



**By Vehicle Systems, Inc.**

*Motor Coach Heating Specialist*

# Installation Manual

Model Numbers

920431/432

# TABLE OF CONTENTS

## ■ Sections

<b>1.0</b>	<b>Hydronic Heating System Overview</b>
<b>2.0</b>	<b>Aqua-Hot Overview</b>
2.1	Technical Data
2.2	Aqua-Hot Reference Illustration
<b>3.0</b>	<b>Heat Exchanger Information</b>
<b>4.0</b>	<b>Installation Procedures</b>
4.1	Choosing a permanent mounting location for the Aqua-Hot
4.2	Mounting the Aqua-Hot
4.3	Choosing permanent mounting locations for the interior heat exchangers
4.4	Mounting the interior heat exchanger(s)
4.5	Choosing a permanent mounting location for the bay heat exchanger
4.6	Mounting the bay heat exchanger
4.7	Heat exchanger plumbing overview
4.8	Installing the plumbing lines from all heat exchangers to the Aqua-Hot
4.9	Engine preheating plumbing overview
4.10	Installing the plumbing lines to the engine's coolant system
4.11	Domestic hot water plumbing overview
4.12	Installing the plumbing lines to the domestic hot water system
4.13	Wiring the interior heat exchangers
4.14	Choosing mounting locations for the interior thermostats
4.15	Wiring the interior thermostats
4.16	Choosing a mounting location for the bay thermostat
4.17	Wiring the bay thermostat and heat exchanger

# TABLE OF CONTENTS

## ■ Sections, continued

- 4.18 Installing and wiring the diesel burner control switch and indicator light
- 4.19 Installing and wiring the engine preheat switch
- 4.20 Diesel burner's fuel supply system overview
- 4.21 Installing the diesel burner's fuel lines
- 4.22 Installing the Aqua-Hot's exhaust system
- 4.23 Installing the Aqua-Hot's expansion tank
- 4.24 Bleeding the interior heating system
- 4.25 Bleeding the engine preheat system
- 4.26 Installing DC power to the Aqua-Hot
- 4.27 Installing AC power to the Aqua-Hot's electric heating element
- 4.28 Turning on the system for the first time

# SECTION 1: HYDRONIC HEATING SYSTEM OVERVIEW

## Introduction

### 1.0 Hydronic Heating System Overview

A hydronic heating system utilizes a heated solution of water and antifreeze as the heating medium. The heated solution is circulated by centrifugal coolant pumps to the system's heat exchangers whenever interior thermostats "call for heat." As the heated solution is circulated through the heat exchangers, heat is drawn out and delivered to each particular heating zone.

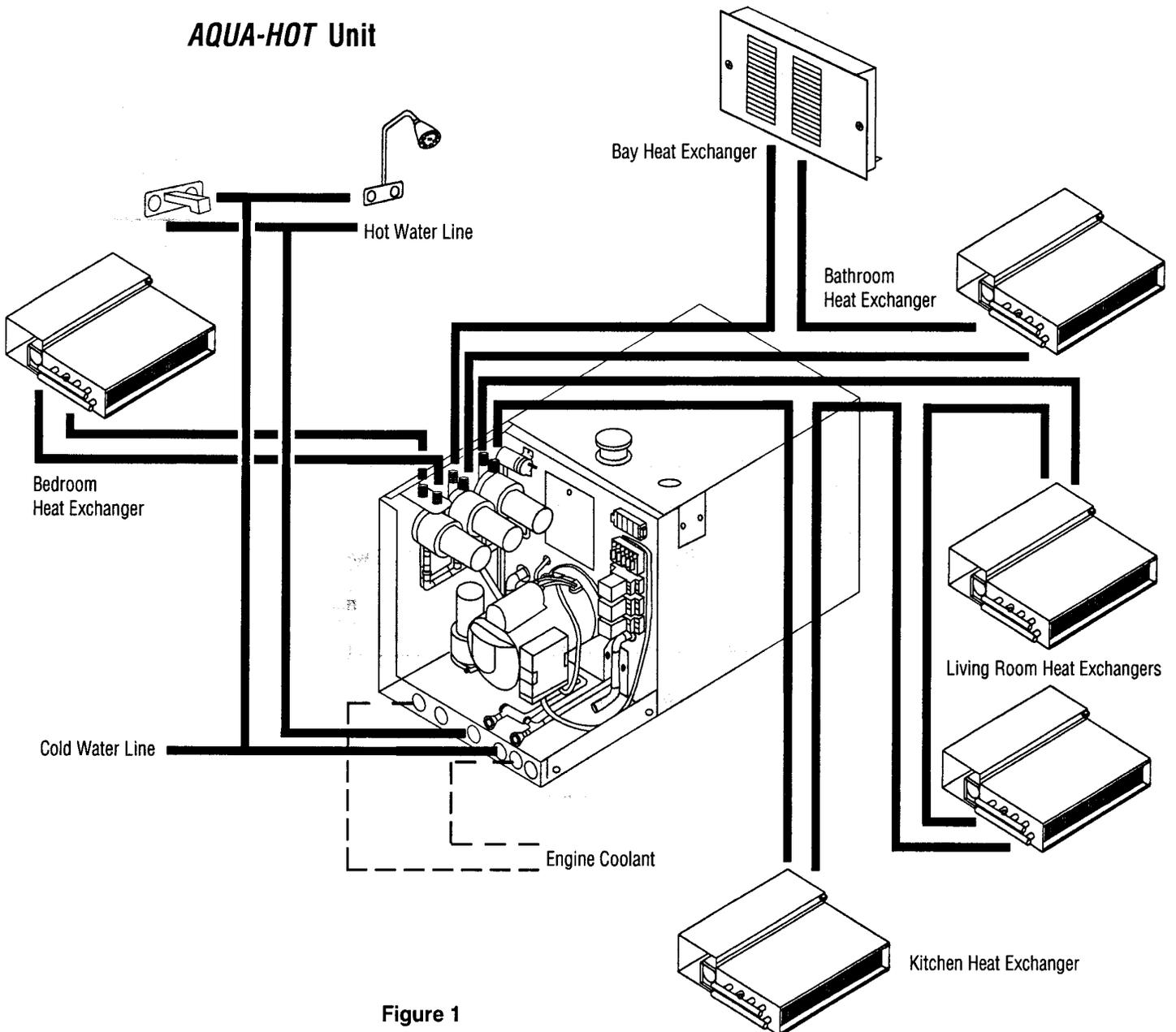


Figure 1

## SECTION 2: AQUA-HOT OVERVIEW

### ■ Overview

#### 2.0 Aqua Hot Overview

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The Aqua-Hot Motor Coach and Marine Heating System is an on-board heating system that provides an on-demand, continuous supply of domestic hot water, as well as interior heat where and when it is needed. Both heating features are accomplished by a 50,000 BTU DC operated, diesel-fired burner and a 1650 watt electric heating element (110 volt/AC). These two heating sources maintain the temperature of the Aqua-Hot's 50/50 solution of water and antifreeze. In addition, the Aqua-Hot has been designed to preheat the vehicle's engine prior to starting. This feature provides easy engine start-up when cool weather conditions exist.

The Aqua-Hot is simple to operate, was designed easy installation in mind, and its compact size, 18.5" X 18.5" X 36.75", requires minimal cargo space.

### ■ Data

#### 2.1 Technical Data

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Diesel burner, heat output .....	50,000 BTU/hr
Diesel burner, fuel consumption .....	0.5 gal/hr, #1 or #2 diesel fuel
Diesel burner, power consumption .....	60 watts
Electric heating element .....	110 volt AC, 1650 watts
Heat tank, capacity .....	15.75 gallons
Engine preheat, heat output .....	20,000 BTU/hr (estimated)
Circulating pumps .....	(4) 12 watt magnetic drive pumps, rated @ 3.5 gpm flow rate
Number of heating zones .....	(3), plus engine heat loop
Domestic water heating capacity .....	55° temperature rise @ 1.5 gpm continuous flow
Dimensions .....	18.5"H X 18.5"W X 36.75"L
Dry weight .....	approximately 200 lbs
Warranty .....	2 year
Complies with the requirements of UL307A, UL778 and (USCG) CFR 33. TerraLab Engineers Listing No. 15717. Patent No. 5,025,985 and 5,067,652.	

# SECTION 2: AQUA-HOT OVERVIEW

## ■ Aqua-Hot

### 2.2 Aqua-Hot Reference Illustration

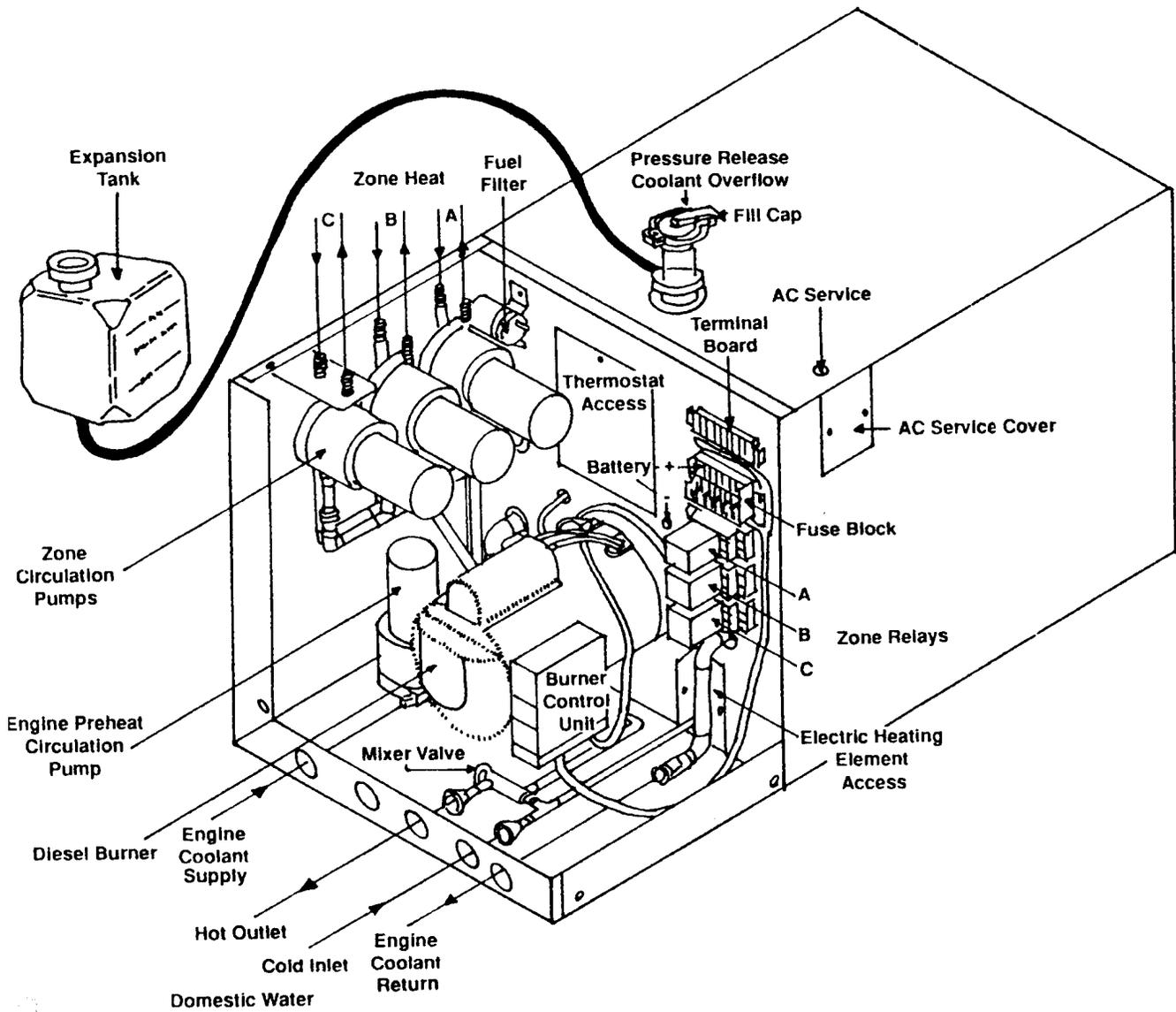


Figure 2

## SECTION 3: HEAT EXCHANGER INFORMATION

### Choosing Interior Heat Exchangers

#### 3.0 Heat Exchanger Information

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Before moving to Section 4, Vehicle Systems Inc. (VSI) feels it is important to mention some general things to consider concerning the choosing of heat exchangers for your particular application. Our experience has taught us that inefficient heat exchangers rob the Aqua-Hot of its full interior heating capabilities.

