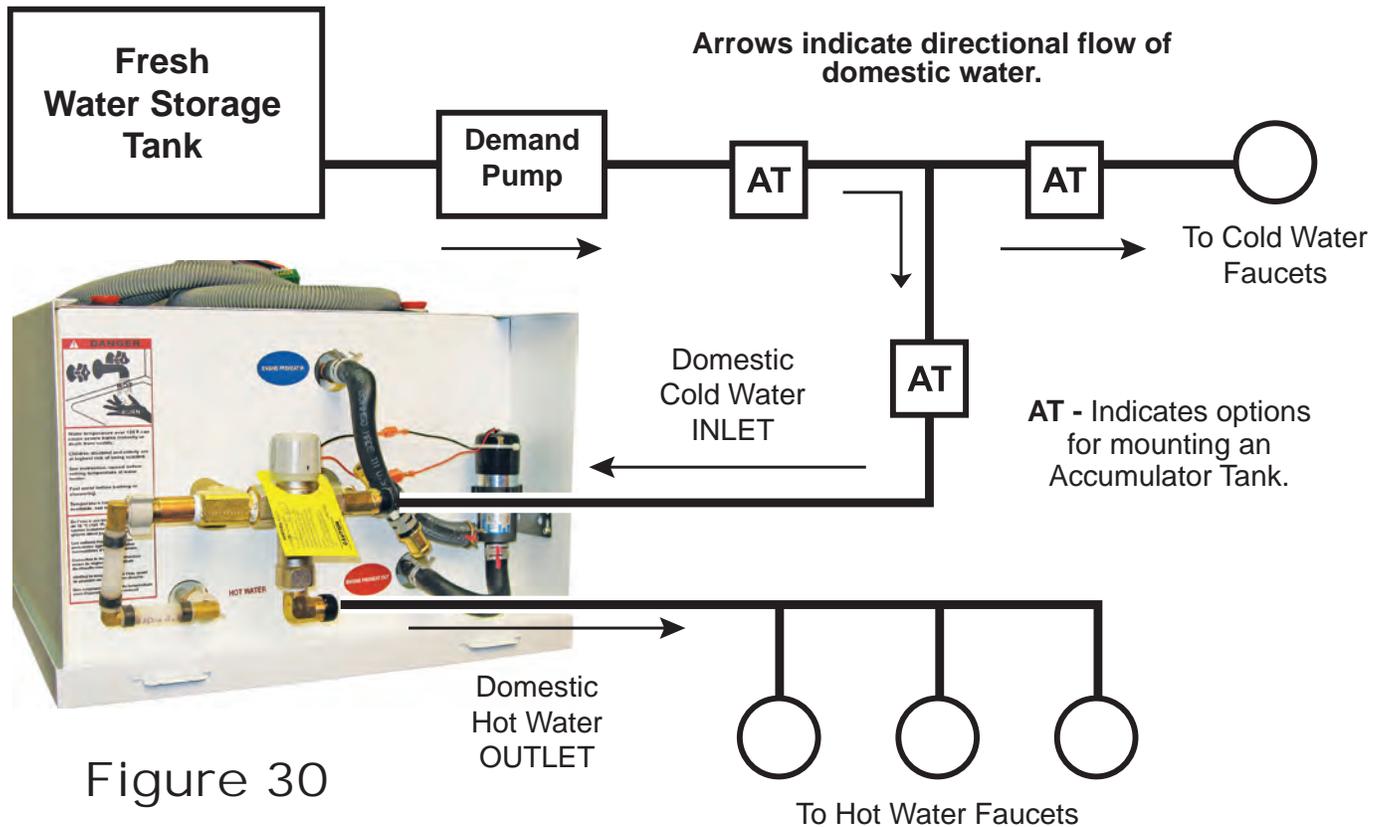


Figure 30

# Section 5: Switch Panel

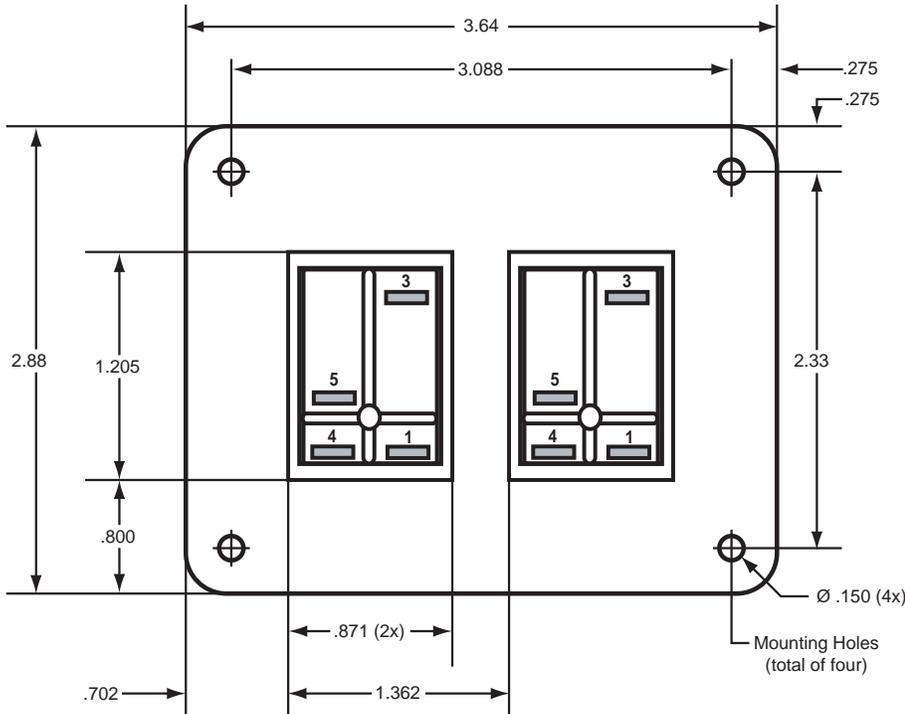
## Switch Panel Location:

Select a location in the interior of the coach that allows for easy operator access.

All electric installations, systems, and equipment shall comply with Article 551, Parts I and III through VI of NFPA 70, as well as the regulation of authorities having jurisdiction and CSA Standard B139.

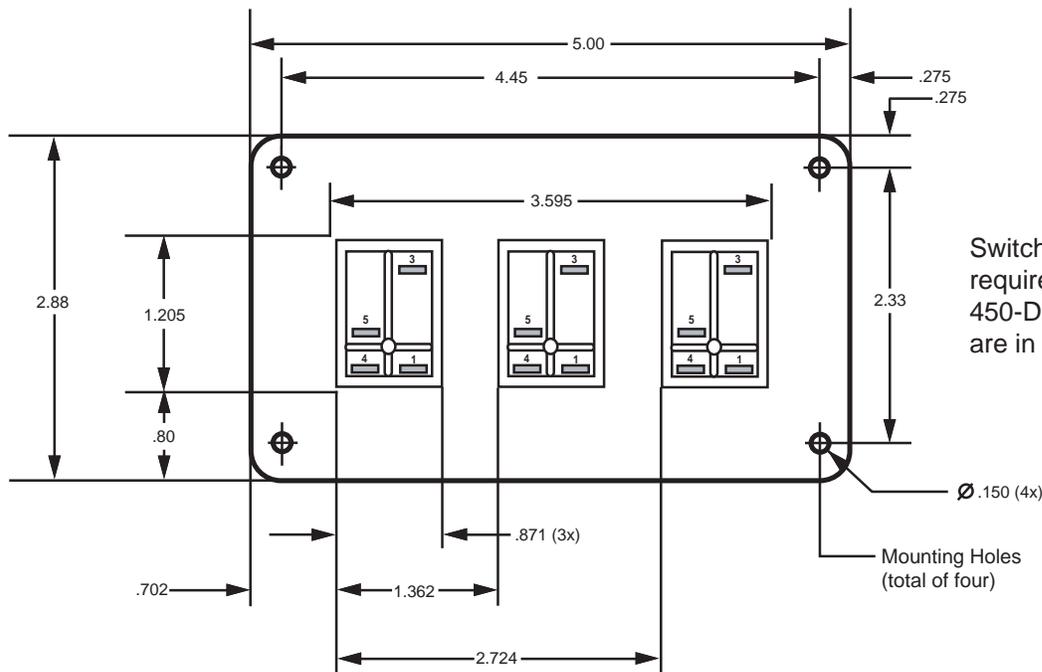
## Switch Panel Mounting:

1. Cut out an opening for the switch panel plate. The Aqua-Hot 450 DM requires an 2.25 inch W x 1.25 inch H opening. The Aqua-Hot 450 DE requires a 3.75 inch W x 1.25 inch H opening. Reference Figure 31.
2. Once the switch panel has been completely wired, permanently mount the switch panel in place. Reference Figure 31.
3. Move all switches to their **OFF** position by pressing them in a downward motion.



Switch panel mounting requirements for Aqua-Hot 450-DM. All measurements are in inches.

Figure 31



Switch panel mounting requirements for Aqua-Hot 450-DE. All measurements are in inches.

# Section 5: Switch Panel

## Switch Panel Wiring:

1. Run 16-gauge wires from the switch panel to the electronic controller.

**NOTE:** It is recommended that the wire colors illustrated in Appendix A be used when installing the switch panels. This will ensure installation consistency, differentiate between the separate switches and assist service personnel with troubleshooting. Reference Appendix B for proper wire-gauge sizing.

2. Strip and crimp insulated female terminals onto each wire at the switch panel location.

**NOTE:** Be sure to attach “Jumper Wires” where necessary. Reference Figures 32 and 33.

3. Connect all switch wires to the appropriate switch connections as illustrated in Figures 32 and 33. Reference Appendix A for additional wiring information.
4. Insert all switch wires into the appropriate terminal/switch panel connection on the electronic controller. Reference Appendix A.

