



Avenger® Series

Installation, Operation and Service Manual

Gas Fired Commercial Condensing Stainless Steel Boilers
Hydronic Heating Models ARH1000 thru ARH4000
Hot Water Heater Models ARW1000 thru ARW4000



WARNING

If the information in these instructions is not followed exactly, a fire or explosion may result causing property damage, personal injury or death.

WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance,
- Do not touch any electrical switch; do not use any phone in your building,
- Immediately call your gas supplier from a neighbour's phone. Follow the gas supplier's instructions,
- If you cannot reach your gas supplier, call the fire department.

A Qualified installer, service agency or the gas supplier must perform installation and service.

WARNING

Do not store or use gasoline or other flammable vapours and liquids in the vicinity of this or any other appliance.

TO THE INSTALLER: After installation, these instructions must be given to the end user or left on or near the appliance.

TO THE END USER: This booklet contains important information about this appliance. Retain for future reference.

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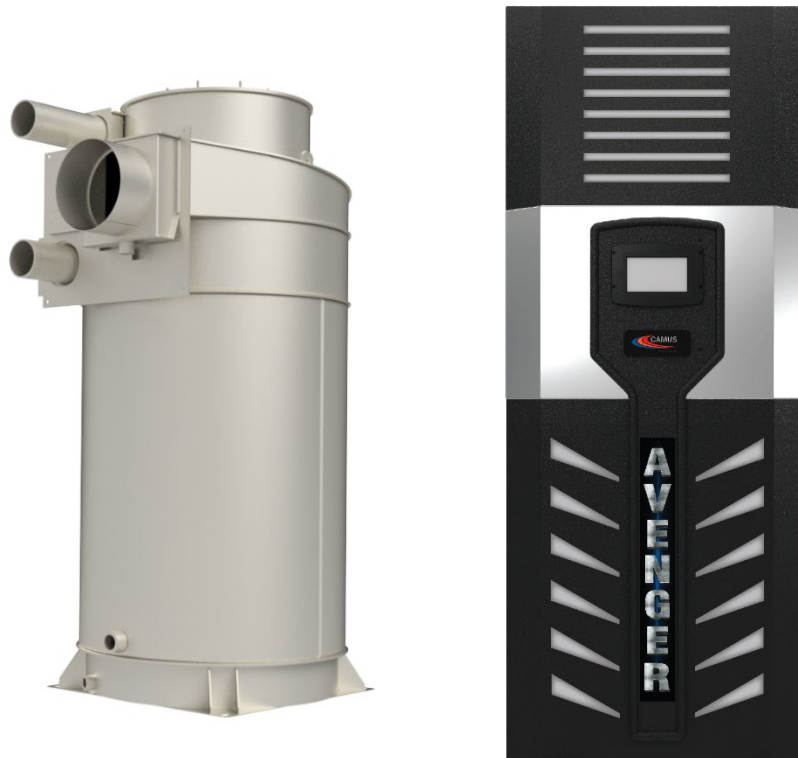
PART 1 GENERAL INFORMATION

1.1 INTRODUCTION

The Avenger is a condensing, forced draft, fire tube boiler and water heater utilizing a premix power burner based on a push through design which offers several venting options. Heat output is controlled by air/gas ratio control gas valves which provide seamless modulation. The Avenger provides central heating or domestic hot water at working pressures up to 160 PSI. It is designed for use with a pumped and pressurized system. The boiler/water heater will automatically modulate to provide heat outputs between 100% and the minimum input.

All Avenger models use two automatic gas valves - one at the low end and one at the high end. The High-End Gas Valve works on the principle of differential pressure. Operation of the fan along with modulating air actuator, generates a differential air pressure, which the air/gas ratio control gas valve matches on the gas side. The steady state efficiency is maintained across the entire range of modulation. Air and gas are metered in precise proportion (1:1 Ratio) to modulation signal, allowing combustion characteristics, which determine efficiency, to remain the same over the entire operating range. The Low-End Gas Valve works on the principle of negative pressure.