**Choose a heat exchanger that:**

1. Has an adequate BTU output for your particular application.

**NOTE:** The following general rule of thumb helps in determining what adequate BTU output is in regards to interior heating. For every 500 cubic feet of interior space, 10,000 BTU's of heat exchanger will be required. This will also depend on the insulation factor and the total square footage of window (glass) surface area.

2. Utilizes a low-power consumption electric motor. This is especially important when limited reserve battery power is available (i.e. dry camping).
3. Has a low-profile and/or compact design. This allows you to place them under cabinets and other tight fitting areas.
4. Incorporates a flow-through design. A flow-through design allows the heated solution of water and antifreeze to flow through the heat exchanger with little or no restrictions. Also, it allows for multiple heat exchangers to be plumbed in-series instead of in-parallel, (in-series is a simpler system to design and install).
5. Operates quietly, yet has a good airflow, 50-125 CFM (cubic feet per minute) output.

**NOTE:** A heat exchanger with a high CFM output (150 CFM or higher) should be avoided for the following reasons:

- Large amounts of airflow traditionally stir up dust particles.
- Uneven heating distribution may be felt (hot & cold air pockets) throughout the interior instead of gradual even heating that a lower CFM heat exchanger would provide.
- Higher CFM heat exchangers require larger electric motors which are characteristically noisier. This is an important consideration especially while dry camping.
- Also, larger electric motors draw additional and unnecessary amperage.

## SECTION 4: INSTALLATION PROCEDURES

### Aqua-Hot Installation

#### 4.0 Installation Procedures

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**NOTE:**

1. All vehicle installations must comply with the requirements listed in the ANSI A119.2 (American National Standards Institute) NFPA 501C (National Fire Protection Association) Recreational Vehicles. To receive a copy of RVIA Standards, write to: Recreation Vehicle Industry Association, 1896 Preston White Drive, P.O. Box 2999, Reston, VA 22090-0999
2. All vehicle and marine installations must be installed and operate in strict compliance with all applicable codes, laws, and regulations having the force of law.

### Aqua-Hot Location

#### 4.1 Choosing A Permanent Mounting Location For The Aqua-Hot

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Because motor coach and marine applications will vary, the Aqua-Hot's permanent mounting location should be chosen carefully. Adhering to the general guidelines listed below will ensure maximum system performance as well as safe operation.

- A. The permanent mounting location must be capable of supporting a **minimum** of 400 lbs. Inspect area beneath mounting location to ensure no structural members will interfere with the exhaust and drain holes.
- B. The Aqua-Hot **cannot** be installed anywhere inside the passenger compartments or living areas.
- C. Centralize the Aqua-Hot nearest the area(s) where domestic hot water will be used most frequently (i.e. bathroom and kitchen).
- D. Utilize the drawing(s) provided to assure minimum Aqua-Hot clearances are adhered to. These clearances are important so the Aqua-Hot's access cover can be easily removed.
- E. The Aqua-Hot's exhaust must be able to exit away freely from the vehicle without any obstructions. In addition, the exhaust pipe is **hot** and must be kept away from any heat sensitive material.
- F. Adequate ventilation must be supplied to the Aqua-Hot at all times. This will ensure the diesel burner receives a sufficient supply of combustion-air.

## SECTION 4: INSTALLATION PROCEDURES

### Aqua-Hot Mounting



**CAUTION:** The combustion-air **cannot** be supplied from any passenger compartment.

**CAUTION:** The combustion-air **cannot** be supplied from any compartment which may contain combustible gases (i.e. battery gases, gasoline or propane fumes, etc.).

#### 4.2 Mounting The Aqua-Hot

Once a general mounting location for the Aqua-Hot has been chosen, utilize the following figures.

Figures 3, 4 and 5 provide mounting information, such as:

- Required clearances so the access cover can be easily removed.
- Overall Aqua-Hot dimensions.

Figure 6 provides mounting information, such as:

- Required size and location of exhaust hole.
- Required size and location of heat tank drain hole.
- Required size and location of mounting bracket bolt holes.
- Mounting bracket locations.

- A. Drill all the necessary holes prior to mounting the Aqua-Hot permanently into place, see Figure 6. All four mounting brackets supplied must be installed to ensure the Aqua-Hot does not move or shift under normal operating conditions.

**NOTE:** Only eight mounting bracket bolt holes (5/16") need to be drilled, see Figure 6. Choose the four best mounting positions available. Be sure to drill the hole for the exhaust system and the tank drain hole prior to placing the Aqua-Hot into the permanent mounting position.

- B. Place the Aqua-Hot into the permanent mounting position.
- C. Using 1/4" bolts (total of eight needed) fasten down the Aqua-Hot.
- D. Once the Aqua-Hot has been permanently mounted remove the access cover, see Figure 3.

## SECTION 4: INSTALLATION PROCEDURES

### Aqua-Hot Dimensions

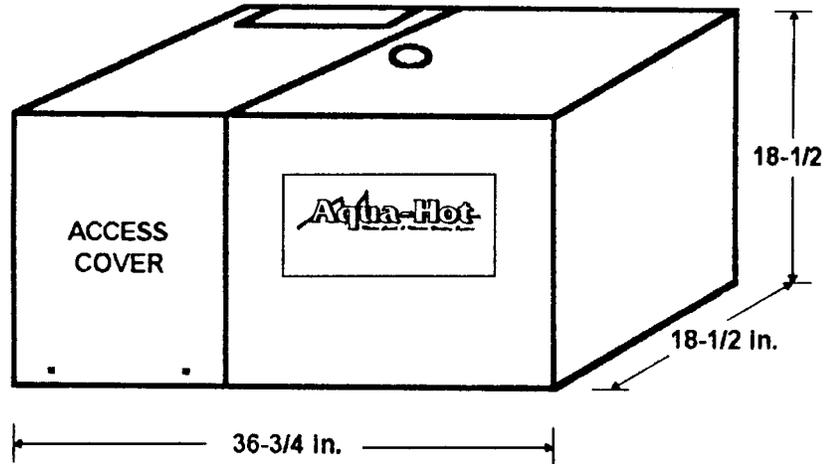


Figure 3

### Clearances For Right Angle Mounting

*Minimum Aqua-Hot Clearances Required If Aqua-Hot Is Mounted At A Right Angle (90°) To The Coaches Chassis*

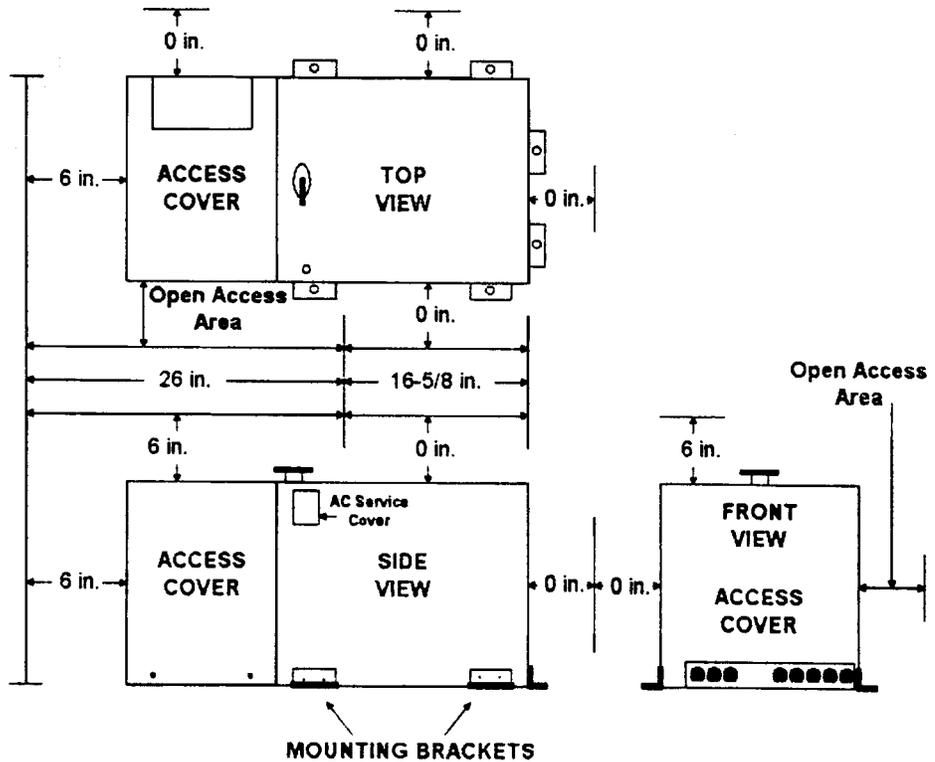


Figure 4

# SECTION 4: INSTALLATION PROCEDURES

## Clearances For Parallel Mounting

*Minimum Aqua-Hot Clearances Required If Aqua-Hot Is Mounted Parallel To The Coaches Chassis*