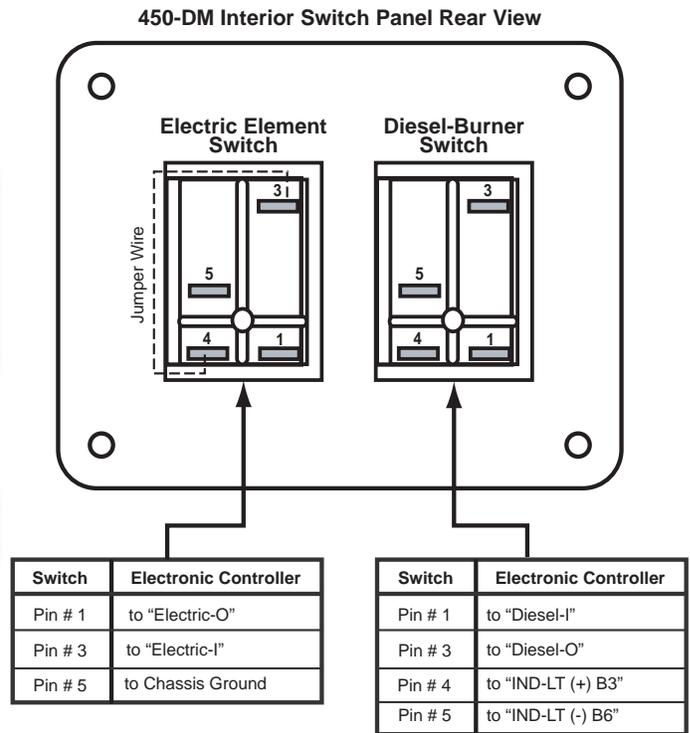


Figure 32

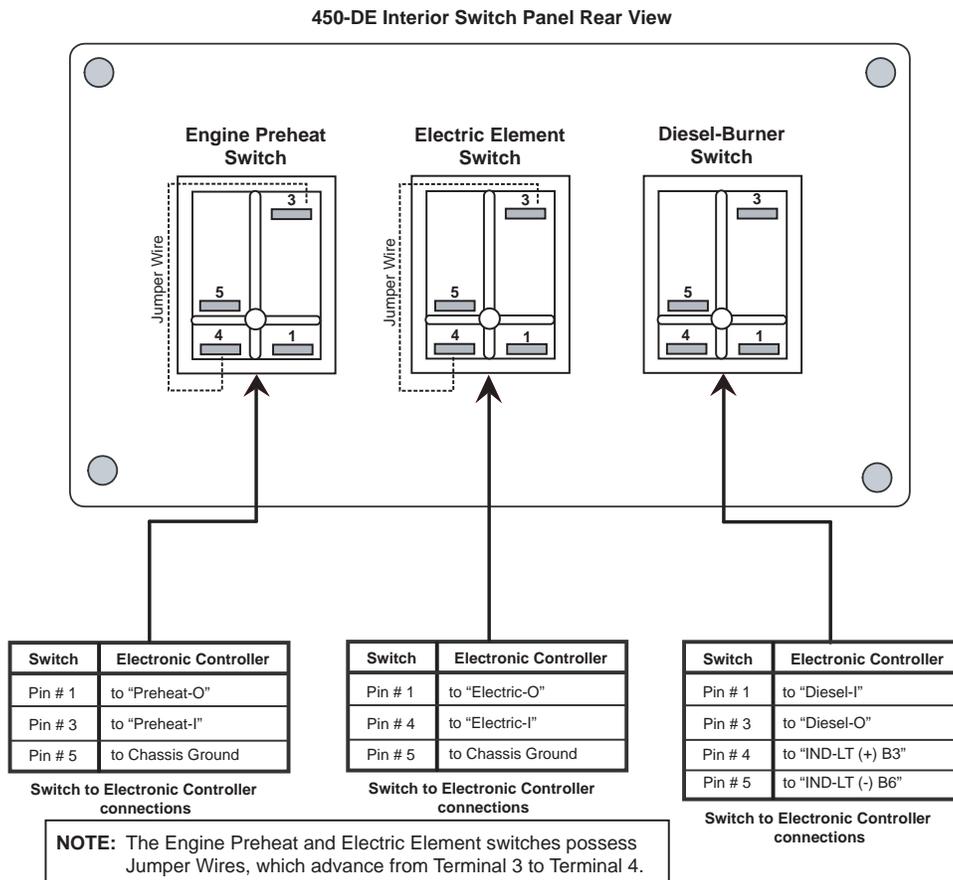


Figure 33

# Section 6: Fuel System

## CAUTION:

A kinked fuel line will increase the fuel pressure to hazardous levels and may cause a fuel line to rupture. A kinked fuel line could also severely damage the diesel-burner's internal fuel system.

### Fuel System Location:

Mount the fuel filter in a location that provides easy access for changing the filter element and for catching any potential fuel spillage when servicing.

### Fuel System Requirements:

The diesel fuel supply should be drawn directly from the vehicle's main fuel tank or from a separate auxiliary fuel tank, if applicable.

The fuel tank should be equipped with a dedicated fuel pick-up pipe (inlet port and outlet port). Reference Figure 34.

**NOTE:** If an auxiliary fuel tank is required, be sure to consult the ANSI/NFPA 1192 Handbook concerning heating systems' diesel fuel system specifications.

Also, be sure to reference the ANSI/NFPA 1192 handbook for information regarding fuel distribution system specifications.

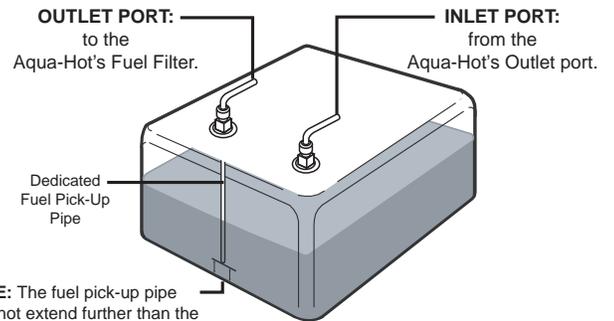
Fuel head pressure should not exceed 10 feet. Reference Figure 35.

Use a minimum of ¼ inch I.D. (internal diameter) fuel lines.

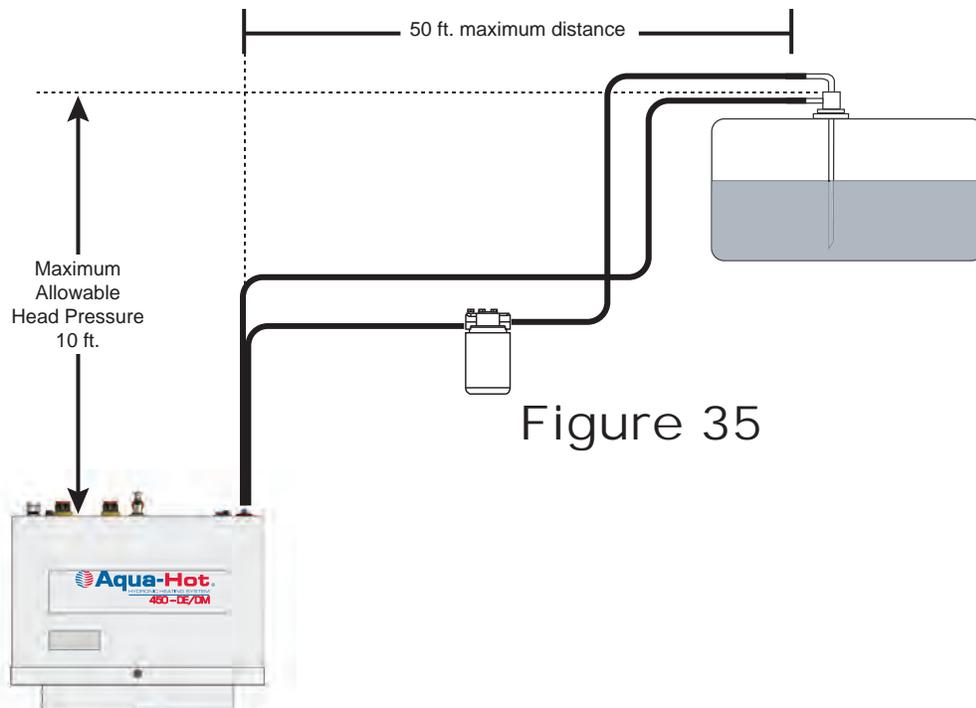
The combined length of the inlet and outlet fuel lines should not exceed 100 feet in total length. Reference Figures 35 and 36.

All fuel-fitting hardware (i.e., at the vehicle's fuel tank, fuel filter, and Aqua-Hot fuel ports) must be ¼ inch NPT or greater with a minimum of ¼ inch barbed fitting. Fuel fittings less than ¼ inch NPT may restrict fuel flow, thereby compromising the diesel-burner's performance.

### Figure 34



**NOTE:** The fuel pick-up pipe should not extend further than the motorhome's engine fuel supply pick-up and should be consistent with the on-board generator's fuel supply pick-up length.



### Figure 35

# Section 6: Fuel System

## Fuel System Installation:

1. Run two minimum of ¼ inch fuel lines from the fuel tank/fuel pick-up to the Aqua-Hot.

Both fuel lines should be laid as flat as possible and any extreme rises in height should be avoided in order to eliminate any potential air-traps.

Run both fuel lines in areas where they cannot be pinched, kinked, or damaged during normal operating conditions.

2. Be sure to secure all fuel lines where necessary and apply protective shielding in areas where chafing may occur.

3. Label both fuel lines indicating whether they are an outgoing line or a incoming line.
4. Connect the fuel lines to the fuel tank/fuel pick-up pipe. Reference Figure 34.
5. Install and tighten the appropriate fuel fittings onto the Aqua-Hot's fuel ports, as well as the two ports of the fuel filter. Reference Figures 37 and 38.
6. Connect the inlet and outlet fuel lines to the Aqua-Hot's fuel port connections. Reference Figure 38.
7. Cut the fuel line at the fuel filter mounting location and connect the fuel lines as illustrated in Figures 35 and 36.