Figure 1: Avenger Heat Exchanger and Complete Unit



1.2 SPECIAL INSTRUCTIONS TO OWNER

This installation and service manual supplies information for the installation, operation and servicing of the appliance. It is strongly recommended that this manual be reviewed completely before proceeding with an installation.

CAUTION

It is important that all gas appliances are installed by a qualified installer/technician that is trained by *Camus Hydronics Limited*. It is in your own interest and that of safety to ensure that all local codes, and all the following "NOTES" and "WARNINGS" are complied with. Installing, servicing or adjusting this appliance should be performed only by a qualified installer/technician that is trained by *Camus Hydronics Limited*. The serviceman must utilize a combustion analyzer with CO₂, CO, and draft gauge to set the appliance according to *Camus Hydronics Limited's* recommendations, prior to commissioning.

NOTE

RETAIN THIS MANUAL FOR FUTURE REFERENCE

1.3 CHECKING EQUIPMENT

Check for signs of shipping damage upon receiving equipment. Pay attention to parts accompanying the boiler, which may show signs of mishandling. Verify total number of pieces shown on packing slip with those received. In case there is damage or a shortage, immediately notify carrier.

Figure 2: Checking the Avenger Unit



Do not attempt to pry any panels off. To begin disassembly, you can remove the top panel and side panels without the use of any tools.

Once you have removed the top panels, carefully check and confirm that all 1/4" copper tubing connections are intact and have not broken or loosened in shipment. Leaks at any connections on these lines will result in erratic appliance operation.

1.4 SEQUENCE OF OPERATION

1. Supply power connection as per Table 9.
2. The power switch is placed in the "ON" position.
3. 120 VAC power is supplied to the control transformer.
4. 24 VAC is supplied to the ignition module and low voltage controls.
5. After the appliance water pump starts, flow is proven by the Flow Switch and Water Pressure Switch. The Water Pressure Switch is set to 12 PSI or higher and is installed inside the unit's jacket. The Flow Switch is mounted at the outlet of the appliance. If installing a Flow Switch, it is required to properly trim the Flow Switch Paddles in order not to jam the switch in the tee. The normally open dry contacts in the Low Water Cutoff (LWCO) are to be wired in series with the normally open contacts of the Flow Switch. Locate the probe type LWCO in the piping above the boiler inlet/outlet connection. In all cases, check with local codes.
6. The Avenger controller receives a call for heat via the remote operator contacts and the Demand parameter reads Central Heating, DHW, or Lead Lag Slave.
7. The Avenger controller closes the pump contacts to start the pump, which then causes the Flow Switch to close once minimum flow is reached. If all limit controls are made including temperature, water pressure and water flow, the controller closes the blower contacts to initiate the variable frequency drive (VFD) and allows 60 seconds for VFD to ramp up the frequency to the 3 phase motor of the Combustion Fan using the modulating signal provided by the on board modulating control or the remote operating system. If the Low Air Switch contacts are made within the 60 seconds, the VFD will run at Pre-Purge speed until the Pre-Purge timer is satisfied.
8. Once the Pre-Purge Timer is satisfied, the Avenger controller will target the ignition fan speed.
9. **a) AR1000 – AR2500 (Direct Ignition):** The Avenger controller will activate the Hot Surface Igniter for 28 seconds followed by energizing the Low-End Gas Valve. A signal of 0.8 Vdc minimum must be recognized by the controller at the UV Scanner to keep the Low-End Gas Valve in the open position. The fan is kept at ignition speed until the flame is stabilized. As demand

increases the modulation signal causes the Low-End Gas Valve to draw more gas. If the Low-End Gas Valve cannot satisfy demand, at a preset point the staging relay activates the Hot Surface Igniter to provide seamless transition to the High-End Gas Valve. The fan inlet damper opens and directs power to the High-End Gas Valve while shutting off the Low-End Gas Valve. As target temperature is approached, the demand signal is reduced and at a pre-set point the hot surface igniter is activated, the High-End Gas Valve shuts off and the Low-End Gas Valve is energized. At the same time the fan inlet damper is closed. As demand continues to decrease the Low-End Gas Valve shuts off and the boiler proceeds to post purge.