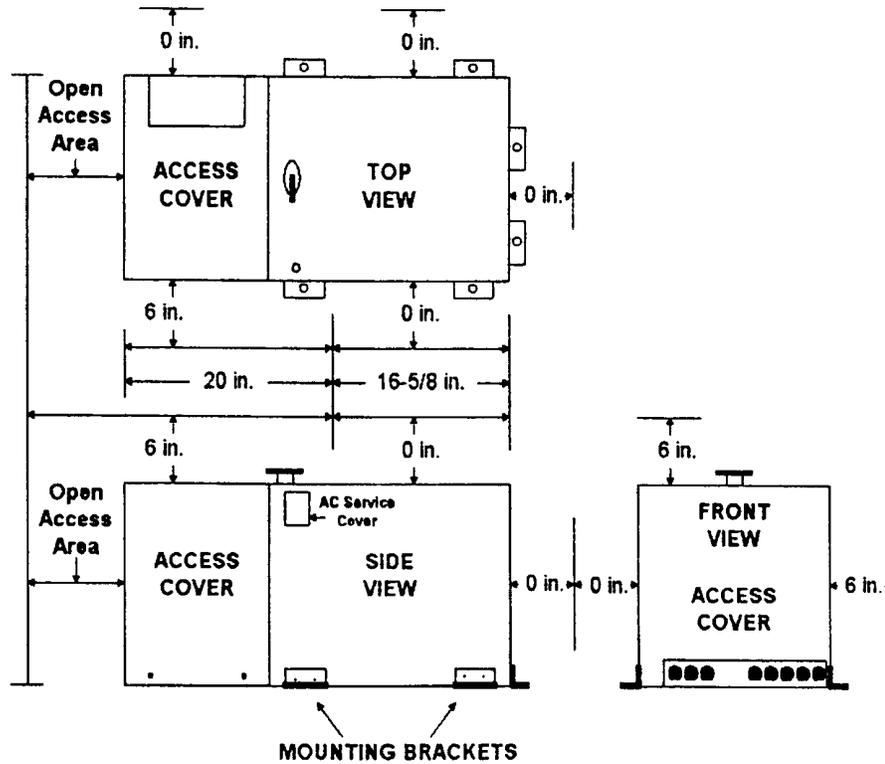


Figure 5



# SECTION 4: INSTALLATION PROCEDURES

## Base Mounting Dimensions

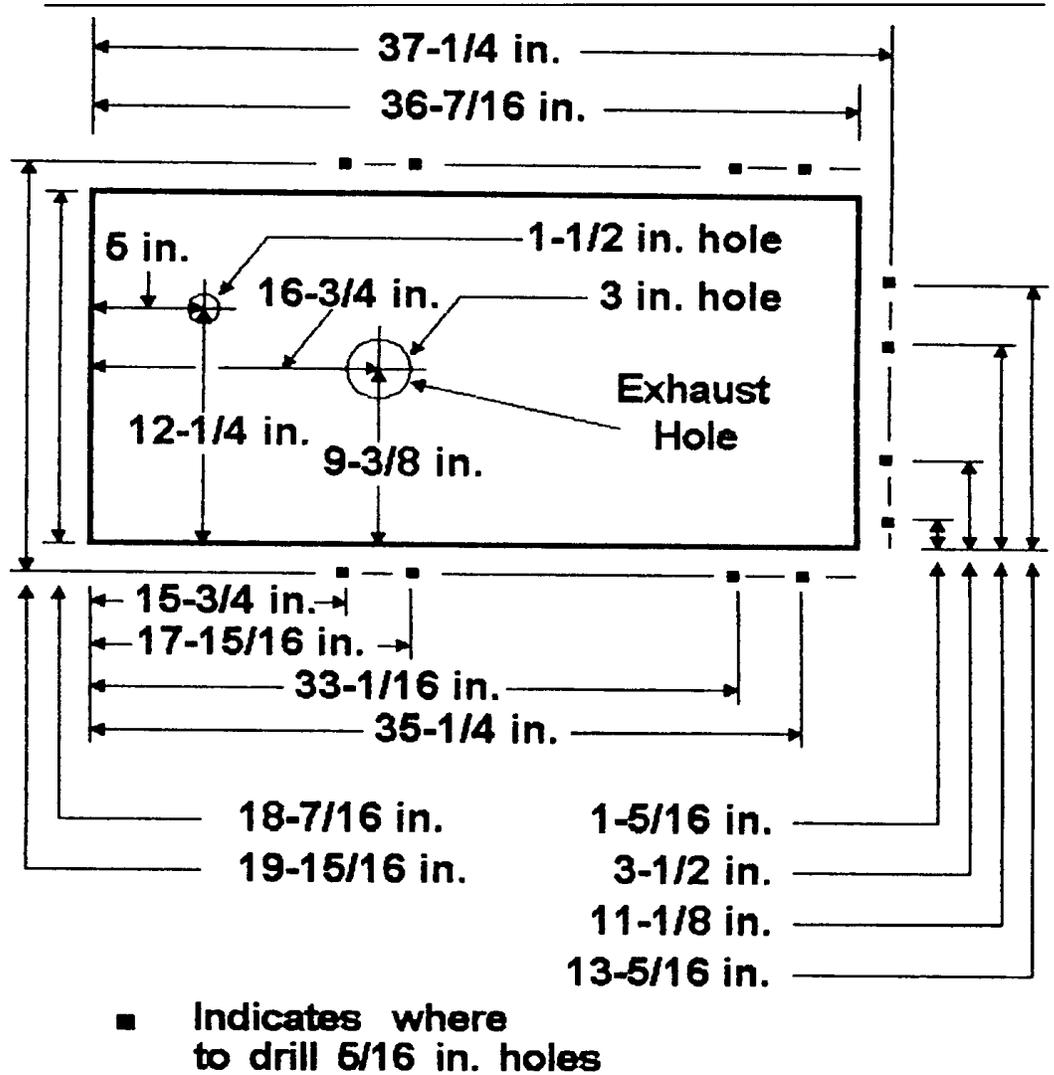


Figure 6

## SECTION 4: INSTALLATION PROCEDURES

### Interior Heat Exchanger Location

#### 4.3 Choosing Permanent Mounting Locations For The Interior Heat Exchangers

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Adhering to the general guidelines listed below will assure maximum heat exchanger efficiency and even-heat distribution throughout each heating zone (i.e. living room, kitchen, bedroom, bathroom).

- A. Centralize and position the heat exchanger(s) in each area so even-heat distribution will be felt throughout the interior. To accomplish this it is recommended that a floor plan drawing showing the interior layout be obtained.
- B. Sufficient ventilation (return-air) must be supplied to each heat exchanger, see Figure 7. **Do not** mount heat exchanger(s) in areas that have no openings for return-air to enter. Mounting heat exchangers without sufficient ventilation will severely reduce their overall performance (heat output) and will also increase their overall noise level (due to cavitation). Return-air should be drawn in from the interior heating zone.

**NOTE:** The following general rule of thumb helps in determining what sufficient ventilation is in regards to heat exchanger(s): The return-air vent must be one to one and a half times the size of the output register (ratio of 1:1 - 1.5).

- C. Allow for easy access to all heat exchangers for future serviceability and cleaning (i.e. dust, etc.). Easy access will also be very important in Section 4.8 (Installing the heat exchanger plumbing lines) and Section 4.24 (Bleeding the heating system).

## SECTION 4: INSTALLATION PROCEDURES

### Interior Heat Exchanger Mounting

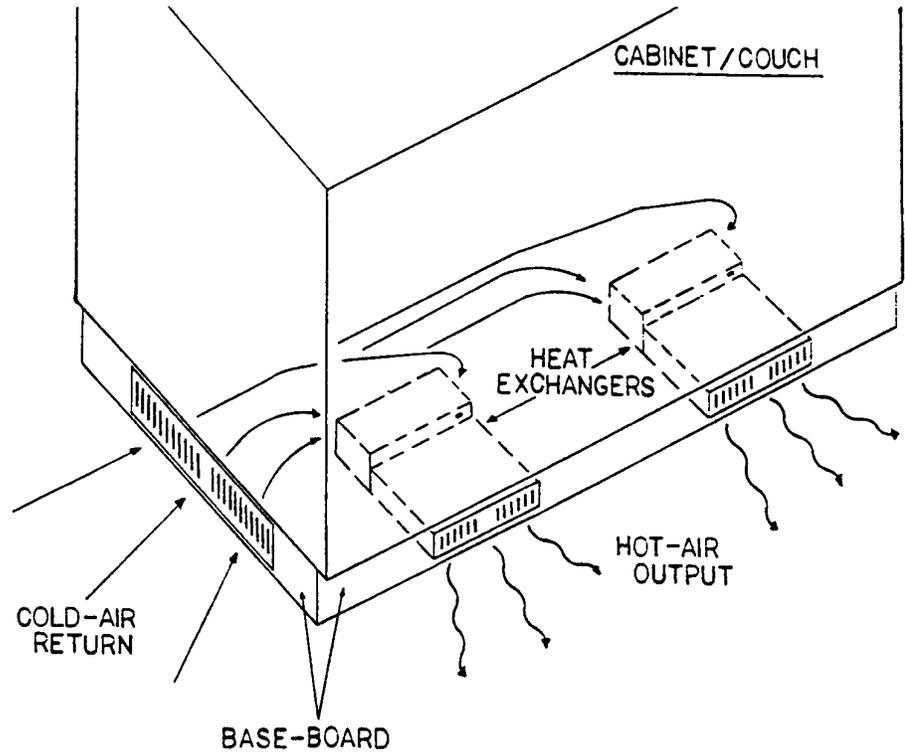


Figure 7

## SECTION 4: INSTALLATION PROCEDURES

### Interior Heat Exchangers, continued

#### 4.4 Mounting The Interior Heat Exchanger(s)

Once all permanent mounting locations for each individual heat exchanger have been chosen, cut out the opening for each output register and temporarily fasten down each heat exchanger into place.

- A. If mounting a VSI Cozy heat exchanger (Part # 950120, 12 volt) the exchanger must be mounted flat on a smooth surface. Cozys **cannot** be mounted on their side, upside down, or in an upright position. For proper positioning, see Figures 7 and 8.
1. Cut an opening of 3-1/8" X 14-1/2" for the output register. Utilize Figure 9 that shows the front view and side view.
  2. Fasten each Cozy with a maximum of four screws, in at least two positions, so they cannot move or shift under normal operating conditions, see Figure 10.
  3. Cut and install return-air vents.

### Plumbing Line Connections

#### Cozy Heat Exchanger

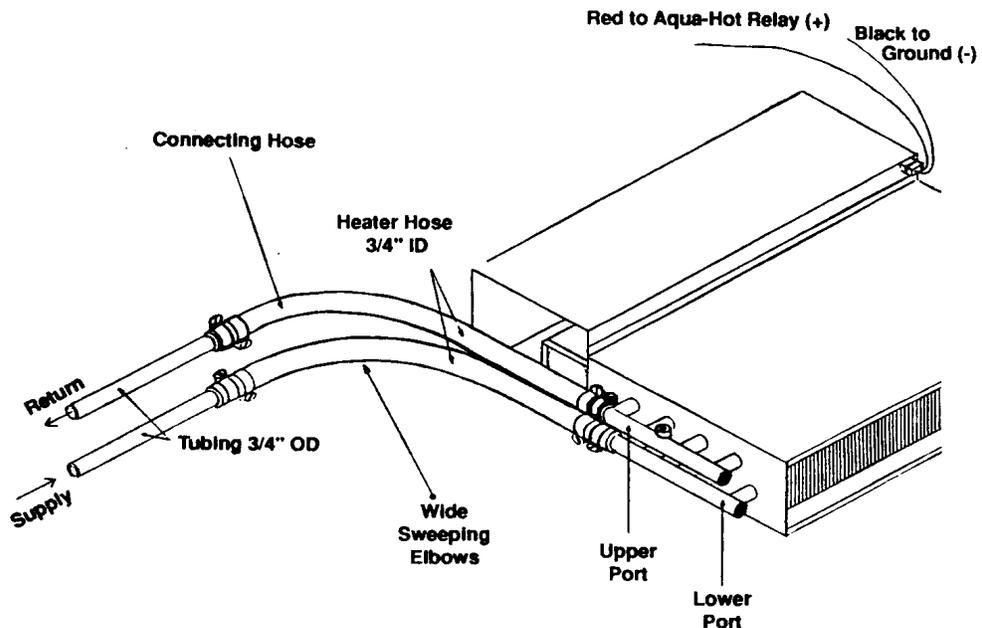
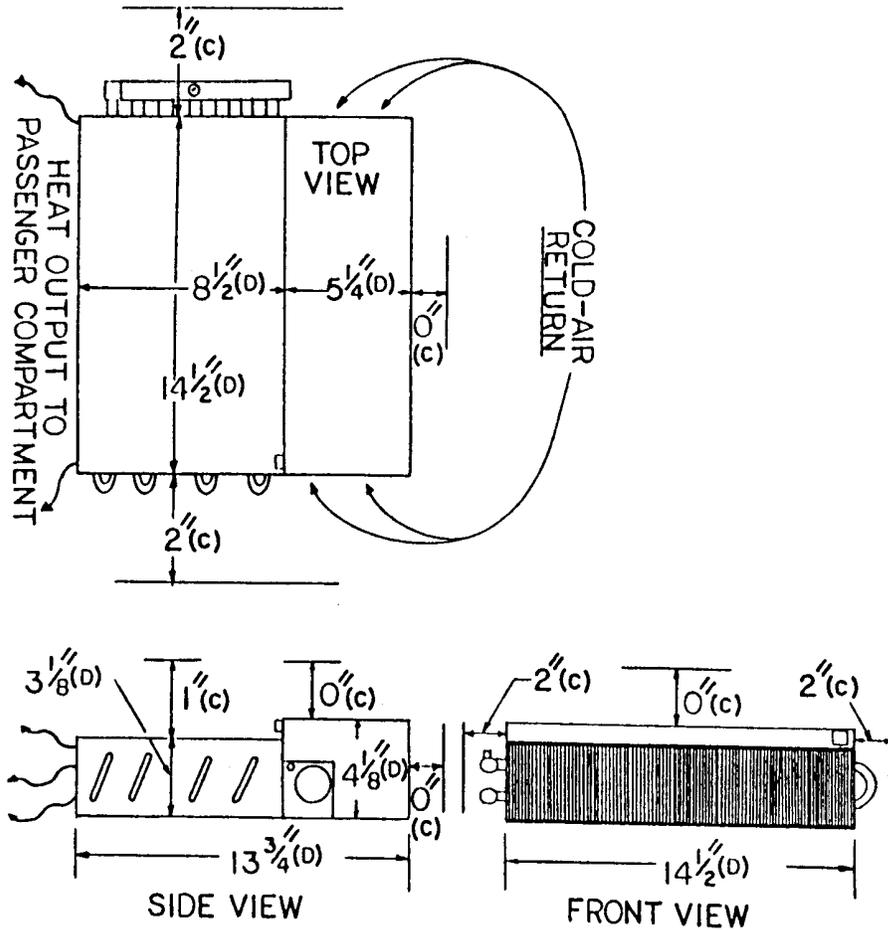