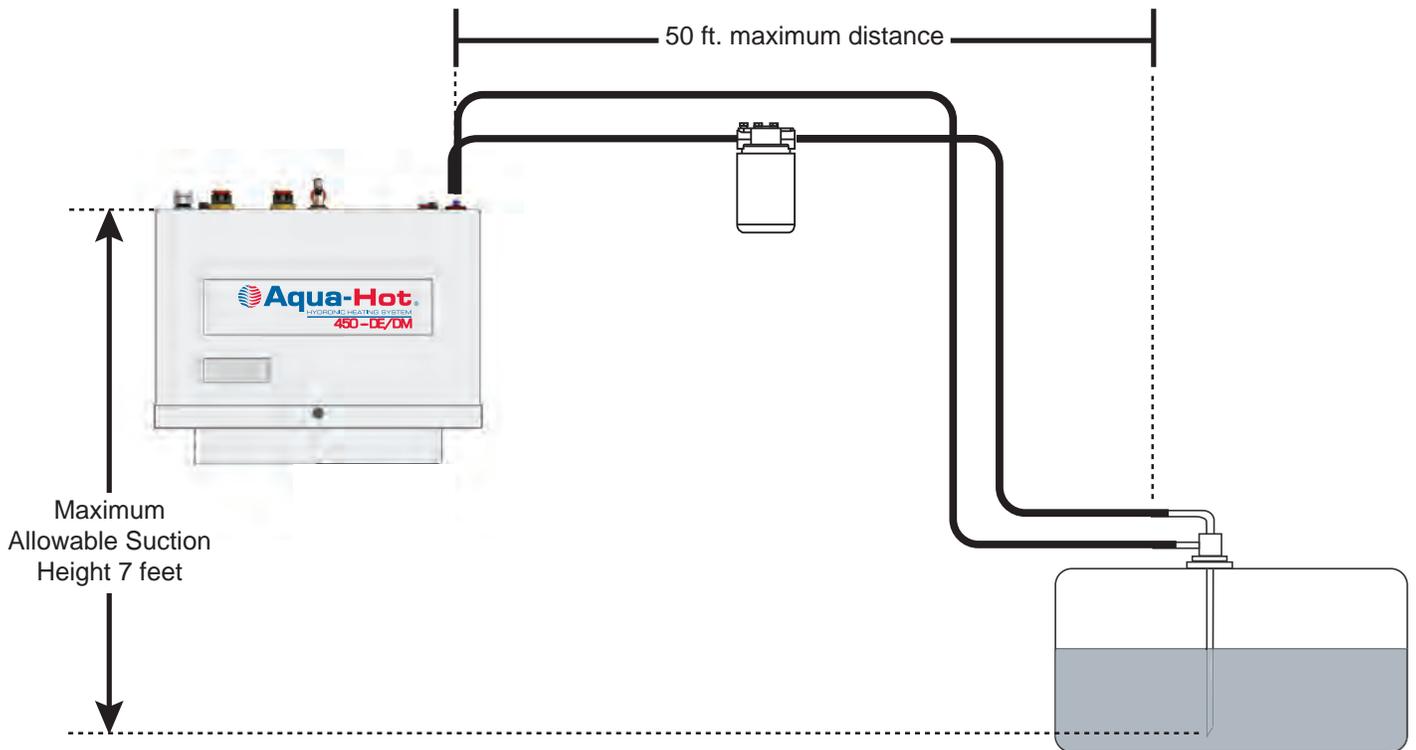


Figure 36

Figure 37

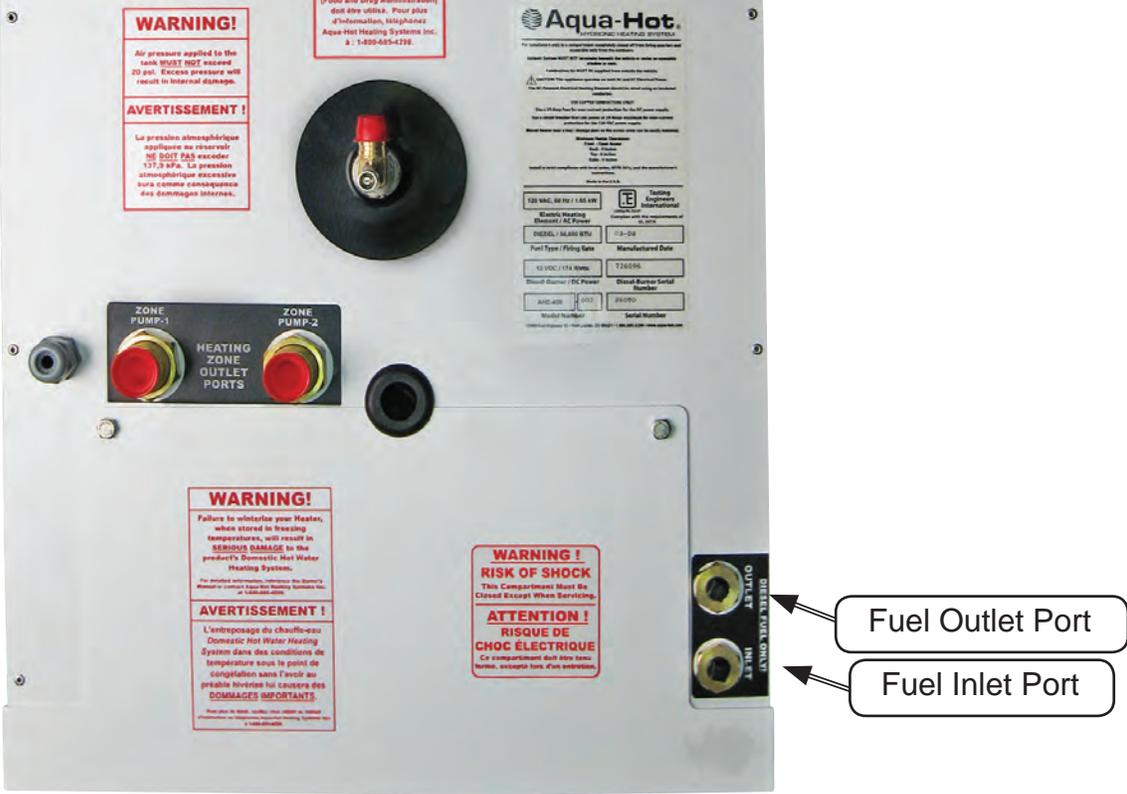
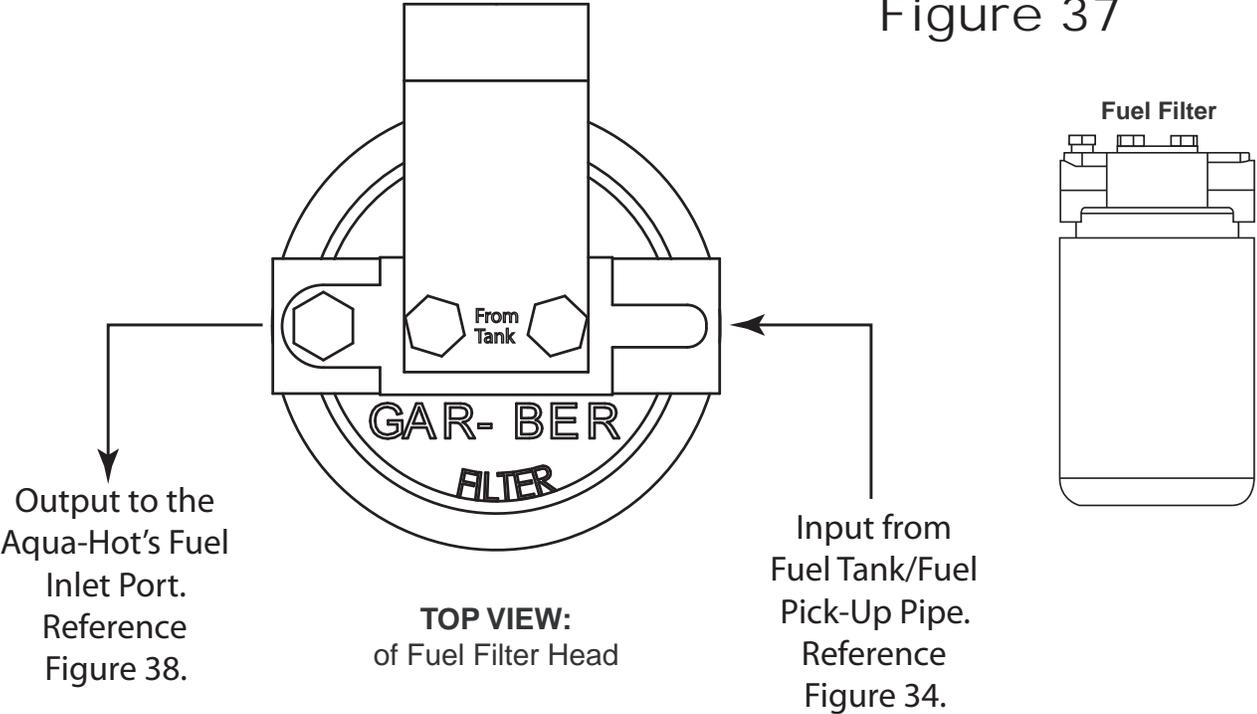


Figure 38

# Section 7: Engine Preheat and Motoraide System

## Engine Preheat and Motoraide System:

The Aqua-Hot 450-DE and 450-DM both include a motoraide feature, which uses the circulation of the motorhome's engine to transport the antifreeze and water heating solution from the Aqua-Hot's boiler tank to the motorhome's warm engine and back to the boiler tank.

The Aqua-Hot 450-DE includes an engine preheat feature. This preheat feature provides an easy engine start-up whenever cool weather conditions are present.

## Location:

The inlet and outlet ports on the vehicle's engine should be kept as far apart as possible. This will ensure that the entire engine is thoroughly preheated. Reference Figure 39.

**NOTE:** If assistance is needed in determining the best inlet and outlet ports for a specific engine, please contact the particular engine's manufacturer or chassis supplier.

The engine's coolant should be allowed to flow as freely as possible to maximize the Aqua-Hot's engine preheating system.

The engine's inlet port is where the heated coolant is transported to the engine block from the Aqua-Hot. This port should be a high connection point on the engine block. Reference Figure 39.

The engine's outlet port is where the engine's coolant is transported to the Aqua-Hot. This port should be a low connection point on the engine block or a pressure outlet port on the engine's water pump. Reference Figure 39.

Ensure that the engine preheat inlet and outlet hoses are not placed too close to the engine's turbo charger.

## Plumbing Requirements:

Use 3/4 inch I.D. (Inside Diameter) plumbing lines/automotive-type heater-hose for the engine preheating system.

Lay both engine preheat lines as flat as possible and avoid any extreme rises in height in order to eliminate the potential for air traps.

Run both plumbing lines in areas where they cannot be pinched off or damaged during normal operating conditions.

Secure both plumbing lines where necessary and apply protective shielding in areas where chafing may occur.

**NOTE:** Rubber coated/closed-type clamps are recommended when securing the plumbing lines.

Use one-piece engine plumbing fittings in order to reduce the potential for coolant leaks. It is recommended that pipe thread sealant be used on all engine plumbing fittings.

## Installing the Plumbing:

1. Install both engine preheat plumbing lines and mark with arrows and/or labels at both ends.

**NOTE:** The labels should indicate whether the plumbing line is transporting coolant to the Aqua-Hot or whether it will be transporting heated coolant to the vehicle's engine. Reference Figure 39.

2. Drain the engine's coolant.
3. Remove the selected inlet and outlet port "plugs" from the engine.

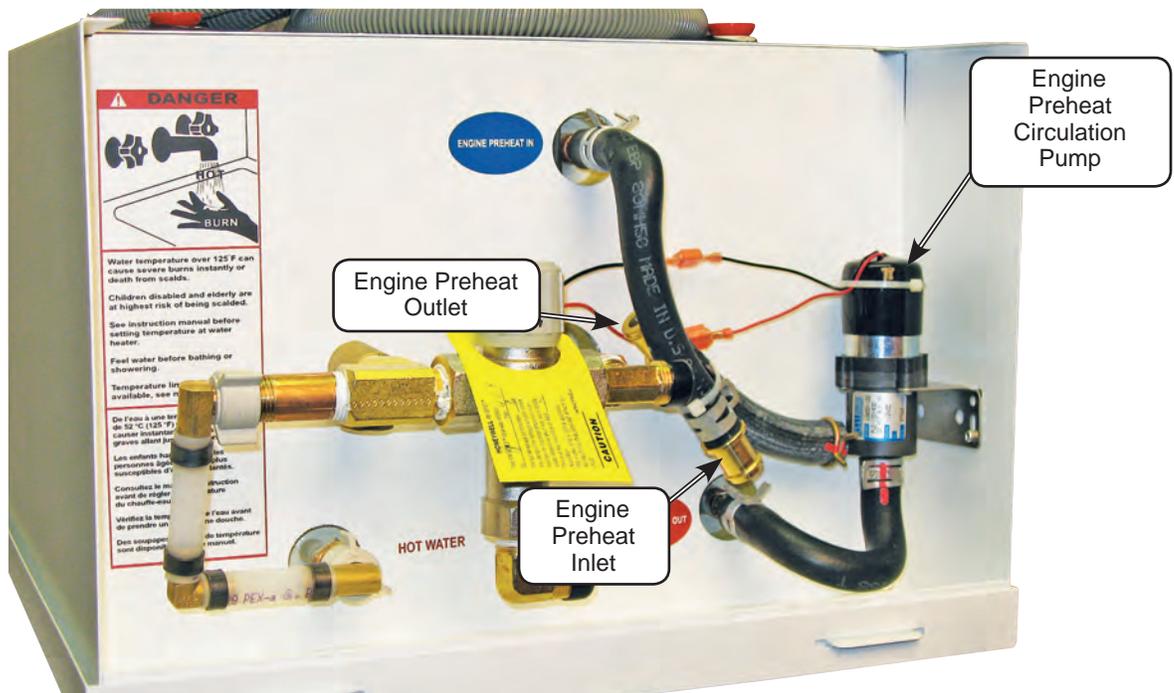
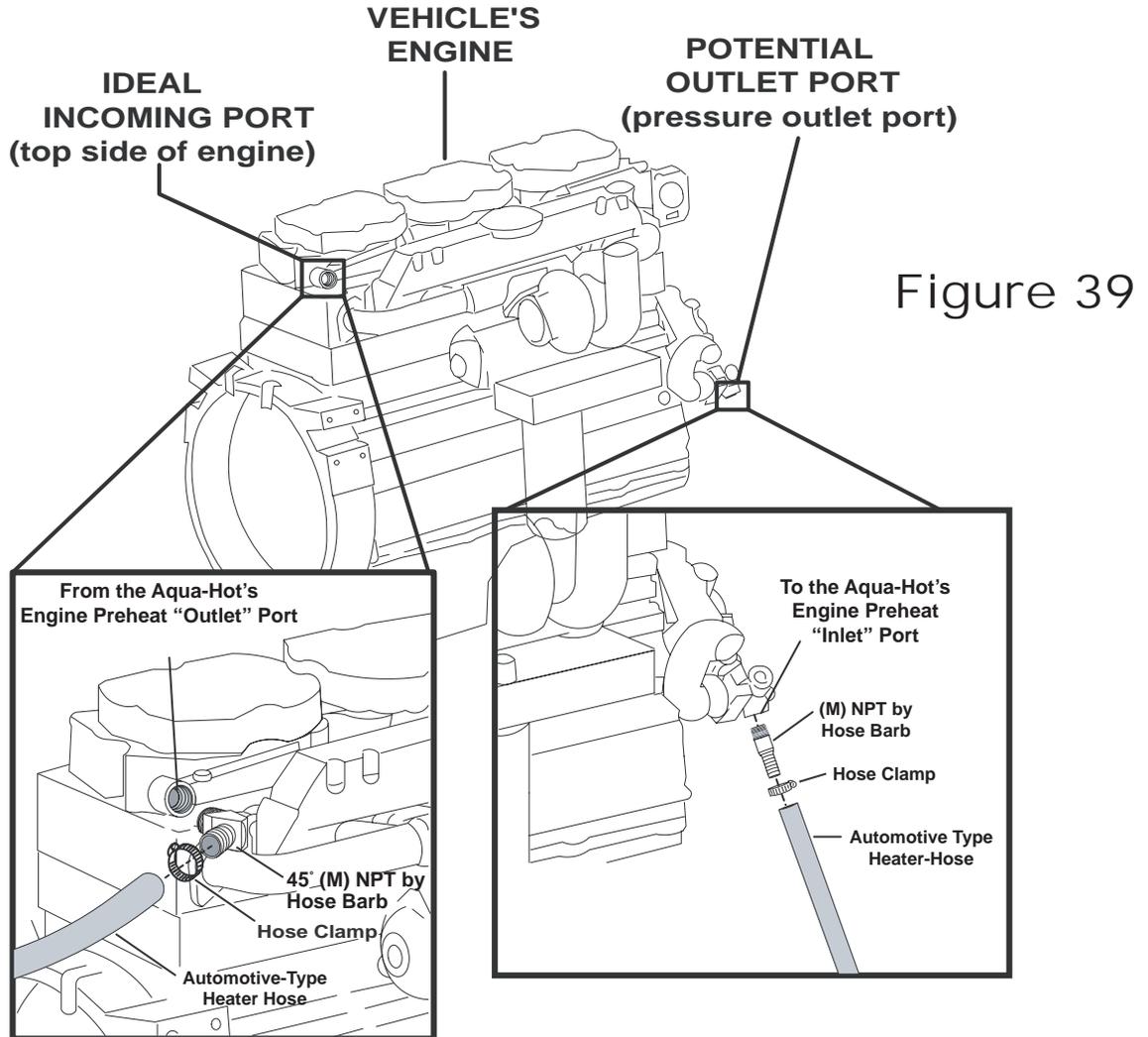
**NOTE:** Should one or both of the selected engine ports already have plumbing fittings attached to them, it may be necessary to "tee" into those existing plumbing fittings. Please contact the Aqua-Hot Heating Systems product application department at 1-800-685-4298 for additional assistance.