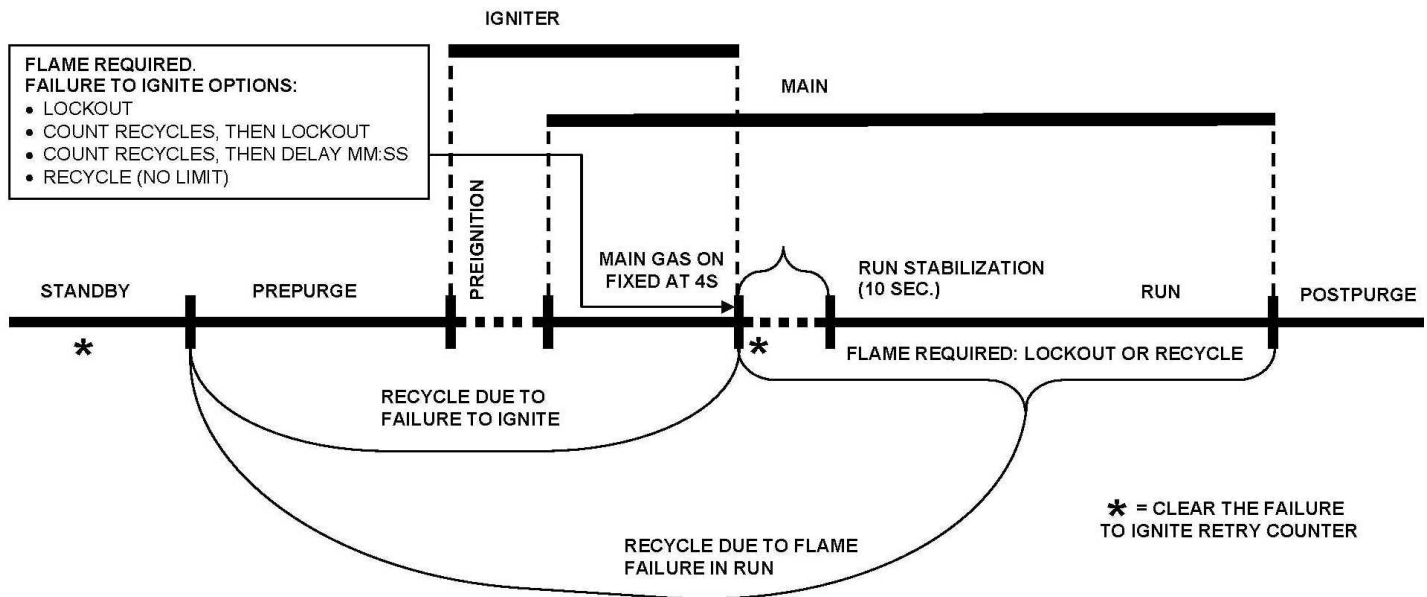
b) AR3000 - AR4000 (Proven Pilot): The Avenger controller will activate the Hot Surface Igniter for 22 seconds followed by energizing the Pilot Valve for 10 seconds, whereupon a signal of 0.8 Vdc must be recognized by the controller at the UV Scanner to keep the Pilot Valve in an open position. The fan is kept at ignition speed until the stabilization timer is satisfied. After the stabilization timer expires the Low-End Gas Valve is opened and the Pilot Valve is deactivated. As demand increases, the modulation signal causes the Low-End Valve to draw more gas and the sequence as detailed in (a) above is followed.