Figure 8

## SECTION 4: INSTALLATION PROCEDURES

### Cozy Heat Exchanger

*Minimum Heat Exchanger Clearances (C) and Overall Dimensions (D)*

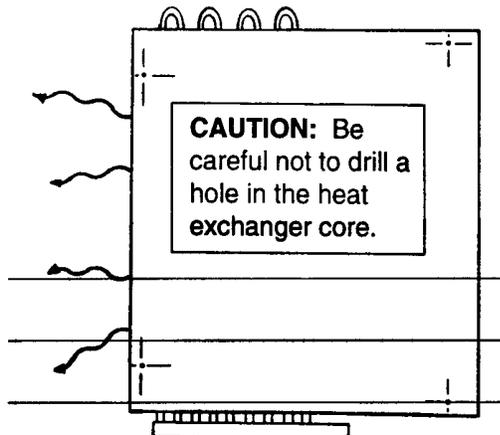


**Figure 9**

### Cozy Hole Locations

**Bottom View Of Cozy Heat Exchanger**

—|— Indicates Where To Drill Holes



**Figure 10**

## SECTION 4: INSTALLATION PROCEDURES

### Bay Heat Exchanger Location

#### 4.5 Choosing a Permanent Mounting Location For The Bay Heat Exchanger

The bay heat exchanger should be strategically placed in the cargo area to prevent freezing conditions in the plumbing bay.

- A. Centralize and position the heat exchanger in the domestic water storage tank bay area so even-heat distribution will be accomplished, see Figure 11.

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

- B. Sufficient ventilation (return-air) must be supplied to the heat exchanger, see Figures 12 and 13. **Do not** mount the heat exchanger in an area that has no opening for return-air to enter. Mounting the heat exchanger without sufficient ventilation will severely reduce its overall performance (heat output). If possible, return-air should be drawn in from the same bay the heat exchanger is located in.

### Plumbing Bay

#### Plumbing Bay Heating Overview

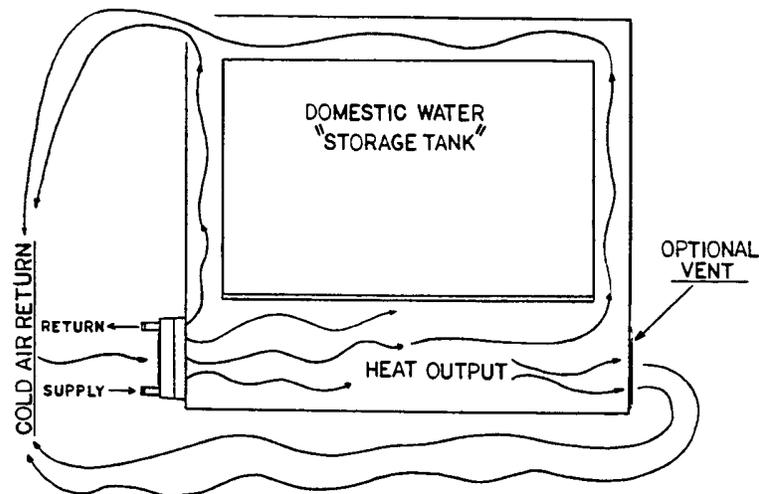


Figure 11

## SECTION 4: INSTALLATION PROCEDURES

### Bay Heat Exchanger Mounting

#### 4.6 Mounting The Bay Heat Exchanger

Once a permanent mounting location for the bay heat exchanger has been chosen, fasten the heat exchanger **temporarily** into place.

- If mounting a VSI Whisper heat exchanger (Part #5506580, 12 volt), the supply and return (input and output) ports must be mounted parallel to the vehicle's floor. For proper positioning, see Figure 13.
- Fasten the Whisper's two mounting brackets (two screws or bolts required) so the heat exchanger cannot move or shift under normal operating conditions, see Figures 12 and 13.

### Whisper Heat Exchanger

*Minimum Heat Exchanger Clearances (C) And Overall Dimensions (D)*

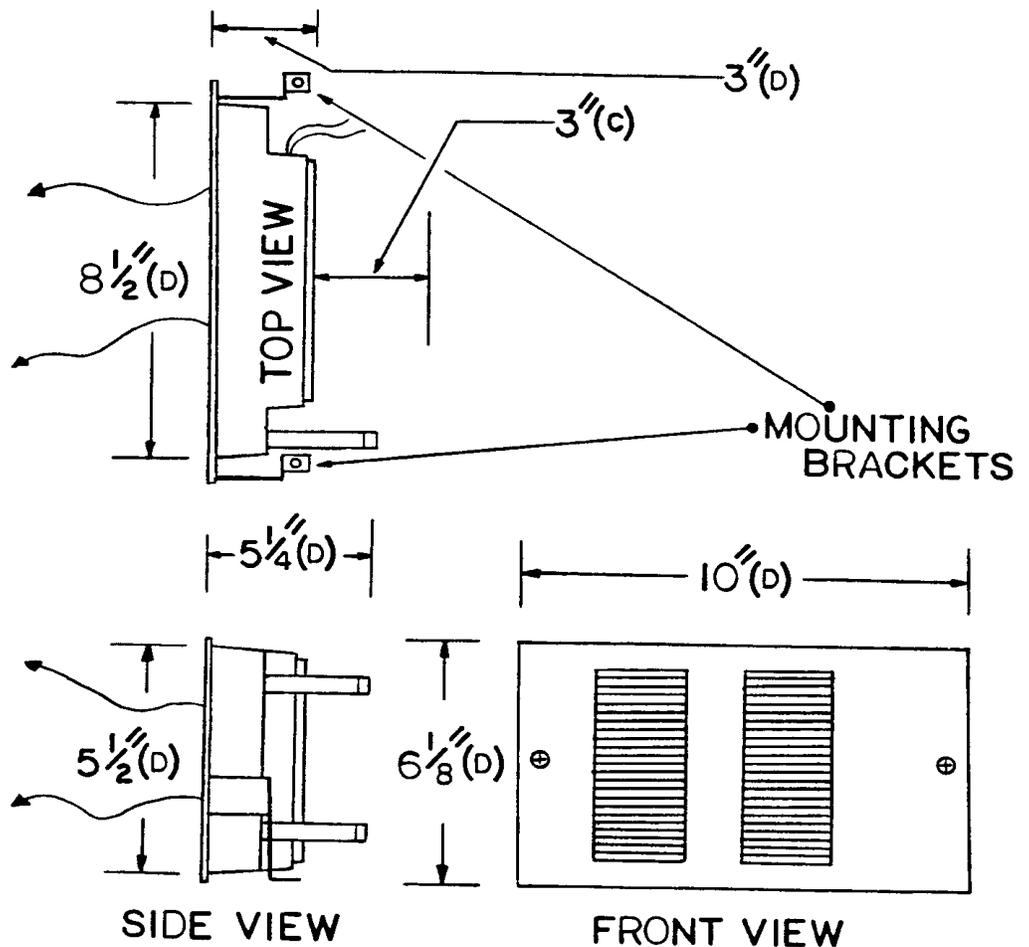


Figure 12

## SECTION 4: INSTALLATION PROCEDURES

### Whisper Heat Exchanger, continued

#### Allowable Whisper Mounting Configurations

**NOTE:** If mounting the Whisper in this position, the supply and return ports must be mounted in the upright position, as shown. This will allow any trapped air to escape naturally.

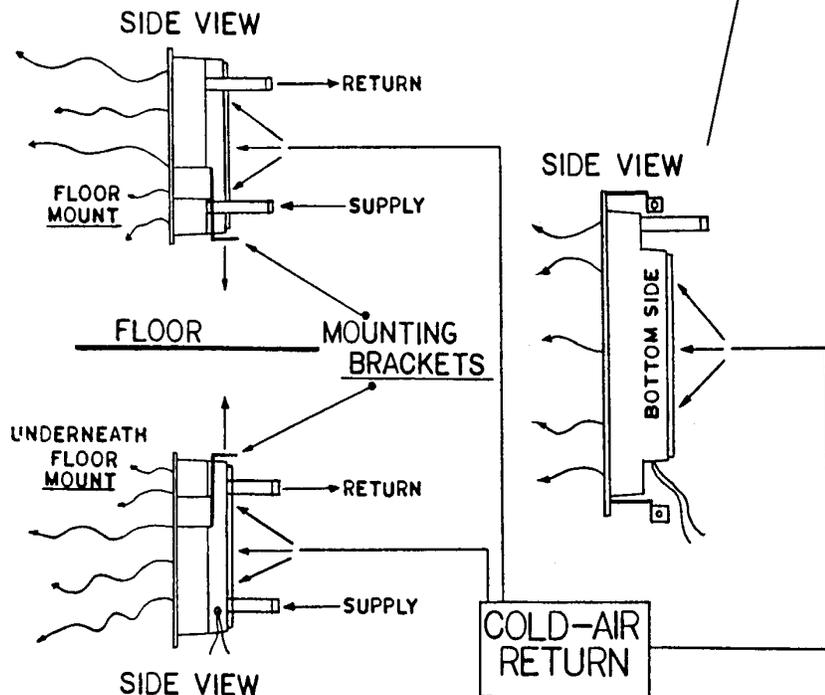


Figure 13

### Planning Heat Exchanger Plumbing

#### 4.7 Heat Exchanger Plumbing Overview

Once all heat exchangers have been temporarily mounted, you will now need to choose the proper plumbing line size, and plan the routing of the plumbing lines from each heating zone to the Aqua-Hot. The plumbing lines are the roadways that carry the heated solution of water and antifreeze from the Aqua-Hot to the heat exchangers in each heating zone. Adhering to the general guidelines listed below will assure maximum heat output.

- A. The heated solution of water and antifreeze should be allowed to flow as freely as possible. The easier it is for the heated solution to flow (minimal restrictions) will maximize the Aqua-Hot's overall interior heating capabilities.

## SECTION 4: INSTALLATION PROCEDURES

### Heat Exchanger Plumbing, continued

- B. Choose a **series** or **parallel** (or combination of both) plumbing system, see Figure 14.

**NOTE:**

1. A series system is a simpler system to install and bleed.
2. The bathroom and bay heat exchangers should be plumbed together on the same plumbing circuit, see Figure 1.
3. If using Cozy heat exchangers, remember up to 3 can be plumbed in series. For most applications, 3 - 10,000 BTU exchangers will be the maximum required in any one heating zone.
4. A parallel system is more complicated to install and should only be used when installing exchangers with poor flow characteristics.