4. Install and tighten the plumbing fittings into the inlet and outlet ports on the vehicle's engine.
5. Install and clamp both the inlet and outlet engine plumbing lines/automotive-type heater hoses to the engine's plumbing fittings. Reference Figure 40.
6. Install and tighten a plumbing fitting into the "Inlet" port on the Aqua-Hot's engine preheating system. Reference Figures 1 and 40.

**NOTE:** It is recommended that two wrenches be used when tightening these plumbing fittings.

7. Attach and clamp the engine's incoming plumbing line to the Aqua-Hot's outlet connection. Reference Figure 40.
8. Attach and clamp the engine's outgoing plumbing line to the Aqua-Hot's inlet connection. Reference Figure 40.
9. Verify that all fittings and connections have been tightened, then refill the engine's coolant system.

# Section 7: Engine Preheat and Motoraide System



**Figure 40**

## Section 8: Exhaust System

### WARNING!

The Aqua-Hot's exhaust is **HOT** and must be kept away from any heat-sensitive material.

**DO NOT** direct exhaust downward as a fire may result when parked in dry, grassy areas.

Exhaust must not terminate beneath the vehicle or beneath an openable window or vent.

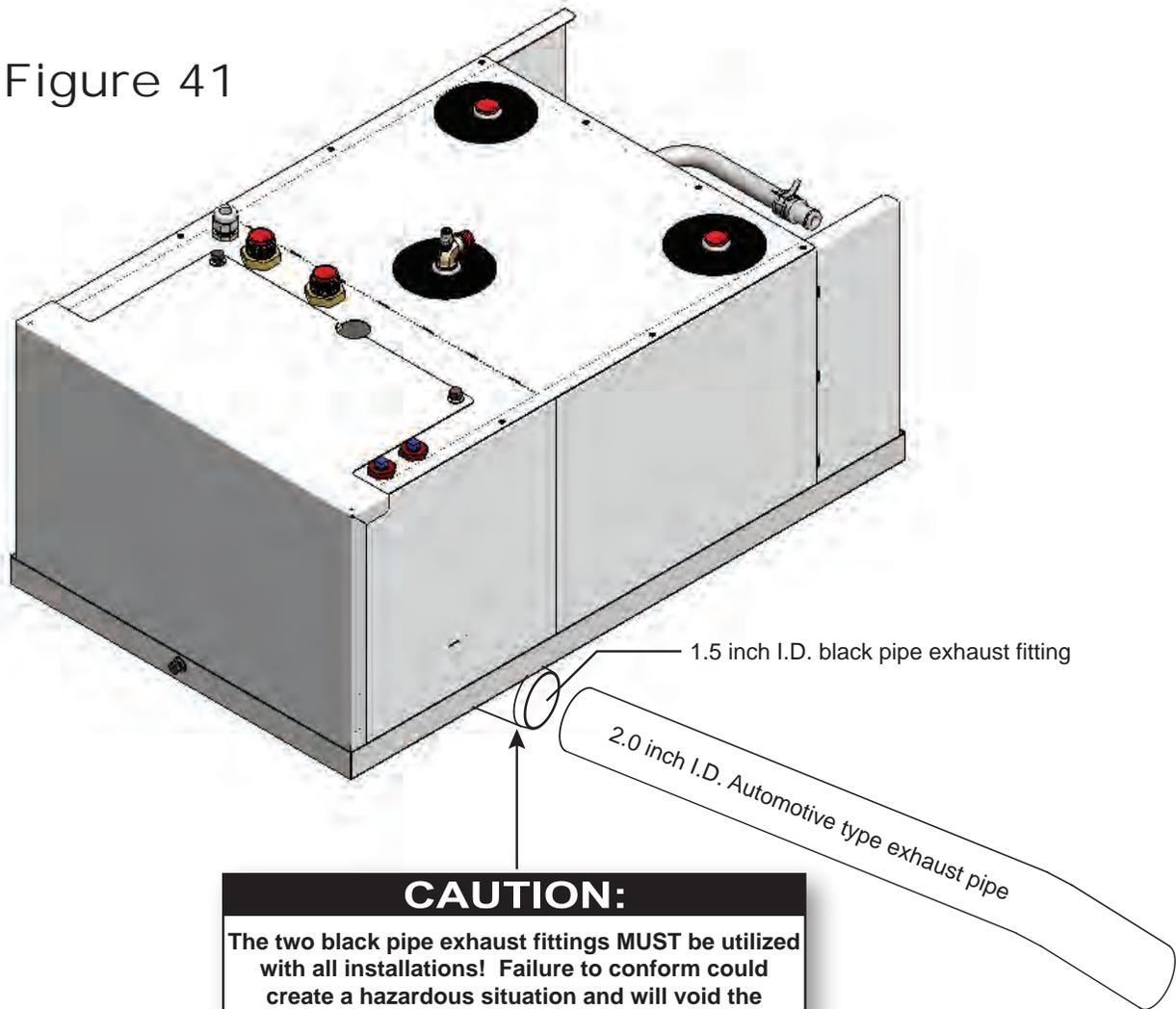
**DO NOT** terminate the exhaust pipe within the awning area of the motorhome, if applicable. Be sure to keep the exhaust away from the slideout areas.

### CAUTION:

All Aqua-Hot exhaust system installations **MUST** utilize the two black pipe nipples and the black pipe elbow, which are provided with the heating system, in the configuration best suited for the particular recreational vehicle application. Failure to conform could create a hazardous situation and will void the Aqua-Hot's ETL product listing.

**NOTE:** Refer to "Internal Combustion Engine Exhausts and Vehicle Wall Openings" in RVIA's ANSI/NFPA 1192 Handbook for the Recreational Vehicle Standards, as well as the National Fire Protection Association's (NFPA) 1192 Standard on Recreational Vehicles for additional information.

Figure 41



### CAUTION:

The two black pipe exhaust fittings **MUST** be utilized with all installations! Failure to conform could create a hazardous situation and will void the Aqua-Hot's ETL product listing.

**NOTE:** A maximum of two 90° bends are allowed in the exhaust pipe. Also, the exhaust pipe cannot be longer than 20 feet.

# Section 8: Exhaust System

## Exhaust System Requirements:

The exhaust must be able to freely exit away from the vehicle without any obstructions.

Angle the exhaust pipe towards the rear of the vehicle so that the exhaust fumes will naturally move away while the vehicle is in motion. Reference Figure 42.

Use standard 2 inch automotive-type exhaust piping and avoid bends, if possible. Reference Figure 41.

A maximum of two 90° exhaust pipe bends are allowed. Reference Figure 41.

Do not use galvanized pipe or fittings; only black-iron pipe and fittings should be used.

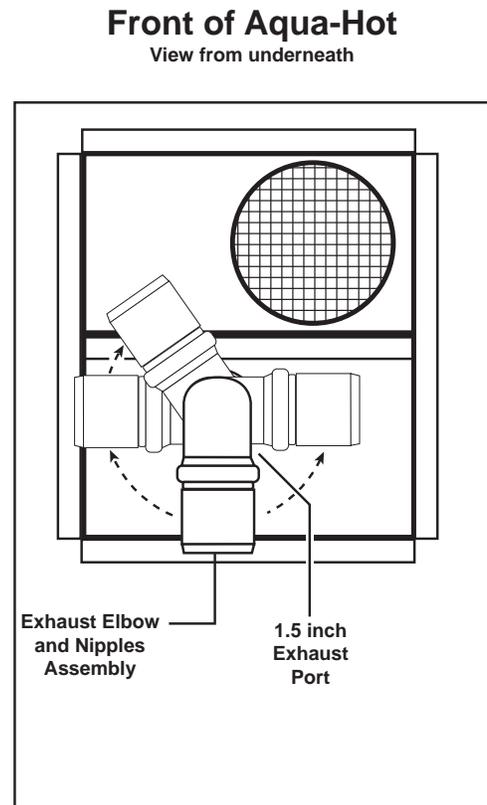
The total length of exhaust pipe should not exceed 20 feet.

The Aqua-Hot is supplied with a 3 inch and a 4 inch black pipe nipple (1½ inch diameter) along with a 1½ inch exhaust elbow. Reference Figure 42. These three exhaust system components **MUST BE** utilized with all product installations. Be sure to reference Figure 43 to determine which exhaust nipple should be connected directly to the Aqua-Hot's exhaust port (i.e., the 3 inch or the 4 inch black pipe nipple).

**NOTE:** Should the particular application require more than 20 feet of exhaust pipe, please contact the Aqua-Hot Heating Systems Product Application Department at 1-800-685-4298 for assistance.

Figure 42

**NOTE:** The exhaust elbow can be rotated 270° as shown in the illustration; however, the exhaust must not terminate beneath the vehicle or beneath an openable window or vent.



# Section 8: Exhaust System

## Installing the Exhaust System:

1. Run the exhaust pipe to the driver's side of the vehicle and ensure that the exhaust fumes cannot enter into the passenger compartment. Be sure to keep the exhaust away from the slide-out areas.
2. Be sure to secure the end of the exhaust pipe to the vehicle with the proper exhaust hanger/support hardware.