10. If the flame signal is not reached, the module will stop the ignition sequence after the "Main Gas On" period & recycle.
11. The fan speed will slowly decrease as the temperature nears the target. The modulation rate is controlled via a 4-20 mA signal. If the heat demand is sustained without change, the boiler firing rate will reach a point of steady-state and the fan will rotate at constant speed.
12. When the heat demand is satisfied or the remote enable is removed, the burner will shut off and the fan speed will ramp up to the preset Post-Purge speed until the Post-Purge timer is satisfied.
13. The pump continues to circulate until the Post-Purge time is satisfied.
14. The boiler will then go into Standby as it waits for the next heat demand or remote enable.

NOTE

The Hot Surface Igniter is energized with 115V AC when control is switching to/from the High-End Gas Valve to the Low-End Gas Valve. To avoid shock do not contact bare Ignitor wires at this time

Figure 3: Avenger Ignition Cycle



NOTE:

1. If a flame signal is detected at the end of the Pre-Purge period, an error will occur.
2. If at the end of the safety period (4 sec) no flame is detected, the control will go to Post-Purge to remove the unburned gas. After this, a re-ignition attempt is started following the same cycle. The number of re-ignition attempts is limited to 2 after which a lockout occurs.
3. The burner can only be ON continuously for a period of 24 hours. After this, the burner is switched OFF and a restart sequence follows.
4. The Hot Surface Igniter is de-energized at the end of the ignition period to allow for ionization detection.

1.4.1 HEAT TRANSFER PROCESS

1. Burner input rate continues to increase until water temperature reaches the set point temperature.
2. Burner input rate may stabilize at a fixed rate when demand equals input.
3. Burner input rate will decrease when water temperature approaches temperature set point.

1.4.2 END OF SEQUENCE

1. Set point temperature is reached.
2. Power to the gas valve is turned off.
3. Combustion air fan ramps to a stop over the factory pre-programmed time period.
4. Thermostat is now in a standby mode waiting for the next "Call for Heat".

WARNING

To minimize the possibility of serious personal injury, fire or damage to your appliance, never violate the following safety rules.
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WARNING

IMPROPER INSTALLATION, ADJUSTMENT, ALTERATION, SERVICE OR MAINTENANCE can cause injury or property damage. Refer to this manual. For additional information, consult a qualified installer, service agency or gas supplier.

WARNING

Do not use this appliance if any part of it has been under water . The possible damage to a flooded appliance can be extensive and present numerous safety hazards. Any appliance that has been under water must be replaced.

WHAT TO DO IF YOU SMELL GAS

Do not try to light any appliance. Do not touch any electric switch. Do not use any phone in your building. Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions. If you cannot reach your gas supplier, call the fire department.
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IMPORTANT

Consult and follow local Building and Fire Regulations and other Safety Codes that apply to this installation. Contact the local gas utility company to authorize and inspect all gas and flue connections.

Installation and service must be performed by <i>Camus Hydronics Limited</i> qualified factory trained service technicians.
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WARNING

Should overheating occur or the gas supply fails to shut off, DO NOT turn off or disconnect the electrical supply to the pump. Shut off the gas supply at a location external to the appliance.
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Boilers and water heaters are heat producing appliances. To avoid damage or injury, do not store materials against the appliance or the vent-air intake system. Use proper care to avoid unnecessary contact (especially children) with the appliance and vent-air intake components.

- Never cover your appliance, lean anything against it, store trash or debris near it, stand on it or in any way block the flow of fresh air to your appliance.
- **UNDER NO CIRCUMSTANCES** may flammable materials such as gasoline or paint thinner be used or stored in the vicinity of this appliance, vent-air intake system or any location from which fumes could reach the appliance or vent-air intake system.
- A gas appliance that draws combustion air from the equipment room where it is installed must have an adequate supply of fresh air circulating around it during burner operation for proper gas combustion and proper venting.