### Heat Exchanger Plumbing Options

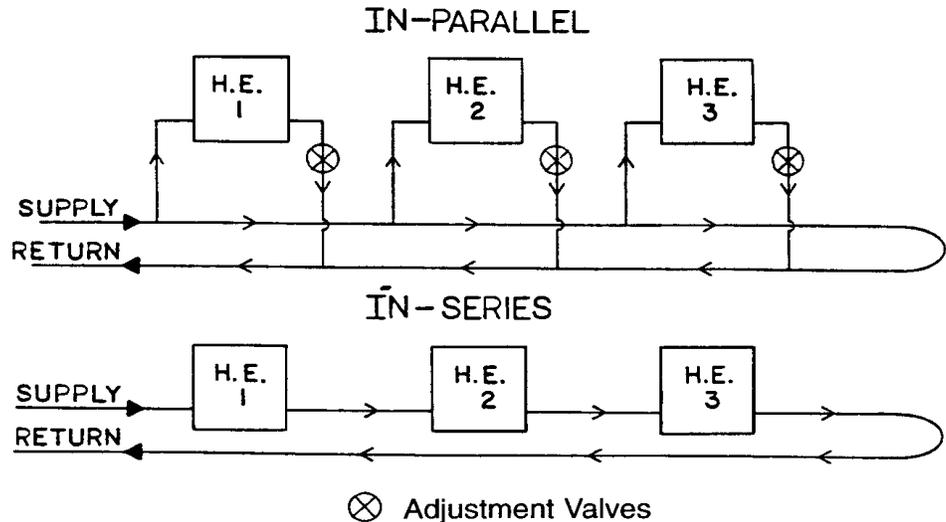


Figure 14

### Heat Exchanger Plumbing, continued

- C. Choose the I.D. of the plumbing lines by gathering the following information concerning your specific installation:
1. For each heating zone, measure (approximately) the total length of supply and return plumbing line needed.
  2. Add up the total number of Cozy heat exchanger(s) that will be used for each heating zone.
  3. Utilize Chart 1 to determine what I.D. plumbing line will be required for your particular application, see page 18.
- D. If using Poly-Tubing or Flexible Heater Hose
1. Use wide sweeping elbows wherever plumbing lines may be susceptible to kinking (i.e. 90° bends or greater), see Figure 8.

## SECTION 4: INSTALLATION PROCEDURES

### Plumbing, continued

### Plumbing Line Diameters

#### E. If using Copper Tubing

1. 1/2" I.D. copper tubing is suitable for most applications. Longer runs (50+ feet) on some applications may require larger I.D. tubing.

**NOTE:** Chart 1 shows that up to three VSI Cozy Heat Exchangers can be plumbed **In-Series** (up to 50 feet) when using 5/8" inside diameter plumbing lines. This chart also shows that the minimum allowable plumbing line size is 1/2" inside diameter.

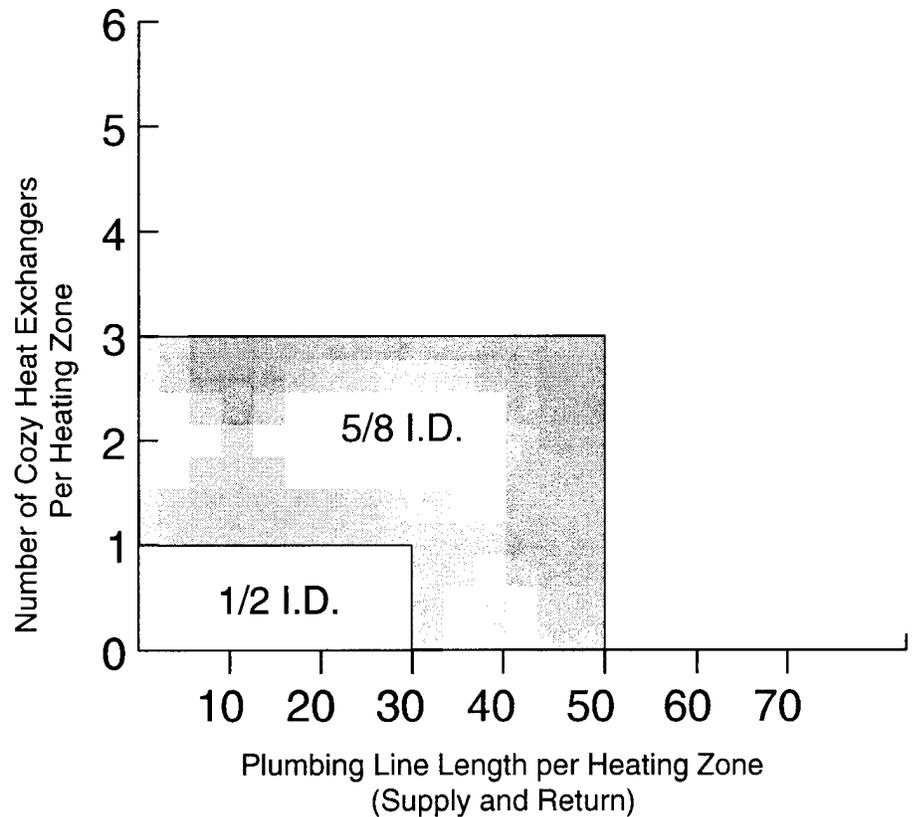


Chart 1

### Installing Heat Exchanger Plumbing

#### 4.8 Installing The Plumbing Lines From All Heat Exchangers To The Aqua-Hot

- A. Install all plumbing lines and mark with **arrows and/or labels** at both ends. These should indicate which heating zone the lines are going to (i.e. living room, bathroom, bedroom, etc.), and whether they are a **supply or return** line. Do this prior to running the plumbing lines or as the lines are being laid out.

## SECTION 4: INSTALLATION PROCEDURES

### Installing Plumbing, continued

- B. 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.
- C. Run all plumbing lines in areas where they cannot be pinched off or damaged under normal operating conditions.
- D. Be sure to fasten all lines where necessary, and apply protective shielding in areas where chafing may occur.

**NOTE:** Use rubber coated closed type clamps when fastening the plumbing lines.

- E. Connect and clamp the supply line to the lowest port on heat exchanger.
- F. Connect and clamp the return line to the highest port on heat exchanger.

**NOTE:** Plumbing heat exchangers in this manner will allow air to escape naturally. If air gets trapped in any heat exchanger it will significantly reduce the heat exchanger's overall efficiency.

- G. Install and tighten check valves (located underneath the Aqua-Hot's access cover) to zone circulation pump's supply ports, see Figure 15.

**NOTE:** Be sure that valve arrows are pointing upward, and to apply teflon tape to the plumbing fitting threads to help eliminate possible coolant leaks.

- H. Connect and clamp heat exchanger supply line to the appropriate check valve supply port for each heating zone, see Figure 15.
- I. Connect and clamp heat exchanger return line to the appropriate return port on the return manifold for each heating zone, see Figure 15.

**CAUTION:** Be careful not to connect the heat exchanger supply and return lines backwards onto the Aqua-Hot.

### Planning Engine Preheat Plumbing

#### 4.9 Engine Preheating Plumbing Overview

Engine preheating is accomplished by a closed-loop water to water heat exchanger that is an integral part of the Aqua-Hot's "heat-tank". Adhering to the general guidelines listed below will assure maximum engine preheating efficiency.

- A. The inlet and outlet ports on the engine, that will supply and return engine coolant to the Aqua-Hot, should be kept as far apart as possible. This will assure the entire engine is preheated, see Figure 16. Should you need assistance in determining the best inlet and outlet ports for your specific engine, contact VSI at (303) 857-2901.

## SECTION 4: INSTALLATION PROCEDURES

### Planning Plumbing, continued

#### NOTE:

1. The chosen engine **inlet** port is where the heated coolant returns back to the engine from the Aqua-Hot, see Figures 2 and 16. The chosen inlet port should be a high connection point on the engine block or a suction port on the engine's water pump.
2. The chosen engine **outlet** port will supply the Aqua-Hot's engine preheat circulation pump with the engine's coolant, see Figures 2 and 16. The chosen outlet port should be a low connection point on the engine block.

### Aqua-Hot Heating Zone Plumbing

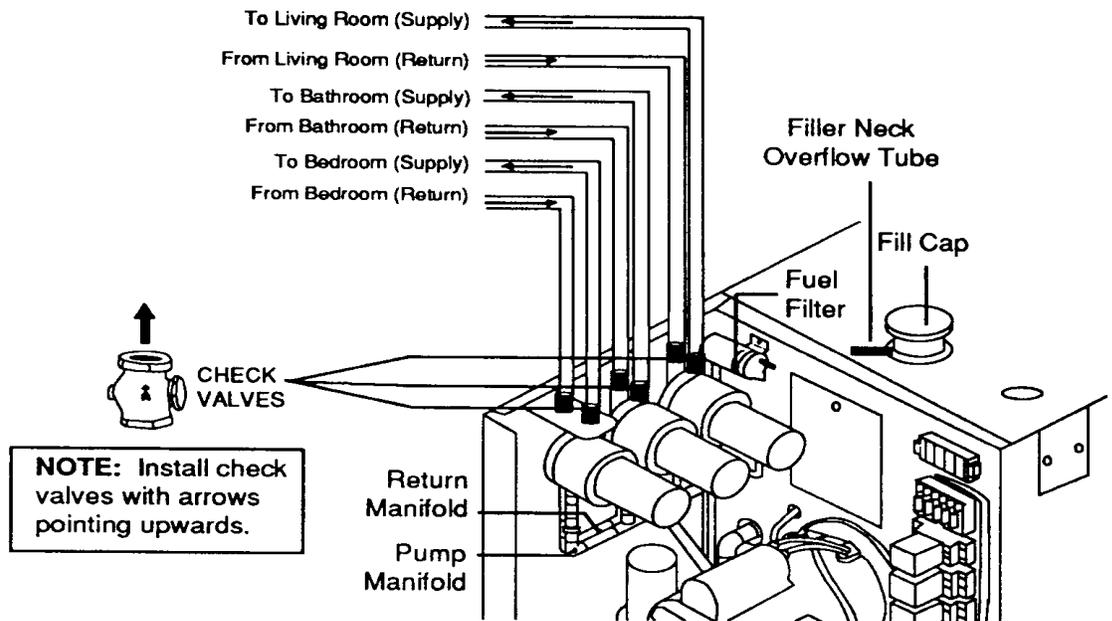


Figure 15

### Engine Preheat Plumbing

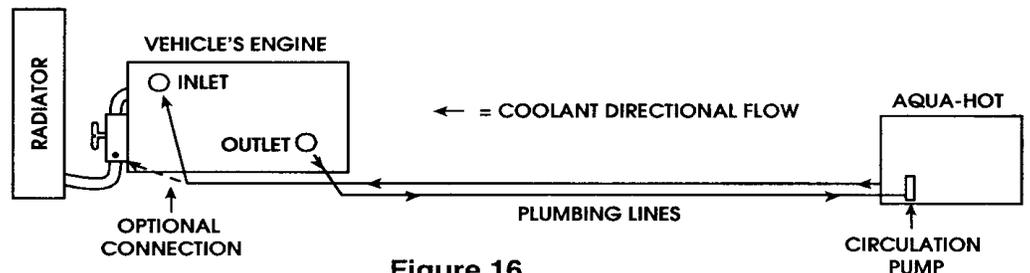


Figure 16

## SECTION 4: INSTALLATION PROCEDURES

### Preheat Plumbing, continued

- B. The coolant should be allowed to flow as freely as possible under normal operating conditions. The easier it is for the engine's coolant to flow (with minimal restrictions) will maximize the Aqua-Hot's engine preheating system capabilities.
- C. Use 1/2", 5/8" or 3/4" I.D. plumbing lines. This will depend on how far away the Aqua-Hot is from the vehicle's engine.