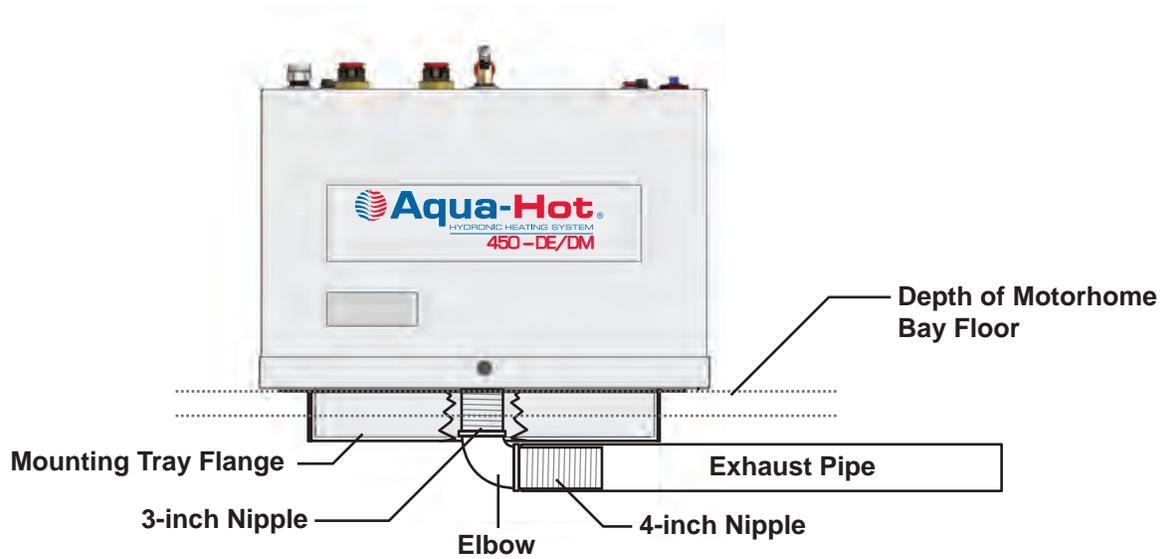
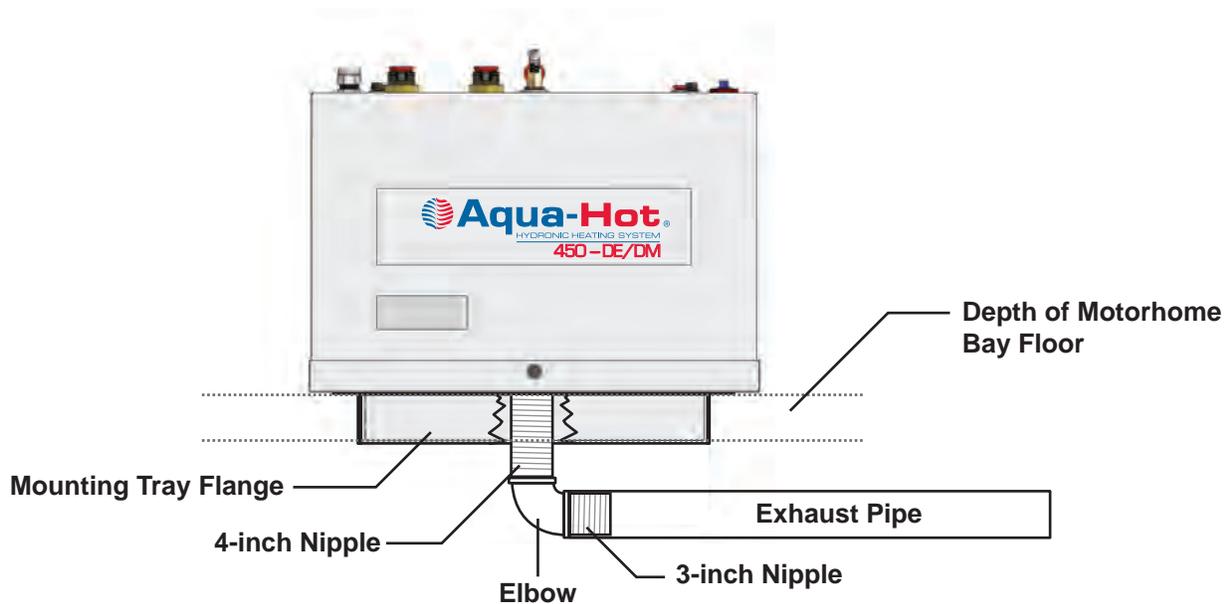


Figure 43



# Section 9: Electronic Controller Wiring

## Electronic Controller Wiring:

**NOTE:** Please reference Appendix A for specific wiring information.

**NOTE:** A maximum power consumption of 24 Watts can be supplied by the electronic controller for each “FAN” heating zone.

Most electronic controller thermostat and switch connections possess an “(I)” or an “(O)” symbol. The “(O)” symbol indicates a positive 12 Volt-DC **output** to a particular thermostat or switch, while the “(I)” symbol indicates a positive 12 Volt-DC **input** signal from a particular thermostat or switch. The 12 Volt-DC **output** signal is always present as long as the electronic controller is powered by a 12 Volt-DC power source, while the 12 Volt-DC **input** signal is only present whenever a switch is activated or whenever a thermostat is calling for heat. Reference Appendix A.

All electronic controller fan power connections (and two switch connections) illustrate a “(+)” or a “(-)” symbol, which indicates that they are polarity-sensitive. Therefore, be sure to use care when wiring these particular components to the electronic controller.

Each heating zone “FAN” circuit can supply up to 2.0 Amps of direct current. This 12 Volt-DC power source allows for multiple Cozy III heat exchangers to be wired “in-parallel”. Reference Figure 44 and Appendix A.

Heating Zone 1 is reserved electrically for the “Living Room/Kitchen Heating Zone” (Heating Loop 1) **ONLY**, and Heating Zones 2, 3, and 4 are reserved electrically for the “Bathroom, Fresh Water Tank, and Bedroom Heating Zone” (Heating Loop 2) **ONLY**.

Heating Zone 5 is reserved electrically for the “Optional Heating Zone” (Heating Loop 1) **ONLY**.

All switch connections are to be wired directly to the Aqua-Hot’s interior switch panel. Reference Figures 44 and 44 and Appendix A. Both the “IND-LT (+) B3” and the “IND-LT(-) B6” connections on the electronic controller are reserved electrically **ONLY** for the diesel-burner switch indicator light connections.

The Aqua-Hot’s electronic controller is designed to work with most electronic room thermostats; however, the chosen thermostat must produce a constant 12 Volt-DC output signal and must receive its 12 Volt-DC power supply from the electronic controller (i.e., “THERM-O”) in order to ensure that the thermostat and electronic controller are properly **fuse protected**.

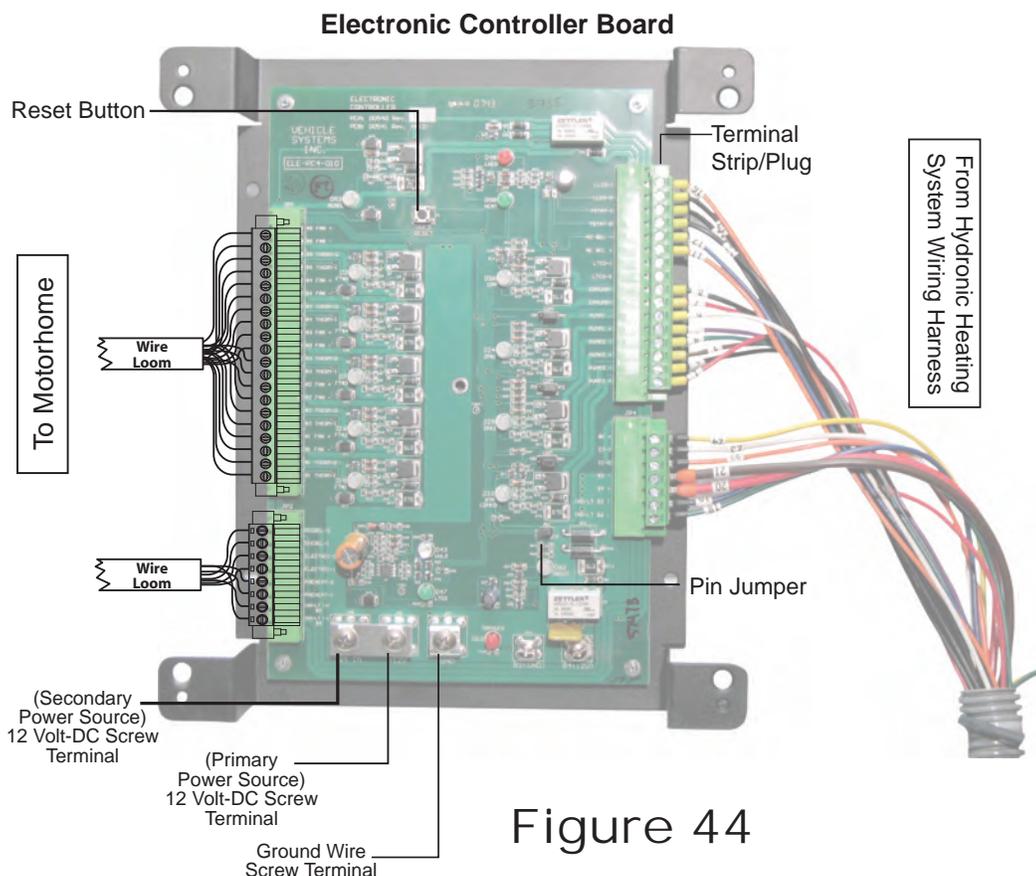


Figure 44

# Section 9: Electronic Controller Wiring

## CAUTION:

**DO NOT** activate the diesel-burner until the antifreeze and water heating solution has been added to the boiler tank and the heating system has been completely bled of air. Operating the Aqua-Hot without the antifreeze and water heating solution will cause **serious damage** to the Aqua-Hot's boiler tank.

**DO NOT** connect the 12 Volt-DC power to the Aqua-Hot if the vehicle requires welding. Electrical welding will cause **serious damage** to the diesel-burner controller and the Aqua-Hot's electronic controller.

**NOTE:** Reference Appendix B for proper wire-gauge sizing. Please note that under full-load conditions, the Aqua-Hot can draw as much as 22 Amps of DC current.

Because the Aqua-Hot is designed to shut down in the event that the DC voltage level drops too low to properly operate, it is imperative that the proper wire gauge be determined and utilized.

Be sure to protect against accidental shorting (i.e., chassis shorting) by incorporating a 25-Amp rated in-line fuse into the power wire at the battery location. Reference Figure 46.

All electric installations, systems, and equipment shall comply with Article 551, Parts I and III through VI of NFPA 70, as well as the regulation of authorities having jurisdiction and CSA Standard B139.

## Wiring Harness Connection:

1. Attach wiring harness connectors to the electronic controller. Reference Figures 44 and 45 and Appendix A.
2. Tighten the screw-type fasteners on the terminal strips to secure them to the electronic controller. Reference Appendix C.