1.5 CODES

The equipment shall be installed in accordance with those installation regulations enforced in the local area where the installation is to be made. These shall be carefully followed in all cases. Authorities having jurisdiction shall be consulted before installations are made. In the absence of such requirements, the installation shall conform to the latest edition of the National Fuel Gas Code, ANSI Z223.1 and/or CAN/CGAB149 Installation Code. All electrical wiring must be done in accordance with the requirements of the authority having jurisdiction or, in the absence of such requirements, with National Electrical Code, ANSI/NFPA70 and/or the Canadian Electrical Code part 1 CSA C22.1. Where required by the authority having jurisdiction, the installation must conform to the American Society of Mechanical Engineers Safety Code for Controls and Safety Devices for Automatically Fired Boiler, ANSI/ASME CSD-1. All boilers conform to the latest edition of the ASME Boiler and Pressure Vessel Code, Section II & IV. Where required by the authority having jurisdiction, the installation must comply with the CSA International, CAN/CGA-B149 and/or local codes. This appliance meets the safe lighting performance criteria with the gas manifold and control assembly provided, as specified in the ANSI standards for gas-fired units, ANSI Z21.13 & ANSI Z21.10

1.6 WARRANTY

- Factory warranty (shipped with unit) does not apply to units **improperly installed** or **improperly operated**.
- Factory warranty shall apply only when the appliance is installed in accordance with local plumbing and building codes, ordinances and regulations, the printed instructions provided with it and good industry practices.

- Excessive **water hardness** causing a lime build-up on the stainless steel tubes is not a fault of the appliance and is not covered by warranty. Consult the factory for recommendations for use in hard water areas (See Water Treatment and Water Chemistry).
- Factory warranty does not apply to units damaged by using **low water pressure** (below 15 psi).
- Factory warranty does not apply to units damaged by using **low water flow** causing **excessive temperature rise** (above 60°F).
- Factory warranty does not apply **to improper water/glycol mixture**.
- **Excessive cycling** of the unit will reduce the life of the heat exchanger and its components. Factory warranty does not apply to units damaged by using improper control parameters (such as PID) which cause excessive cycling of units.
- Using or storing **corrosive chemicals** in the vicinity of this appliance can rapidly degrade the stainless steel tubes and voids warranty.
- Damage caused by **freezing or dry firing** voids warranty.
- This appliance is not to be used for **temporary heating** of buildings under construction.
- The manufacturer shall **NOT** be held liable for any personal injury or property damage due to ice formation or the dislodging of ice from the vent system or the vent termination.

1.7 REMOVAL OF EXISTING APPLIANCE

When an existing appliance is removed from a common venting system, the common venting system is likely to be too large for proper venting of the appliances remaining connected to it. At the time of removal of an existing appliance the following steps must be followed with each appliance remaining connected to the common venting system placed in operation, while the other appliances remaining connected to the common venting system are not in operation.

- Seal any unused opening in the common venting system.
- Visually inspect the venting system for proper size and horizontal pitch and determine that there is no blockage, restriction, leakage, corrosion or other deficiency, which could cause an unsafe condition.
- Insofar as is practical, close all building doors and windows and all doors between the space in which the appliances remaining connected to the common venting system are located and other spaces of the building. If applicable, turn on the clothes dryers and any appliances not connected to the common venting system. Turn on any exhaust fans, such as range hoods and bathroom exhausts, so they will operate at maximum speed. Do not operate a summer exhaust fan. Close fireplace dampers.
- Place in operation the appliance being inspected. Follow the lighting instructions. Adjust thermostat so that the appliance operates continuously.
- If provided, test for spillage at the draft control device relief opening after 5 minutes of main burner operation. Use a cold mirror, the flame of a match, or candle or smoke from a cigarette.
- After it has been determined that each appliance remaining connected to the common venting system properly vents when tested as outlined above, return doors, windows, exhaust fans, fireplace dampers and any other gas-burning appliance to their previous condition of use.
- Any improper operation of the common venting system should be corrected so that the installation conforms to the National Fuel Gas Code, ANSI Z223.1/NFPA 54 and/or the Natural Gas and Propane Installation Code, CAN/CGA B149.1, Installation Codes. When resizing any portion of the common venting system, the common venting system should be resized to approach the minimum size as determined using the appropriate tables in Chapter 13 of the National Fuel Gas Code, ANSI Z223.1/NFPA 54 and/or the Natural Gas and Propane Installation Code, CAN/CGA B149.1, Installation Codes.