**NOTE:** If the combined length of the two plumbing lines exceeds 30 feet, use 3/4" plumbing lines.

### Installing Engine Preheat Plumbing



#### 4.10 Installing The Plumbing Lines To The Engine's Coolant System

- A. Install both plumbing lines and mark with **arrows and/or labels** at both ends. This indicates whether the line is **supplying** coolant from the vehicle's engine (connected to the Aqua-Hot's engine preheating circulation pump) or **returning** heated coolant to the vehicle's engine.
- B. Both plumbing lines should be laid as flat as possible and any extreme rises in height should be avoided (to eliminate any potential air traps).
- C. Run both plumbing lines in areas where they cannot be pinched off or damaged under normal operating conditions.
- D. Be sure to fasten both lines where necessary and apply protective shielding in areas where chafing may occur.

**NOTE:** Use rubber coated closed type clamps when fastening the plumbing lines.

- E. Drain the engine coolant.
- F. Remove the inlet and outlet port plugs on the engine.

**NOTE:** Should one or both ports have plumbing fittings with heater hoses or temperature sensing devices already attached to them, it may be necessary to tee into these existing lines. Contact VSI at (303) 857-2901 for engine plumbing help.

- G. Install and tighten the plumbing fittings into the Inlet and Outlet ports on the engine.

**NOTE:** A one piece plumbing fitting will help eliminate possible engine coolant leaks. Be sure to apply pipe thread compound to the plumbing fittings threads that will screw into the engine block. This will also help to eliminate possible coolant leaks.

- H. Install and tighten both the supply and return plumbing lines to the engine's plumbing fittings.

## SECTION 4: INSTALLATION PROCEDURES

### Preheat Plumbing, continued

- I. Install and tighten the plumbing fittings onto the supply and return ports on the Aqua-Hot's engine preheating system, see Figure 2.

**NOTE:** Use plumbing fittings compatible with the plumbing line material being used (i.e. copper tubing, silicone heater hose, etc.).

- J. Install and tighten both the supply and return plumbing lines to the Aqua-Hot's engine preheating system.
- K. After all plumbing fittings and connections have been tightened and double checked; refill the engine with coolant.

### Planning Domestic Hot Water Plumbing

#### 4.11 Domestic Hot Water Plumbing Overview

A major benefit of the Aqua-Hot is that it operates like a domestic hot water heater by providing a continuous supply of domestic hot water as required. The major difference is the Aqua-Hot heats the domestic water **on demand** so there is no need for a separate storage tank type water heater. Adhering to the following general guidelines will assure maximum domestic hot water efficiency.

- A. The following information concerning the sizing of water supply piping was taken directly from the ANSI A119.2/NFPA 501C Standard on Recreation Vehicles, 1993 Edition. This information should be used as a general guideline:

"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. The size of water supply piping and branch line shall not be less than shown in Table 4-6.5.1

**Table 4-6.5.1**

*Minimum Size Tubing And Pipe For Water Distribution Systems\**

Minimum Size Tubing and Pipe for Water Distribution Systems*			
Number of Fixtures	Tubing		Pipe
	I.D. (Inches)	O..D. (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 manufacturer.

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

\*\*\* 6 ft. (1.8 m) maximum length.

## SECTION 4: INSTALLATION PROCEDURES

### Planning, continued

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

### Installing Domestic Hot Water Plumbing

#### 4.12 Installing Plumbing Lines To The Domestic Hot Water System

The Aqua-Hot's design incorporates a hot water extender tempering valve ("Mixer Valve," see Figure 2) that helps prevent excessively hot water from flowing to the taps. Please note that a tempering valve is **not** the same as an "anti-scald" valve.

- A. Run all domestic hot water plumbing lines in areas where they cannot be pinched off or damaged under normal operating conditions.
- B. Be sure to fasten all lines, where necessary, and apply protective shielding in areas where chafing may occur.
- C. Run a plumbing line from the cold domestic water supply to the **cold inlet** port on the Aqua-Hot; see Figures 2 and 17.

**NOTE:** Be sure to install an accumulator tank in the domestic cold water supply line, on the output side of the demand pump, see Figure 17.

- D. Run a plumbing line from the **hot outlet** port on the Aqua-Hot to the hot water distribution lines, see Figures 2 and 17.

### Domestic Hot Water System Overview

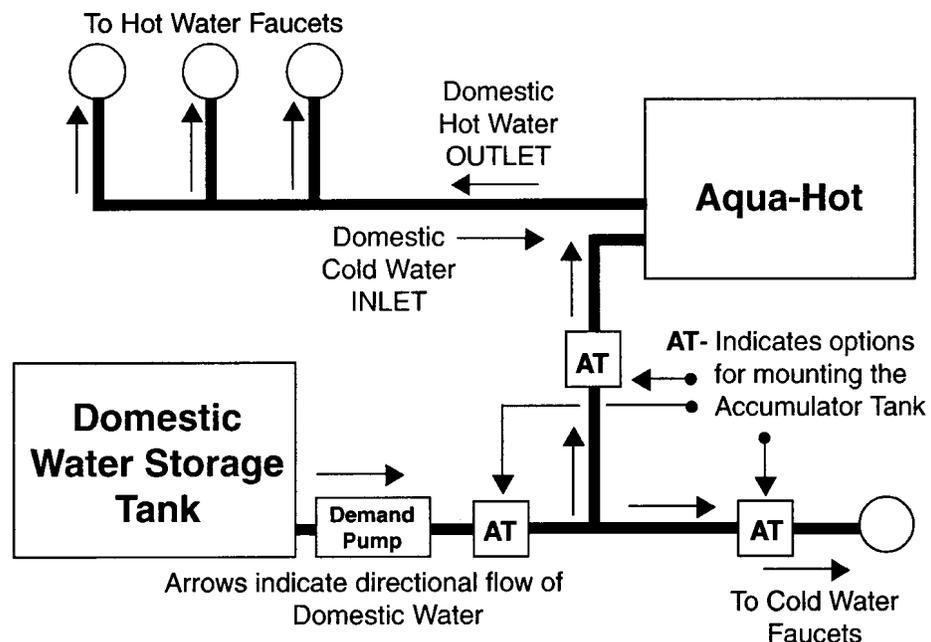


Figure 17

## SECTION 4: INSTALLATION PROCEDURES

### Wiring Interior Heat Exchangers

#### 4.13 Wiring The Interior Heat Exchangers

---

The Aqua-Hot has been designed to supply electrical power to all interior heat exchangers. When a particular heating zone thermostat "calls for heat," the Aqua-Hot's electrical system will automatically supply power to the heat exchanger(s) in that particular heating zone.

- A. Run a 14 gage wire, from the closest interior heat exchanger, from each particular heating zone to the Aqua-Hot's zone relay distribution block, see Figures 2 and 18.
- B. Label the three wires indicating the heating zone they pertain to (i.e. living room, bedroom, bathroom, etc.).
- C. Crimp an electrical connector (fork or ring type) onto each wire and connect to the appropriate zone relay (Pin #4), see Figure 18.
- D. Connect wires to the positive leads at each heat exchanger, see Figure 8.

**NOTE:** For heating zones with two or more heat exchangers wire them in PARALLEL.

- E. Fasten all heat exchanger ground wires to a good chassis ground or to the ground post on the Aqua-Hot, see Figures 8 and 18.

### Interior Thermostat Location

#### 4.14 Choosing Mounting Locations For The Interior Thermostats

---

The mounting locations for the interior thermostats should be chosen carefully to assure even-heat distribution throughout each heating zone.

- A. Locate each thermostat at approximately chest level.

**NOTE:** Do not mount the thermostats on outside walls, in drafty areas or where hot and cold sources will interfere with the thermostats operation (i.e. near a kitchen stove, heater outlet register, or on a vented wall of the refrigerator compartment etc.)

**Aqua-Hot  
Electrical  
Panel**

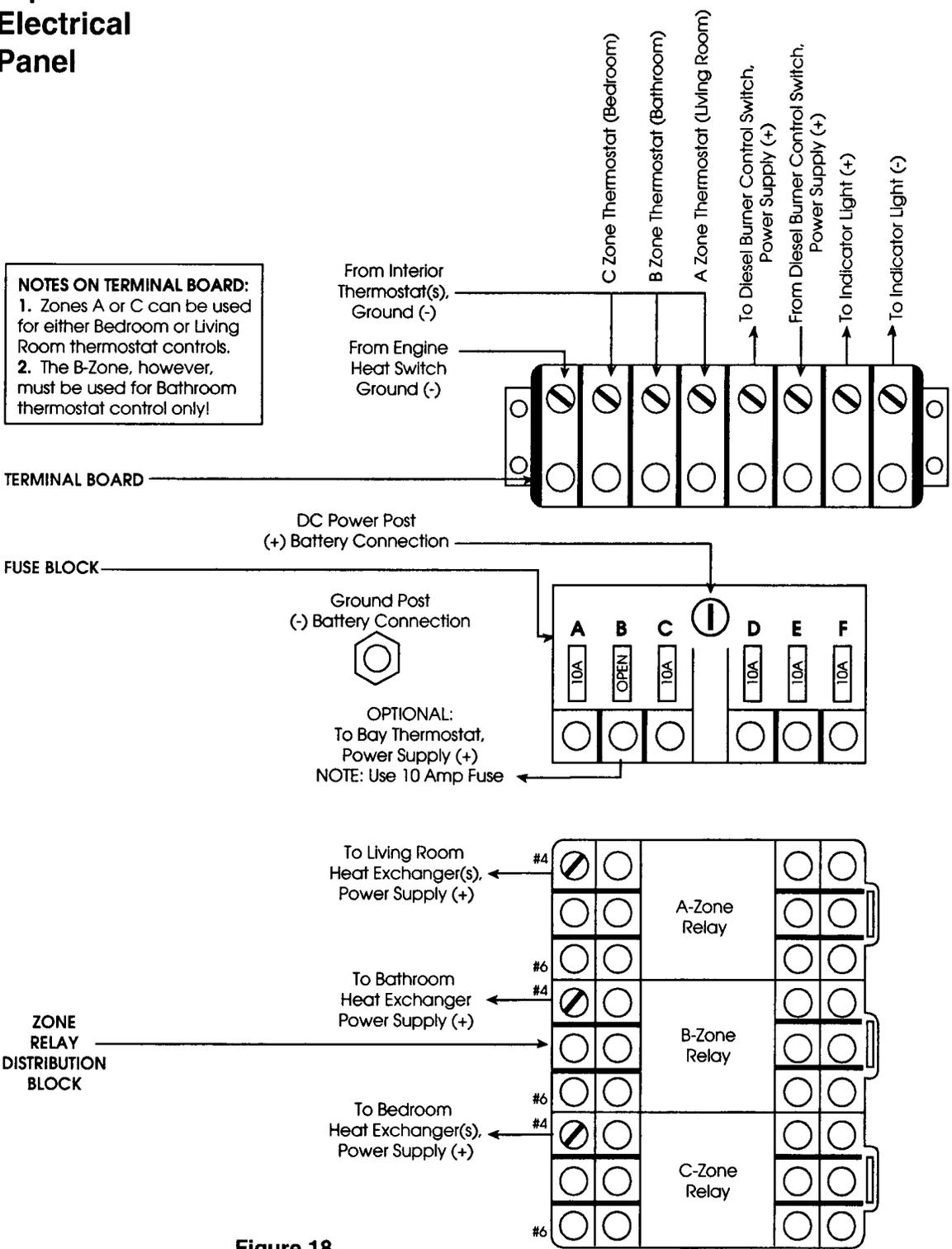


Figure 18

## SECTION 4: INSTALLATION PROCEDURES

### Wiring Interior Thermostats

#### 4.15 Wiring The Interior Thermostats

---

- A. Run a 14 gage wire from each interior thermostat mounting location to the Aqua-Hot's terminal board, see Figures 2 and 18.
- B. Label the three wires indicating the heating zone they pertain to (i.e. living room, bedroom, bathroom, etc.).
- C. Crimp an electrical connector (fork or ring type) onto the wire, and connect to the appropriate terminal .
- D. Connect the wires to either lead of each thermostat.
- E. Connect the other thermostat lead to a good chassis ground or to the ground post on the Aqua-Hot, see Figure 18.
- F. Mount thermostats in place.
- G. Turn the thermostats OFF or to their lowest temperature setting.