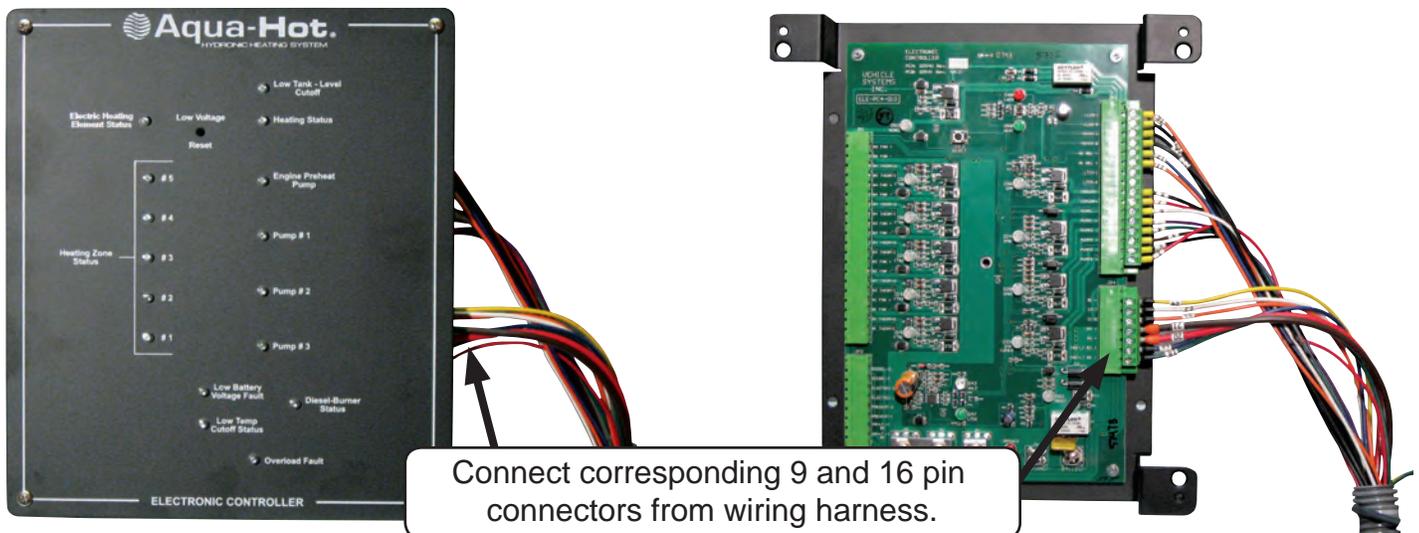
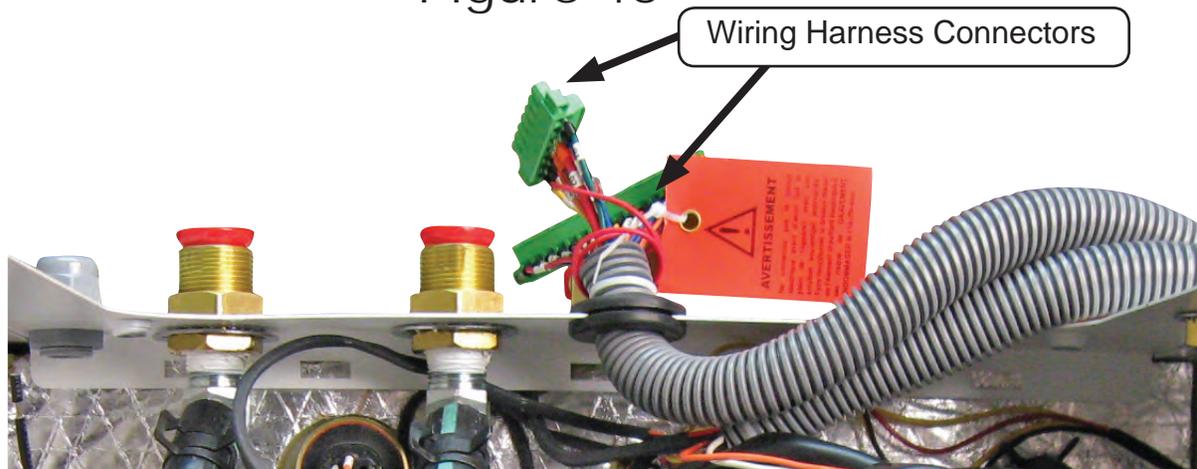


Figure 45



# Section 9: Electronic Controller Wiring

## Connecting the 12 Volt-DC Power:

### CAUTION:

**DO NOT** connect the 12 Volt-DC power to the Aqua-Hot if the vehicle requires welding. Electrical welding will cause serious damage to the diesel-burner controller.

The Aqua-Hot is designed to shut down in the event that the DC voltage level drops too low to properly operate, it is imperative that the proper wire gauge be determined and utilized. Reference Appendix B for proper wire-gauge sizing. Please note that under full-load conditions, the Aqua-Hot can draw as much as 22 amps of DC current.

Be sure to protect against accidental shorting (i.e., chassis shorting) by incorporating a 25-Amp rated in-line fuse into the power wire at the battery location. Reference Figure 47.

1. Run and connect two wires — one red (+) wire and one black (-) wire (power and ground), from the vehicle's battery to the Aqua-Hot's electronic controller. Reference Appendix A and Figure 47.
2. Label the wires indicating whether they are a power or a ground wire.
3. Attach the VDC power wires onto the appropriate terminal/battery connections on the electronic controller. Reference Appendix A.
4. Connect both power and ground wires **directly** to the vehicle's batteries.

### WARNING!

**DO NOT** activate the diesel-burner until the antifreeze and water heating solution has been added to the boiler tank and the heating system has been completely bled of air. Operating the Aqua-Hot without the antifreeze and water heating solution will cause serious damage to the Aqua-Hot's boiler tank.

## Connecting the 120 Volt-AC Power:

1. Route and insert three 120 VAC power source wires into the AC terminal block through the AC wiring port's cable clamp fitting and into the proper terminal. Reference Appendix A and Figure 46.
2. Secure the wires into their terminals by tightening the corresponding screw on the terminal block. Reference Appendix A.

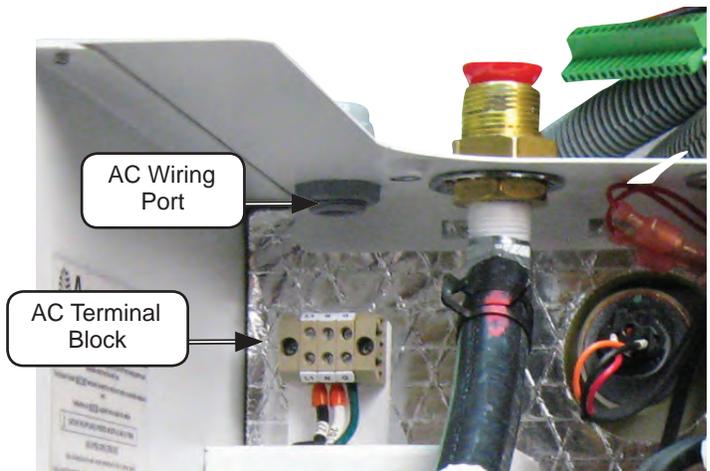
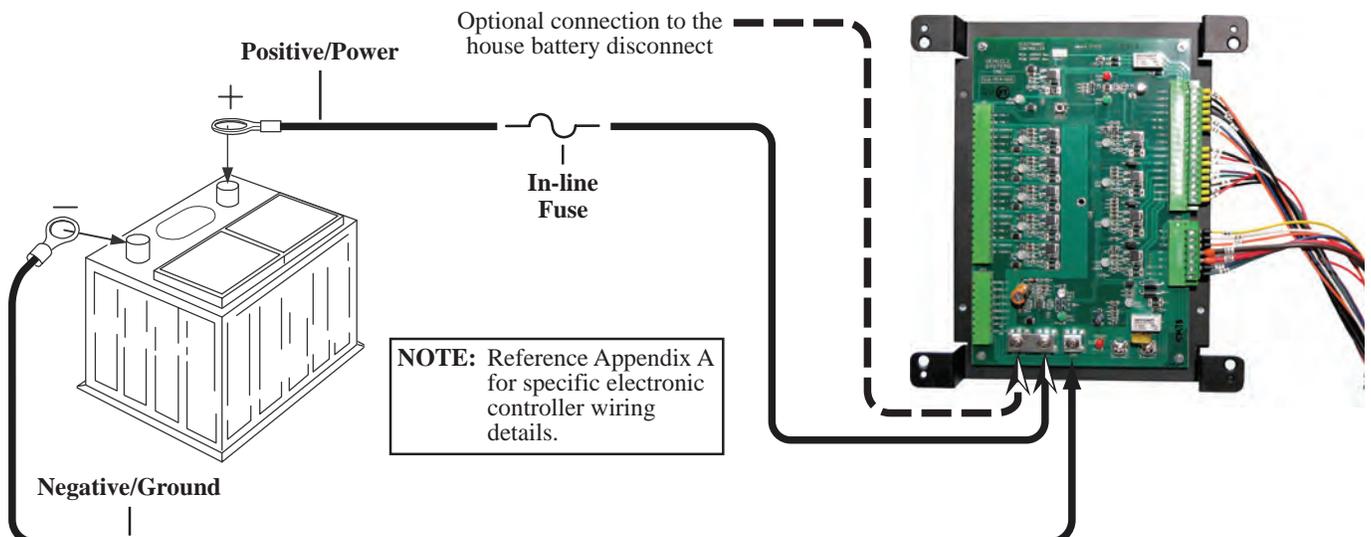


Figure 46

Figure 47

**NOTE:** If the optional power connection is used, remove the jumper plate from the two power terminals - "JP5" and "JP8".



# Section 10: Purging the System

## **⚠ DANGER! ⚠**

Only propylene glycol based “boiler” type antifreeze deemed “GRAS” (Generally Recognized as Safe) by the FDA shall be used in the Aqua-Hot’s hydronic heating system. Failure to use the above specified antifreeze type could result in serious injury or death.

## **CAUTION:**

Ensure that the overflow tube is connected from the Aqua-Hot’s expansion tank connection to the expansion tank’s bottom connection and from the expansion tank’s top connection through the overflow tube hole in the motorhome’s bay floor prior to beginning this antifreeze and water heating solution fill procedure. Failure to do so could result in an antifreeze spill in the motorhome’s bay. Reference Figure 12.



Figure 48

Drain valve

## Purging the Hydronic Heating System:

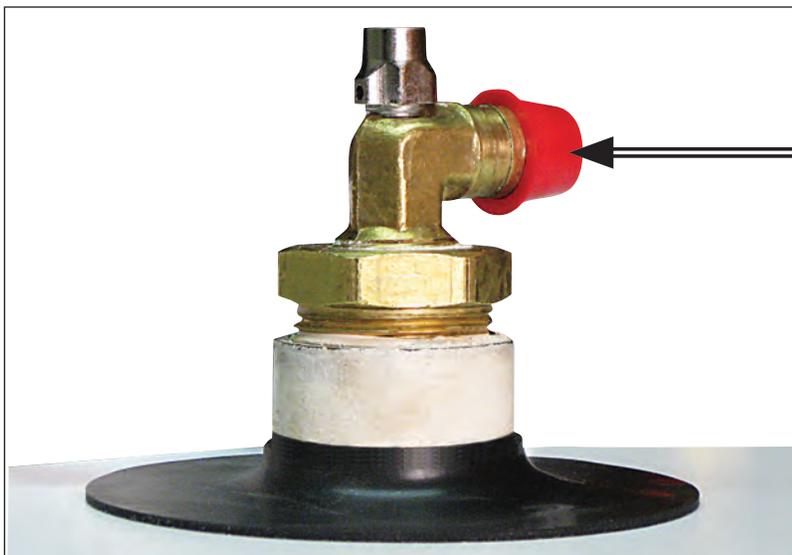
In order to provide the best freeze protection, boil-over protection, and anti-corrosion and rust protection, a 50/50 mixture of “GRAS” approved boiler type propylene glycol antifreeze and water is recommended.

Reference Appendix D for additional information regarding the antifreeze and water heating solution. Be sure to use a “GRAS” boiler-type propylene glycol based antifreeze rather than an RV and Marine antifreeze or an automotive antifreeze/coolant.

If assistance is needed in selecting an appropriate 50/50 antifreeze and water mixture, please contact the Aqua-Hot Heating Systems Product Application Department at 1-800-685-4298.

**NOTE:** The Aqua-Hot’s boiler tank must be filled with the antifreeze and water heating solution through the drain valve and not through the top of the unit, in order to avoid air traps. Reference Figure 48.

1. Open the Aqua-Hot’s drain valve located at the front of the heater. Reference Figure 48.
2. Connect a piece of ½ inch PEX tubing (this piece should be long enough to be used to transport the antifreeze and water heating solution from its source to the Aqua-Hot) to the drain valve.