Heat exchanger surfaces and vent piping should be checked every six months for deterioration and carbon deposits. Remove all soot or other obstructions from chimney and flue, which might impede draft action. Replace any damaged or deteriorated parts of the venting system.

A qualified service technician should follow this procedure when inspecting and cleaning the heat exchanger and vent pipe.

1. Turn off electrical power and main gas shut-off and allow appliance to cool down.
2. Remove the vent pipe running to the chimney and check heat exchanger, vent and chimney for obstruction and clean as necessary.
3. Remove burner from appliance and carefully clean as required. Never brush or wipe the knitted metal fiber surface – use a garden hose and wash instead. **Caution: Never use a pressure washer to clean the burner.**
4. Use a pressure washer to clean heat exchanger, if necessary.
5. Reinstall parts removed in steps 2 and 3. Be sure that vent pipe has proper pitch and is properly sealed. Replace any damaged gasket. Note that the burner is supplied with two gaskets; a high temperature graphite coated ceramic paper gasket under the burner flange, and a stamped silicon gasket between the burner flange and fan flange. Tighten fan flange mounting nuts to 25 ft-lb (Models 1000-4000).
6. Restore electrical power and gas supply to appliance.
7. Place appliance in operation using lighting instructions provided.
8. Confirm proper operation of all safety devices.
9. Check for gas leaks and proper vent operation.

NOTE
Improper installation or system design, rather than faulty equipment, is the cause of most operating problems.

1.8 BOILER ROOM OPERATING CONDITION

- Due to low jacket losses from the appliance, temperatures in a typical boiler room may drop significantly; supplemental heat is required to maintain ambient temperature at acceptable levels.
- Camus Avenger boilers are required to be vented as a Category II or IV condensing appliance.

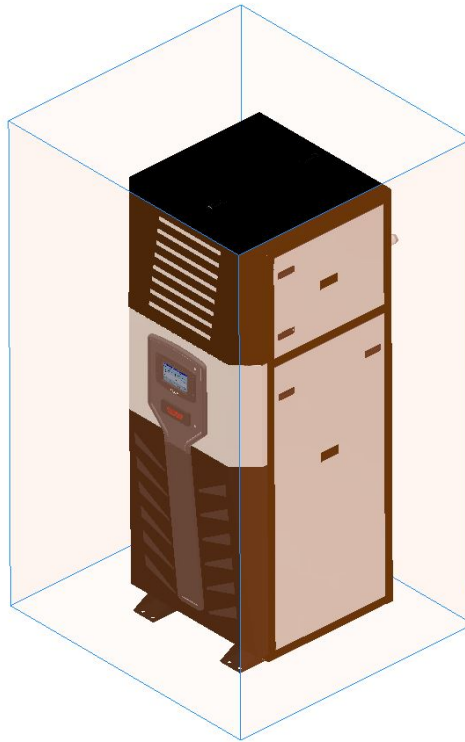
1.9 CLEARANCE FROM COMBUSTIBLE MATERIAL

This appliance is suitable for alcove (a closet without a door) installation with minimum clearances to combustibles as follows:

Table 1: Clearance from Combustibles

Clearance from Combustibles			
TOP	12"	REAR	12"
SIDES	12"	VENT	1"

Figure 4: Clearance from Combustibles



The boiler must not be installed on carpeting.

Note: Clearances from combustible construction are noted on the appliance rating plate. Maintain minimum specified clearances for adequate operation. All installations must allow sufficient space for servicing the vent connections, water pipe connections, circulating pump, bypass piping and other auxiliary equipment, as well as the appliance.