### Bay Thermostat Location

#### 4.16 Choosing A Mounting Location For The Bay Thermostat

---

The mounting location of the bay thermostat should be chosen carefully to assure even-heat distribution throughout the bay compartment.

- A. Centralize the Bay thermostat in the domestic water storage compartment.
- B. Choose a low temperature setting thermostat (not to exceed 50° F).
- C. The chosen mounting location should allow for easy access to the thermostat.

**NOTE:** If using VSI low temperature thermostat (Part #02E552) note that only the bulb needs to be physically mounted in the bay area. The thermostat body can be mounted elsewhere for easy access.

**NOTE:** Do not mount the thermostat in a drafty area.

## SECTION 4: INSTALLATION PROCEDURES

### Wiring Bay Thermostat And Heat Exchanger

#### 4.17 Wiring The Bay Thermostat and Heat Exchanger

**OPTION A:** If mounting a VSI Low Temperature thermostat (part #02E552).

- A. Run a 14 gage wire from the BLACK wire lead to an auxiliary DC power source (fused), see Figure 19..

**NOTE:** The Aqua-Hot's fuse block has an open power slot that can be utilized as an auxiliary DC power source, see Figure 18. If utilized, use a 10 amp fuse (ATO type).

- B. Run two 14 gage wires from the BLUE and ORANGE wire leads of the thermostat to:

- the positive lead (+) of the Bay heat exchanger (BLUE lead wire), see Figure 19.
- the Aqua-Hot's zone relay distribution block (ORANGE wire lead), see Figures 18 and 19. Crimp an electrical connector (fork or ring type) onto the wire and connect to Pin #6 on B ZONE relay block.

- C. Mount the thermostat in place.

- D. Fasten the heat exchanger ground wire to a good chassis ground or to the ground post on the Aqua-Hot, see Figure 18.

**OPTION B:** If mounting a generic thermostat.

- A. Run a 14 gage wire from one terminal of the Bay thermostat to an auxiliary DC power source (fused).

**NOTE:** The Aqua-Hot's fuse block has an open power slot that can be utilized as an auxiliary DC power source, see Figure 18. If utilized, use a 10 amp fuse (ATO type).

- B. Run two 14 gage wires from the other terminal of the thermostat to:

- the positive (+) lead of the Bay heat exchanger (label as WIRE #1).
- the Aqua-Hot's zone relay distribution block, see Figure 18 (label as WIRE #2). Crimp an electrical connector (fork or ring type) onto the wire and connect to Pin #6 on B ZONE relay block.

**NOTE:** A diode must be installed in WIRE #2, see Figure 19 for directional current flow. Without the diode, the Bay thermostat will not be able to control the water storage bay temperatures and overheating may occur. If using a VSI Whisper heat exchanger, the diode rating should be as follows:

1. Forward current rating (I-f) = 3 amps.
2. Reverse voltage rating (V-r) = 50 volts.

## SECTION 4: INSTALLATION PROCEDURES

### Wiring, continued

- C. Mount thermostat in place.
- D. Fasten the heat exchanger ground wire to a good chassis ground or to the ground post on the Aqua-Hot, see Figure 18.

### Wiring Diagram

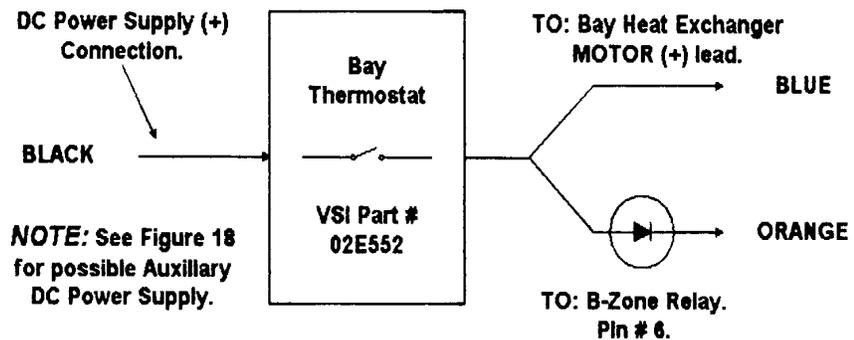


Figure 19

### Diesel Burner Control Switch

#### 4.18 Installing And Wiring The Diesel Burner Control Switch And Indicator Light

The location chosen for the diesel burner control switch will completely depend on your personal preference. Choose a switch and indicator light compatible with other coach controls.

**NOTE:** The control switch must have a minimum amperage rating of 5 amps.

#### Wiring The Control Switch To The Terminal Board

- A. Run two 12 gage wires from the control switch to the terminal board on the Aqua-Hot, see Figures 2 and 18.

## SECTION 4: INSTALLATION PROCEDURES

### Diesel Burner Control Switch, continued

B. Crimp electrical connectors (fork or ring type) onto the two wires at the Aqua-Hot's terminal board, and connect to the appropriate terminals, see Figures 18 and 20.

**NOTE:** The wires are **not** polarity sensitive so either wire can be connected to either control switch connection (+ or -).

### Wiring Indicator Light

#### Wiring The Indicator Light

A. Run two 16 gage wires from the indicator light to the terminal board on the Aqua-Hot, see Figures 2 and 18.

**NOTE:** Choose a wire color differing from the control switch wires.

B. Crimp electrical connectors (fork or ring type) onto the two wires at the Aqua-Hot's terminal board, and connect to the appropriate terminals, see Figures 18 and 20.

**NOTE:** If indicator light is polarity sensitive, see terminal board for proper polarity, see Figure 20.

### Control Switch And Indicator Light Diagram

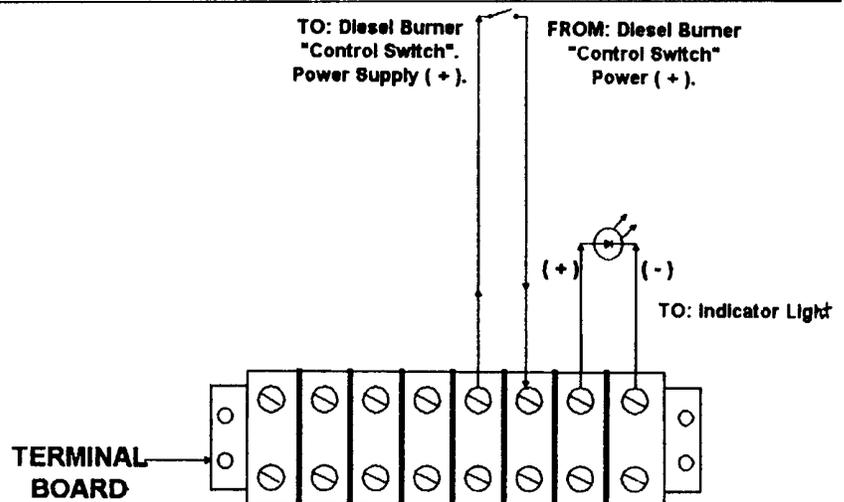


Figure 20

### Engine Preheat Switch

#### 4.19 Installing And Wiring The Engine Preheat Switch

The location chosen for the engine heat switch will completely depend on your personal preference. Choose a switch compatible with other coach controls.

**NOTE:** The preheat switch must have a minimum amperage rating of 5 amps.

## SECTION 4: INSTALLATION PROCEDURES

### Engine Preheat Switch, continued

- A. Run a 14 gage wire from one terminal of the engine preheat switch to the terminal board on the Aqua-Hot, see Figures 2 and 18.
- B. Crimp an electrical connector (fork or ring type) onto the wire and connect to the appropriate terminal, see Figure 18.
- C. Connect the other terminal of the switch to a good chassis ground or to the ground post on the Aqua-Hot, see Figure 18.

### Planning the Fuel System

#### 4.20 Diesel-Burner's Fuel Supply System Overview

The diesel burner is the Aqua-Hot's primary heat source so care should be taken when installing the fuel-system.

- A. The fuel supply can be drawn directly from the main fuel tank (only if diesel) or from a separate fuel tank. The tank should be equipped with a pick-up stand pipe and return port dedicated for the diesel burner, see Figure 21.

#### NOTES:

1. If an auxiliary fuel tank is required, be sure to reference the ANSI A119.2 NFPA 501C Standards Manual regarding Fuel Systems and Equipment.
2. Be sure to reference the ANSI A119.2 NFPA 501C Standards Manual for information regarding the Fuel Distribution's System (i.e., the Fuel Lines that will be used to supply and return Diesel Fuel to and from the Aqua-Hot's Diesel-Burner)

- B. Excessive fuel head pressure should be avoided (head should not exceed 2').
- C. Use 1/4" I.D. fuel lines.
- D. The combined length of the fuel line (supply and return) should not exceed 66 feet.

### Exhaust System

#### 4.21 Installing the Diesel-Burner's Fuel Lines

- A. Run both fuel lines (1/4" ID) from the fuel tank ports to the Aqua-Hot.
- B. Both fuel lines should be laid as flat as possible and any extreme rises in height should be avoided (to eliminate any potential air traps).
- C. Run both fuel lines in areas where they cannot be pinched off, kinked, or damaged under normal operating conditions.



**CAUTION:** A kinked return fuel line will create a hazardous fuel pressure and may cause the line to rupture.

**WARNING:** Never check for fuel leaks with an open flame.

- D. **Label** both fuel lines indicating whether a **supply** or **return** line.
- E. Be sure to fasten down all fuel lines where necessary and apply protective shielding in areas where chafing may occur.

## SECTION 4: INSTALLATION PROCEDURES

### Installing Fuel Lines, continued

### Fuel Tank Diagrams

- F. Install and clamp the supply line to the Aqua-Hot's fuel filter, see Figure 2.
- G. Install and clamp the return line to the return fuel pipe located beneath the diesel burner, see Figure 2.

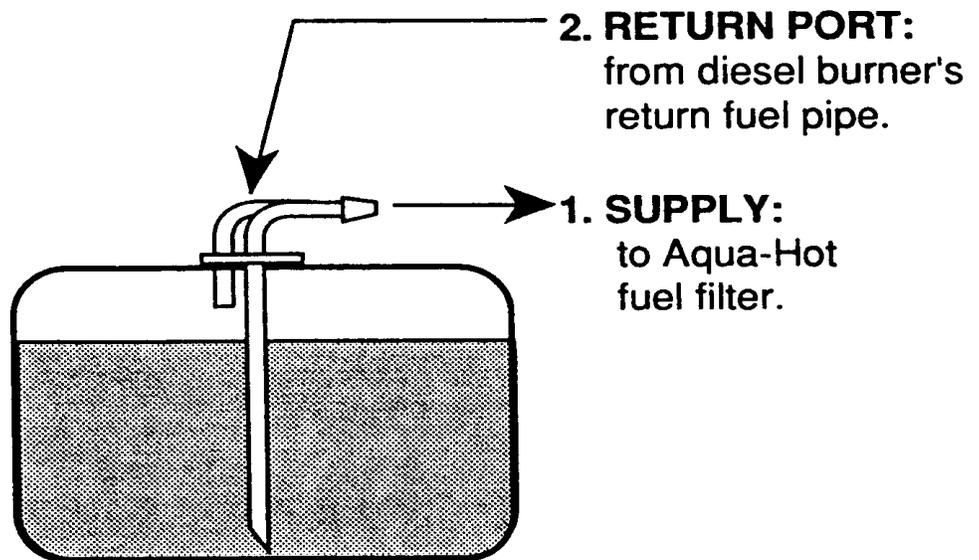


Figure 21

### Exhaust System

#### 4.22 Installing The Aqua-Hot's 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 addition the exhaust must not terminate beneath the vehicle or beneath an openable window or vent. Refer to "Internal Combustion Engine Exhaust" section in the RVIA Standards Manual for additional exhaust information.