Expansion tank connection

Figure 49

# Section 10: Purging the System

3. Fill the Aqua-Hot completely with the 50/50 mixture of antifreeze and water heating solution. This will take approximately 5 gallons; look for the solution to enter the overflow tube attached to the expansion tank connection on top of the Aqua-Hot.
4. Close the drain valve.

## Purging the System by Grounding the Zone Circulation Pumps:

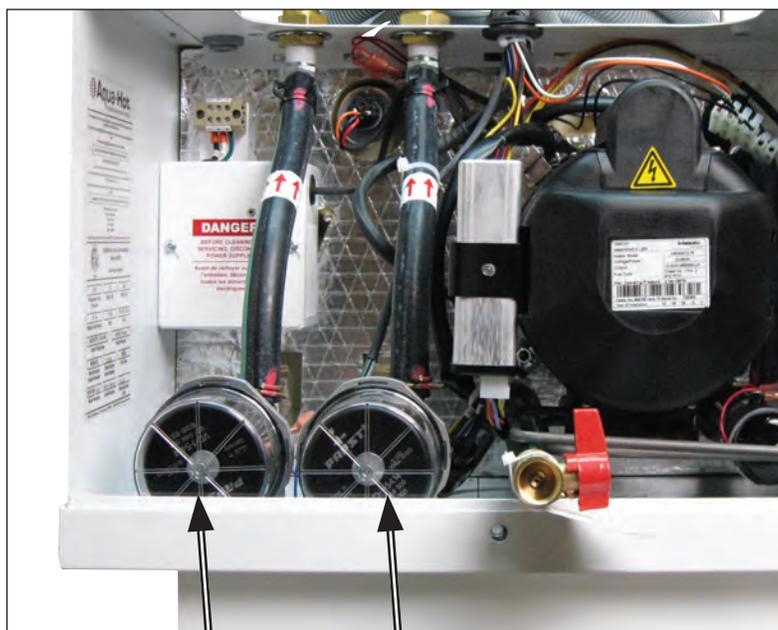
1. Ensure that the boiler tank has been filled with the appropriate 50/50 mixture of antifreeze and water heating solution.
2. Locate the heating zone circulation pumps. Reference Figures 3 and 50.
3. Take the circulation pump's blue (negative) wire and disconnect it from the connector of the opposing wire. Reference Appendix A.
4. Connect an alligator clip to the spade terminal on the circulation pump's blue (negative) wire and clip the opposite end of the cable to a ground source.

**NOTE:** The circulation pump will activate as soon as the pump is connected to a ground source; therefore, disconnect the alligator clip from the ground source during the antifreeze and water heating solution filling procedure.

5. Allow the circulation pump to operate for approximately 1-3 minutes in order to purge the corresponding heating loop, then remove the alligator clip from the ground source.
6. Open the drain valve and completely fill the Aqua-Hot's boiler tank with additional antifreeze and water heating solution.
7. Repeat steps 5 and 6 for both heating loops until all air has been completely bled from the entire heating system.

**NOTE:** All air is bled from the heating system when both plumbing lines are free of air. Reference Figure 19.

8. Once the systems have been purged, disconnect the alligator clips from the ground source and the circulation pump's wires. Reconnect the pump's wires as originally configured. Reference Figure 50.



**Zone 1  
Circulation  
Pump**

**Zone 2  
Circulation  
Pump**

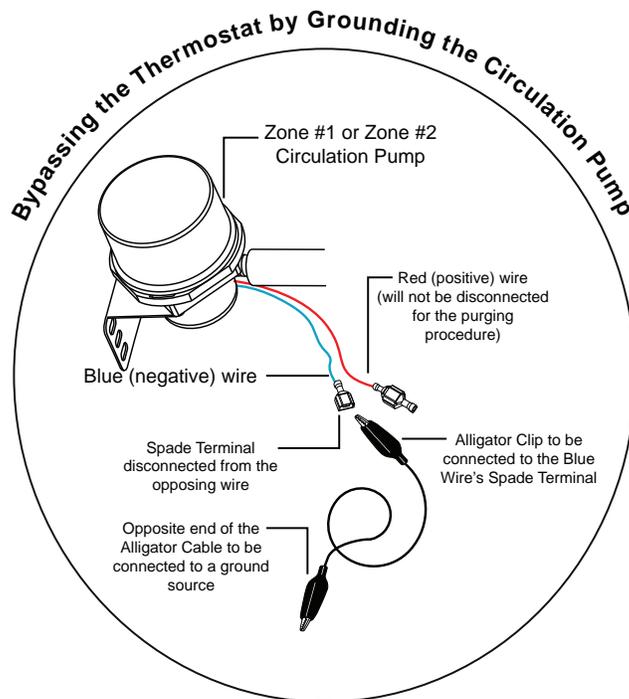


Figure 50

# Section 10: Purging the System

9. Check the Aqua-Hot's expansion tank and top it off to the cold level mark with the 50/50 antifreeze and water mixture, if necessary.
10. Ensure that each circulation pump's wiring has been returned to its original configuration.  
Reference Figure 50.

## **CAUTION:**

Verify that the domestic water tank contains fresh water prior to bleeding the fresh water system.

### **Purging the Domestic Water System:**

1. Ensure that the vehicle's domestic water pump has 12 Volt-DC power, then activate it by opening each hot water faucet, one at a time, and running the water until all air is purged from the domestic water system.
2. Once the domestic water system is completely bled, check for leaks in the domestic water system.

### **Activating the Aqua-Hot:**

1. Reinstall the Aqua-Hot's main access cover and the fastener, which secures the front of the Aqua-Hot's access cover to the mounting tray

The main access cover must be installed prior to operation; a safety switch exists, which will prevent the Aqua-Hot from operating whenever the main access cover is not properly installed.

2. Move the diesel-burner switch to the **ON** position for approximately ten seconds **ONLY**, then switch it **OFF**.

**NOTE:** This procedure will purge the diesel-burner's fuel system by allowing the heater's fuel pump to complete its normal 30-150 second shutdown/purge cycle.

3. After the purge cycle has ended, repeat once more.
4. Move the diesel-burner switch to the **ON** position and leave it on in order to activate the diesel-burner.

**NOTE:** It will take approximately 10 seconds before the diesel-burner will ignite and exhaust can be heard exiting the heater.

Allow approximately 10-20 minutes for the Aqua-Hot to reach normal operating temperature (approximately 190°F).

5. Move the Aqua-Hot's electric element switch to the **ON** position in order to supply 120 Volt-AC power to the electric heating element.

**NOTE:** Both the 12 Volt-DC powered diesel-burner and the electric heating element are thermostatically controlled. Either or both heating sources will automatically maintain the temperature of the boiler tank's antifreeze and water heating solution depending on the heating source activated at the interior switch panel.

**The Aqua-Hot is now ready for normal operation and use.**

# Appendix A: Wiring Diagram



# Appendix B: Wire Gauge Information

# Appendix B: Wire Gauge Information

## AMERICAN BOAT AND YACHT COUNCIL RECOMMENDATIONS

### CONDUCTORS SIZES FOR 3% DROP IN VOLTAGE

TOTAL  
CURRENT  
ON CIRCUIT  
IN AMPS.

Length of Conductor from Source of Current to Device and back to Source—Feet

10    15    20    25    30    40    50    60    70    80    90    100    110    120    130    140    150    160    170

12 Volts - 3% Drop Wire Sizes (gage) - Based on Minimum CM Area																			
5	18	16	14	12	12	10	10	10	8	8	8	6	6	6	6	6	6	6	6
10	14	12	10	10	10	8	6	6	6	6	4	4	4	4	2	2	2	2	2
15	12	10	10	8	8	6	6	6	4	4	2	2	2	2	2	1	1	1	1
20	10	10	8	6	6	6	4	4	2	2	2	2	1	1	1	0	0	0	2/0
25	10	8	6	6	6	4	4	2	2	2	1	1	0	0	0	2/0	2/0	2/0	3/0
30	10	8	6	6	4	4	2	2	1	1	0	0	0	2/0	2/0	3/0	3/0	3/0	3/0
40	8	6	6	4	4	2	2	1	0	0	2/0	2/0	3/0	3/0	3/0	4/0	4/0	4/0	4/0
50	6	6	4	4	2	2	1	0	2/0	2/0	3/0	3/0	4/0	4/0	4/0				
60	6	4	4	2	2	1	0	2/0	3/0	3/0	4/0	4/0	4/0						
70	6	4	2	2	1	0	2/0	3/0	3/0	4/0	4/0								
80	6	4	2	2	1	0	3/0	3/0	4/0	4/0									
90	4	2	2	1	0	2/0	3/0	4/0	4/0										
100	4	2	2	1	0	2/0	3/0	4/0											

24 Volts - 3% Drop Wire Sizes (gage) - Based on Minimum CM Area																			
5	18	18	18	16	16	14	12	12	12	10	10	10	10	10	8	8	8	8	8
10	18	16	14	12	12	10	10	10	8	8	8	6	6	6	6	6	6	6	6
15	16	14	12	12	10	10	8	8	6	6	6	6	6	4	4	4	4	4	2
20	14	12	10	10	10	8	6	6	6	6	4	4	4	4	2	2	2	2	2
25	12	12	10	10	8	6	6	6	4	4	4	4	2	2	2	2	2	2	1
30	12	10	10	8	8	6	6	4	4	4	2	2	2	2	2	1	1	1	1
40	10	10	8	6	6	6	4	4	2	2	2	2	1	1	1	0	0	0	2/0
50	10	8	6	6	6	4	4	2	2	2	1	1	0	0	0	2/0	2/0	2/0	2/0
60	10	8	6	6	4	4	2	2	1	1	0	0	0	2/0	2/0	3/0	3/0	3/0	3/0
70	8	6	6	4	4	2	2	1	1	0	0	2/0	2/0	3/0	3/0	3/0	3/0	4/0	4/0
80	8	6	6	4	4	2	2	1	0	0	2/0	2/0	3/0	3/0	3/0	4/0	4/0	4/0	4/0
90	8	6	4	4	2	2	1	0	0	2/0	2/0	3/0	3/0	4/0	4/0	4/0	4/0	4/0	
100	6	6	4	4	2	2	1	0	2/0	2/0	3/0	3/0	4/0	4/0	4/0				

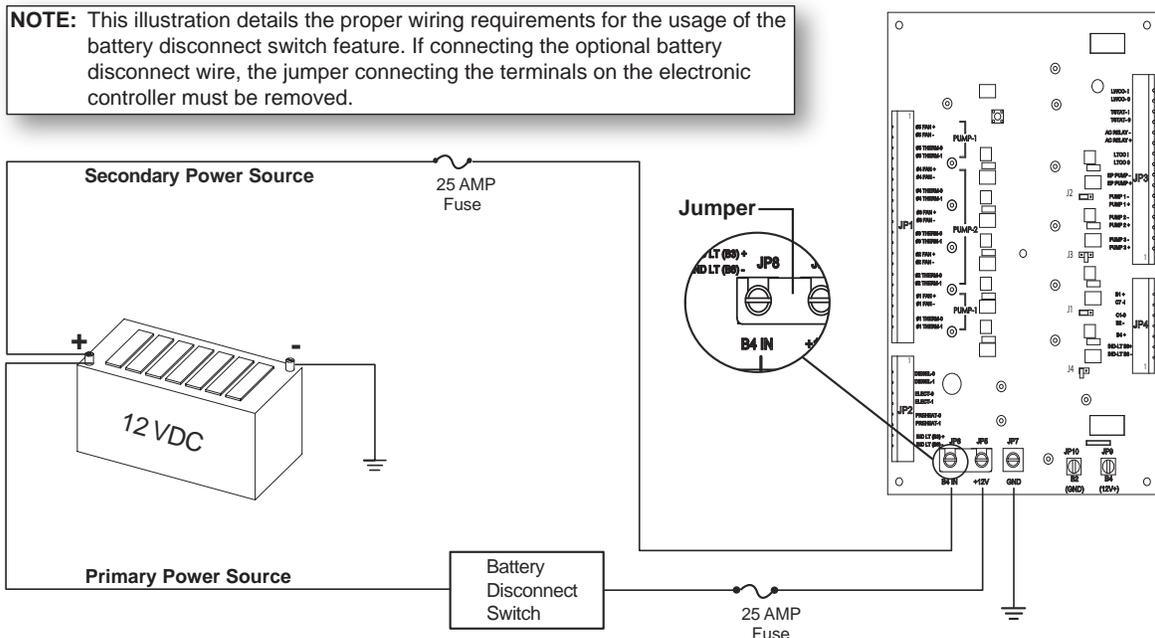
# Appendix C: Electronic Controller Features

# Appendix C: Electronic Controller Features

## Secondary 12 Volt-DC Battery Connection:

The electronic controller is equipped with two 12 Volt-DC power source connections, which allow for a secondary 12 Volt-DC battery connection. This 12 Volt-DC battery connection is a product-safety feature that should be utilized whenever the Aqua-Hot's main 12 Volt-DC power supply is connected to a battery disconnect switch. This feature will ensure that the

Aqua-Hot will be protected in the event that the primary power is interrupted while the Diesel-Burner is operating (e.g., during a burn-cycle). This secondary 12 Volt-DC battery connection will ensure completion of the required 3-minute "purge cycle" of the Aqua-Hot's diesel-burner.