Table 2: Servicing Clearances

Model	Service Clearances				
	Top*	Right Side	Left Side	Back	Front
1000	24" (60cm)	12" (30cm)	12" (30cm)	24" (60cm)	24" (60cm)
1500	24" (60cm)	12" (30cm)	12" (30cm)	24" (60cm)	24" (60cm)
2000	24" (60cm)	12" (30cm)	12" (30cm)	24" (60cm)	24" (60cm)
2500	24" (60cm)	12" (30cm)	12" (30cm)	24" (60cm)	24" (60cm)
3000	24" (60cm)	12" (30cm)	12" (30cm)	24" (60cm)	24" (60cm)
3500	24" (60cm)	12" (30cm)	12" (30cm)	24" (60cm)	24" (60cm)
4000	24" (60cm)	12" (30cm)	12" (30cm)	24" (60cm)	24" (60cm)

* 24" is recommended for service clearances on top. This clearance can also be reduced to 12" in more confined spaces, where it is difficult to leave 24" clearance on top. In such situation, top panels and frames can be removed in order to service the blower assembly and burner assembly.

1.10 INSTALLATION PROCEDURE AND LOCATION OF UNIT

Install this appliance in a clean, dry location with adequate air supply.

- Do not locate this appliance in an area where it will be subject to freezing unless precautions are taken. Radiant losses from the Avenger are minimal and should not be relied on to keep the appliance room warm.
- The appliance should be located close to a floor drain in an area where leakage from the appliance or connections will not result in damage to the adjacent area or to lower floors in the structure. **It is recommended that a suitable drain pan, adequately drained, be installed under the unit.** Under no circumstances is the manufacturer to be held responsible for water damage in connection with this unit, or any of its components.
- If the appliance is installed above the level of the buildings radiation system, a Low Water Cut-Off device must be installed above the heat exchanger inlet/outlet connections. Some local codes require the installation of a low water cut-off on all systems.
- When placing the appliance be aware that a minimum clearance of 24" must be provided at the front to allow easy access to the heat exchanger.
- The appliance must be installed so that the ignition system components are protected from water (dripping, spraying, etc.) during appliance operation and service (circulator replacement, control replacement, etc.)
- Appliances located in a residential garage or in adjacent spaces that open to the garage and are not part of the living space of a dwelling unit, must be installed so that all burners and burner ignition devices have a minimum clearance of not less than 18" (46 cm) above the floor. The appliance must be located or protected so that it is not subject to physical damage by a moving vehicle.
- DO NOT install this appliance in any location where gasoline or flammable vapors are likely to be present.
- **Appliance must be installed on a level floor.** Maintain required clearances from combustible surfaces.
- Indoor models must be installed indoors where it is protected from exposure to wind, rain and weather.
- Outdoor models must be installed outdoors. For outdoor installations, always consider the use of a shelter such as a garden shed to prevent direct exposure of the appliance. The additional protection afforded by the shelter will help to minimize nuisance problems with electrical connections and will allow easier servicing of the appliance under severe weather conditions.