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

## SECTION 4: INSTALLATION PROCEDURES

### Exhaust System, continued

- B. Run the exhaust pipe to the rear or to the driver's side of the vehicle so exhaust fumes **cannot** enter any passenger compartment.

**NOTE:** Should the exhaust pipe exit out the side of the vehicle be sure that it is angled towards the rear so that while in motion the exhaust will naturally move away from the vehicle and towards the rear.

- C. From the Aqua-Hot's 1-1/4" FNPT exhaust port, use 1-1/4" I.D. pipe for lengths up to 4 feet. For lengths exceeding 4 feet, use 1-1/2" I.D. pipe.

**NOTE:** If installing solid pipe be sure to use "Black Pipe". Do not use galvanized pipe.

- D. Total length of exhaust pipe should not exceed 12'.  
E. A maximum of 180 degrees worth of bends is allowed.  
F. A condensation drain must be provided by drilling a small hole (approximately 1/8" diameter) at the exhaust pipe's lowest point, or by sloping the exhaust pipe away from the Aqua-Hot.

### Installing The Expansion Tank

#### 4.23 Installing The Aqua-Hot's Expansion Tank

The chosen mounting location should allow for easy access and visualization of the expansion tank.

**NOTE:** The expansion tank can be located above or below the level of the fill cap, see Figures 2 and 15.

1. Fasten the expansion tank's neck clamp and attach tank.
2. Install overflow tubing from the expansion tank to the Aqua-Hot's filler neck overflow tube, see Figure 15.
3. Connect and clamp the overflow tubing to the expansion tank.

**NOTE:** Do not connect the overflow tubing to the Aqua-Hot's filler neck overflow tube until the interior heating system has been completely bled, Step 4.24.

### System Bleeding

#### 4.24 Bleeding The Interior Heating System

- A. Locate the Aqua-Hot's drain valve, located beneath the diesel burner, see Figure 2. Install a short piece (approx. 4 inches long) of 5/8" heater hose onto it, extending through the floor. Please note that the heater hose can remain on the Aqua-Hot as a permanent part.
- B. Place a 5 gallon bucket underneath the heater hose.

**NOTE:** Be sure to check that the drain valve is completely closed.

## SECTION 4: INSTALLATION PROCEDURES

### System Bleeding, continued

- C. Remove the Aqua-Hot's fill cap and pour in 15 gallons of a 50/50 solution of water and antifreeze, see Figure 2.

**NOTE:** VSI recommends using an antifreeze with the following additives:

**Rust inhibitor formula:** will help prevent rust formation in the Aqua-Hot's heat tank.

**Low silicate formula:** will help protect against pitting and scale formulation in the Aqua-Hot's heat tank.

**Coolant stabilizer formula:** will help maintain proper heat transfer characteristics as well as help prevent the formation of gel deposits.

- D. Place the fill cap back onto the Aqua-Hot and tighten.
- E. Close both pump and return manifold valves, see Figure 15.
- F. Pressurize the system by applying air pressure to the fill neck overflow tube, see Figure 15. Pressurize until the pressure release tab releases (blows out the excess air pressure).
- G. Open the pump manifold valve (upper valve). This will allow the solution to enter into the heating system (i.e. zone pumps, heat exchangers and plumbing lines).
- H. Slowly open the **drain valve** allowing air to escape.
- I. Close drain valve first, then close pump manifold valve.
- J. Continue Steps C.-I. until all air has been bled from the heating system.

**NOTE:**

1. Depending on the plumbing lines diameter and total length it may be necessary to repeat Steps C. through I. several times before any of the solution appears.
2. Be sure to close both the drain valve and pump manifold valve each time that the heat tank is refilled and pressurized.
3. Make sure that the Aqua-Hot's heat tank has a **minimum** of 11 gallons of solution in it at all times while bleeding the heating system. If the capacity should drop below the 11 gallon minimum, air will enter back into the heating system and the bleeding process will need to be repeated.
4. It may be necessary to bleed each heating zone and/or heat exchanger individually. Contact VSI at 303-857-2901 for assistance.

## SECTION 3: AQUA-HOT INSTALLATION PROCEDURES

### System Bleeding, continued

- K. Once all air has been bled from the system, be sure that both the return manifold valve (lower valve), located on the left side of the diesel burner and the pump manifold valve are completely opened, see Figures 2 and 15.
- L. Once all air has been bled from the system, be sure to connect and clamp the overflow tubing to the Aqua-Hot's filler neck overflow tube, see Figure 15.
- M. Once all air has been bled from the system, be sure to permanently fasten all heat exchangers into place (including Bay heat exchanger).

### Bleeding Engine Preheat System

#### 4.25 Bleeding The Engine Preheating System

- A. Check engine coolant and add more if necessary.
- B. Start and run the engine until it reaches normal operating temperature.
- C. Switch engine off.
- D. Again, check engine coolant and add more if necessary.

### DC Power Installation



#### 4.26 Installing DC Power To The Aqua-Hot

##### **WARNING:**

1. **Do not** activate the Aqua-Hot's diesel burner until the solution of water and antifreeze has been added to the Aqua-Hot's heat tank, and the heating system has been completely bled. Operating the Aqua-Hot diesel burner without the 50/50 solution of water and antifreeze will cause **serious damage** to the heater.
2. **Do not** connect DC power to the Aqua-Hot if the vehicle requires additional electrical welding. Electrical welding will cause **serious damage** to the diesel burner's control unit.

**NOTE:** All electric installations, systems, and equipment must comply with Article 551, Part A and other sections of NFPA 70, "National Electrical Code."

- A. Run two 10 gage wires (different colors) from the vehicle's batteries to the Aqua-Hot's fuse block, see Figures 2 and 18.

**NOTE:** If the combined length of the two wires is in excess of 35 feet, use 8 gage wire if less than 35 feet, use 10 gage wire, see Chart 2 on page 37. Note that under full load, at 12 volts, the Aqua-Hot draws approximately 11 amps of current, excluding heat exchanger(s) amperage draw .

## SECTION 3: AQUA-HOT INSTALLATION PROCEDURES

### DC Power Installation, continued

- B. Crimp an electrical connector (5/16" ring type) to the ground (negative) wire, and connect to the Aqua-Hot's ground post, see Figure 18.
- C. Connect the power (positive) wire into the DC power post on the Aqua-Hot's fuse block, see Figure 18.
- D. Connect both power and ground wires to the vehicle batteries.

**NOTE:** Be sure to protect against accidental shorting by placing an in-line fuse (25 amp) to the power wire at the battery.

### AC Power Installation



#### 4.27 Installing AC Power To The Aqua-Hot's Electric Heating Element

**WARNING:** Do not activate the Aqua-Hot's electric heating element until the solution of water and antifreeze has been added to the Aqua-Hot's heat tank and the heating system has been completely bled. Operating the Aqua-Hot diesel burner without the 50/50 solution of water and antifreeze will cause serious damage to the heater.

**NOTE:** All electric installations, systems, and equipment must comply with Article 551, Part A and other sections of NFPA 70, "National Electrical Code."

- A. Run a 12-2 (with ground) ROMEX wire from a fused (15 amp breaker required) 110 volt AC power supply to the Aqua-Hot's AC Service Cover, see Figure 2.
- B. Remove the service cover and connect the 110 volt AC power supply to the Aqua-Hot's electric heating element, see Figure 22.

### Electric Heating Element Wiring

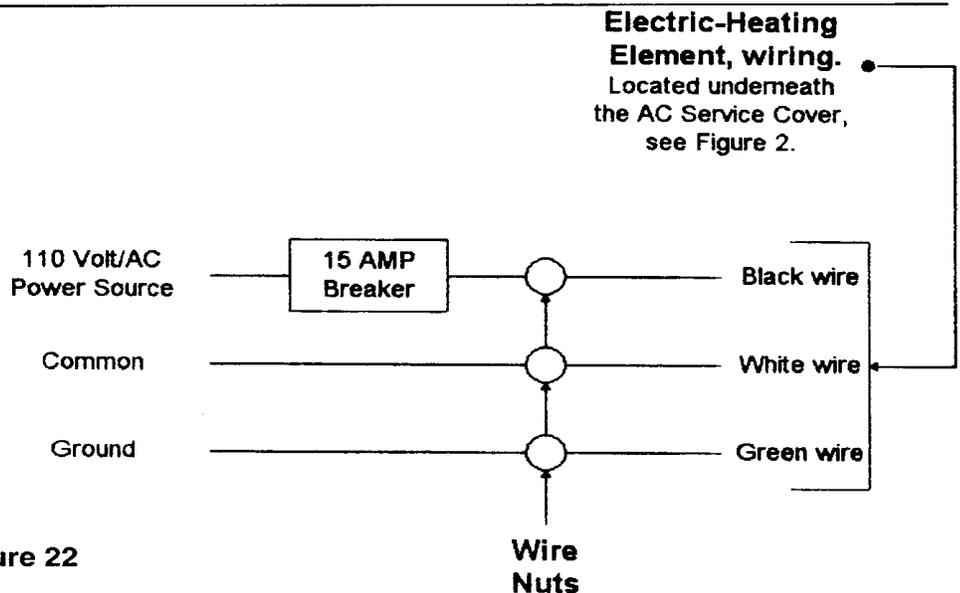


Figure 22

## SECTION 3: AQUA-HOT INSTALLATION PROCEDURES

### Turning On System

#### 4.28 Turning On The System For The First Time

1. Turn the Aqua-Hot's control switch to ON. Count to five, and then turn the control switch OFF. This will bleed/purge the diesel-burner's fuel system of air/dirt particles. Perform this procedure twice.

**NOTE:** Each time the control switch is activated the diesel-burner's electric motor will operate for three minutes. Allow electric motor to operate for the full three minutes each time. This will operate the diesel-burner's fuel pump as well.

2. Turn the control switch ON. This procedure will activate the diesel-burner and indicator light. Please note that it will take approximately 30 seconds for the diesel-burner to ignite.
3. Allow 20-30 minutes for the system to reach operating temperature.
4. Activate the 110 volt/AC power source. This will supply power to the Aqua-Hot's electric heating element.

**NOTE:** Both the diesel-burner and electric heating element are thermostatically controlled. Either or both heating source will automatically maintain the temperature of the Aqua-Hot's 50/50 solution of water and antifreeze between 175-195 ° F. (Starting with Aqua-Hot serial number 94180 and higher, the solution of water and antifreeze temperature will now be maintained between approximately 180-205 ° F.

5. Once the system has reached operating temperature, turn all thermo stats to their highest temperature setting. This activates the zone relays which automatically supply power to the heat exchanger(s) in each particular heating zone.
6. Open/close all hot water faucets, one at a time, until hot water is present.

**CAUTION:** Initial domestic hot water maybe extremely HOT!



# SECTION 3: AQUA-HOT INSTALLATION PROCEDURES

■ Chart 2

## 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

12 Volts - 3% Drop Wire Sizes (gage) — Based on Minimum CM Area																			
	10	15	20	25	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
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																			
	10	15	20	25	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
5	18	18	16	16	14	12	12	12	10	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	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				

# Vehicle Systems

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