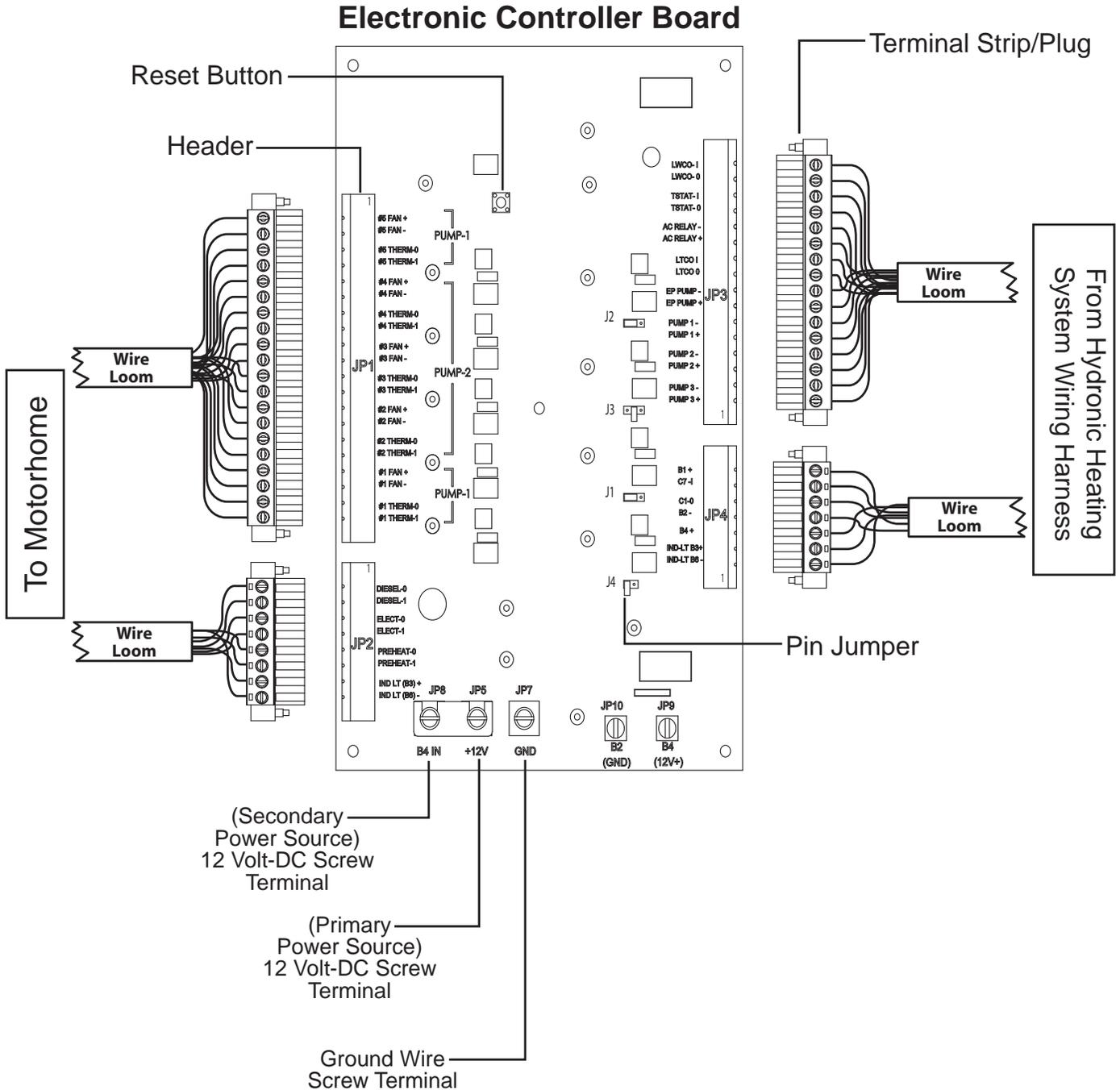


# Appendix C: Electronic Controller Features

## “Low Voltage Reset” Feature:

Whenever the Aqua-Hot’s DC power is interrupted, the “low voltage reset” red indicator light on the electronic controller will illuminate. Reset the electronic controller by pressing the “low voltage reset” button on the electronic controller (use a thin,

straight, nonmetallic object to access the button through the faceplate) or by turning OFF the diesel-burner switch on the interior switch panel for approximately 30 seconds, then turning the switch back ON.



# Appendix D: Antifreeze Types

# Appendix D: Antifreeze Types

The following information addresses the necessary usage of a propylene glycol based “boiler” type antifreeze in the Aqua-Hot. Propylene glycol is a safer alternative to the more toxic ethylene glycol antifreeze; however, as mandated by IAPMO (International Association of Plumbing and Mechanical Officials), only those propylene glycol based “boiler” type antifreezes deemed “Generally Recognized as Safe” (GRAS) by the FDA should be utilized.

Because of the significant impact various types of antifreeze can have on a hydronic heating system, including the level of safety provided, it has been recognized that there is a need to provide an explanation regarding two additional prominent types of antifreeze/coolant available. The following information should be utilized as an educational means of ensuring that the proper type of propylene glycol based antifreeze is selected:

## **RV & Marine Antifreeze:**

These types of propylene glycol based antifreeze products are formulated specifically for “winterizing” applications only. Although RV & Marine antifreeze is often “Generally Recognized as Safe” by the FDA, it should never be used in the Aqua-Hot’s Hydronic Heating

System. This type of antifreeze is not formulated to transfer heat, which is essential to the heating system’s functionality and does not contain rust inhibitors. Please note, however, that RV & Marine antifreeze can be utilized to winterize the Aqua-Hot’s Domestic Hot Water Heating System.

## **Automotive Antifreeze/Coolant:**

These types of propylene glycol based antifreeze products are formulated specifically to protect automotive engines against corrosion, freezing temperatures, and overheating. They also have excellent heat transfer and thermal conductivity characteristics. Although these types of antifreeze products are considered less toxic and safer than ethylene glycol for people, pets, and the environment, they are not “Generally Recognized as Safe” (GRAS) rated by the FDA. Therefore, they must be marked with a “harmful if swallowed” warning. This additional warning is required because these types of antifreeze products contain high levels of chemical rust inhibitors. Due to their potentially hazardous properties, **they should never be used in the Aqua-Hot’s Hydronic Heating System.**

# Appendix E: Antifreeze Mixture Water Quality Recommendations

# Appendix E: Antifreeze Mixture Water Quality

## Antifreeze Mixture Water Quality:

In order to ensure maximum performance and longevity of an Aqua-Hot heating system's boiler tank and associated components, it has been determined that there is a need to use distilled, de-ionized, or soft water in combination with concentrated propylene glycol for the Aqua-Hot's antifreeze and water heating solution. Please note that this is only necessary when mixing concentrated propylene glycol antifreeze with water; suppliers of pre-mixed antifreeze are responsible for the use of high-quality (distilled, de-ionized, or soft) water when preparing their antifreeze for sale.

Hard water possesses a high-level of calcium and magnesium ions, which deplete the propylene glycol antifreeze's corrosion inhibitors. This, in turn, causes the antifreeze and water heating solution to begin turning acidic, which can corrode the Aqua-Hot's Boiler tank and associated components prematurely. Therefore, concentrated propylene glycol should be diluted with distilled, de-ionized, or soft water which is 80 ppm or less in total hardness. The local water agency should have up-to-date water quality reports which should indicate if the local tap water is within this guideline.

# Appendix F: Antifreeze Terms and Mixture Ratio

# Appendix F: Antifreeze Terms and Mixture Ratio

The following information addresses the process of selecting an antifreeze and water mixture ratio that provides adequate freeze, boiling, and rust/anti-corrosive protection. A 50/50 mixture ratio is recommended, which will result in a freeze point of approximately -28°F and a boil point of approximately 222°F.

The following information should be utilized for the purpose of clarifying some terms commonly associated with antifreeze.

## **Freeze Point and Burst Point:**

Antifreeze lowers the freezing point of any liquid, to which it has been added, by preventing the formation of ice crystals; however, as the ambient temperature continues to decline, the water in the solution will attempt to attain a solid state. The point in which the water begins to solidify is termed the “Freeze Point.” Although the water in the solution has begun to freeze, producing a “slushy” consistency, the antifreeze in the solution will continue to combat the normal expansion of the solution as it freezes. The point in which the solution can begin to expand, due to colder temperatures, is called the “Burst Point.” Once the solution reaches the burst point, the potential is present for ruptured pipes to exist. The burst point of the antifreeze and water heating solution is dependent upon the brand of propylene glycol employed.

## **Boiling Point:**

The Aqua-Hot utilizes the antifreeze and water heating solution as a transportation means for the heat produced from the internal processes. The antifreeze absorbs the heat created until its boiling point is reached; it is at this point that the liquid turns to a gas and is expelled to prevent the heating system from overheating. Each time the boiling point is reached, a loss of efficiency occurs because the heat produced is expelled rather than utilized for the function of the heating system. Therefore, a higher boiling point is desired in order to combat the loss of efficiency, which allows the antifreeze to transport the heat created from

the internal process throughout the motorhome where it can be utilized productively rather than dissipating due to its change from a liquid to a gas.

## **Rust and Anti-Corrosive Inhibitors:**

Another major function of antifreeze is to provide protection to the internal metal components of the Aqua-Hot hydronic heating system from corrosion and rust. Antifreeze is able to perform this function by the addition of rust- and anti-corrosive inhibitors, which are designed specifically to activate in a water solution.

## **Summary:**

Antifreeze has three basic functions: freeze protection, boil-over protection, and anti-corrosion and rust protection.

Antifreeze is also primarily responsible for heat transfer; however, antifreeze itself does not possess acceptable heat transfer characteristics. Therefore, as water is an excellent heat conductor, it is added to the mixture. A 50/50 solution of propylene glycol antifreeze and water is recommended to provide the best performance combination of the aforementioned functions. If excess propylene glycol exists within an antifreeze and water heating solution, the water's heat absorption properties are compromised, which could ultimately inhibit the Aqua-Hot from providing adequate domestic hot water and interior heating.

Additionally, if the antifreeze and water heating solution contains over 70 percent antifreeze, the freezing point is actually raised, resulting in less freeze protection. Please reference the attached graphical representation regarding the percentage of antifreeze to water and how it directly affects the solution's freezing point.

# Appendix F: Antifreeze Terms and Mixture Ratio