1.11 SPECIFICATIONS AND DIMENSIONAL DATA

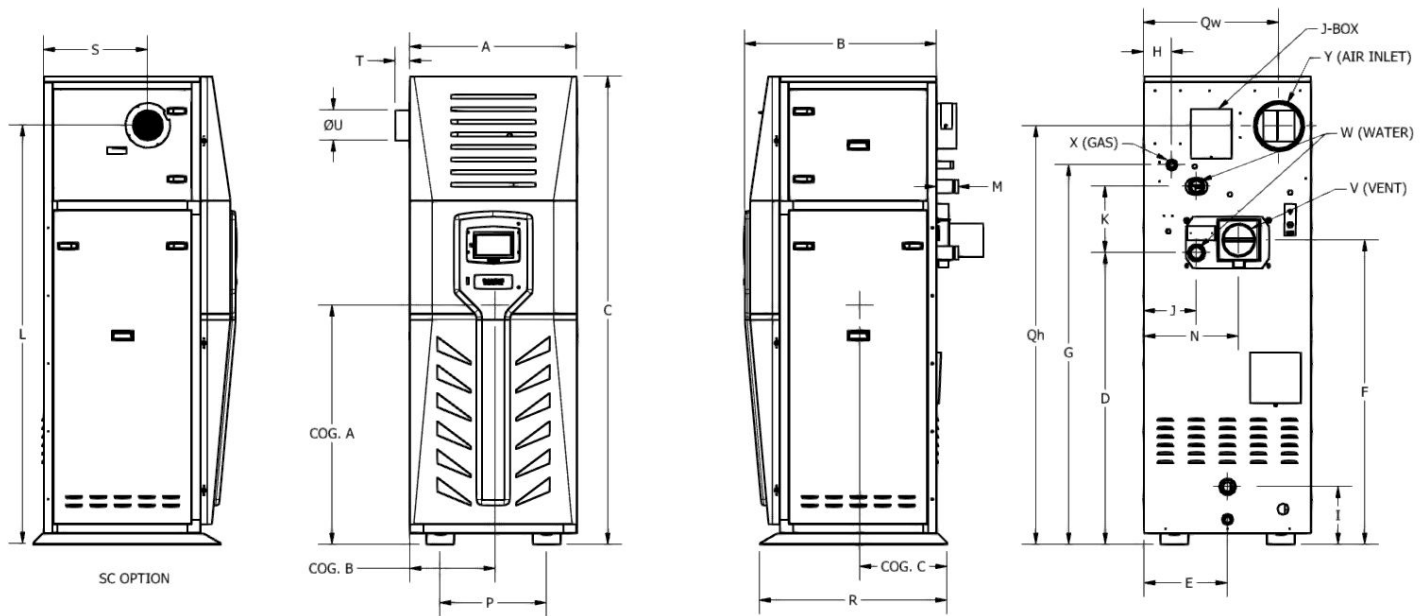


Table 3: Appliance Dimensions and Specifications

Model	A (in.)	B (in.)	C (in.)	D (in.)	E (in.)	F (in.)	G (in.)	H (in.)	I (in.)	J (in.)	K (in.)	*L (in)	COG (A)	COG (B)
1000	29 1/2	34	83	51 1/2	14 7/8	53 7/8	67 1/8	5	10 1/4	9 3/8	11 3/4	74 1/8	40	14 1/2
1500	29 1/2	38	83	52 3/8	14 7/8	55 1/4	68 1/2	3	10 7/8	8 1/8	10 1/2	74	38 1/2	15
2000	35	44	90	52 7/8	17 1/2	57 1/4	72 1/2	4 1/2	10	10 1/8	13 1/4	78 1/2	42	17.75
2500	35	44	90	52 7/8	17 1/2	57 1/4	72 1/2	4 1/2	10	10 1/8	13 1/4	78 1/2	42	17.75
3000	35	44	90	52 7/8	17 1/2	57 1/4	73 1/2	5 1/2	10 1/4	9	13	79 1/8	55	18.5
3500	35	44	99	53 3/8	17 1/2	60	77	3 3/4	10	8 1/2	16	83 1/4	43	18
4000	35	44	99	53 3/8	17 1/2	60	77	3 3/4	10	8 1/2	16	85 1/4	43	18

Model	COG (C)	M (in.)	N (in.)	P (in.)	Qw (in)	Qh (in)	R (in.)	*S (in.)	*T (in.)	U (in.)	W (in.) Ø Water	X (in.) Ø Gas	Y (in) Ø air	Weight (lbs)
1000	13.5	3 7/8	16 7/8	18 7/8	24	74	33 1/4	18 1/2	2 1/2	5 3/8	2	1	8	1180
1500	15	4	17 7/8	19 3/8	23 3/8	74	36 1/2	20 1/2	2 1/2	5 3/8	2 1/2	1 1/4	10	1530
2000	17	4	20	24	28	81	42 1/2	23 1/4	3	5 3/8	3	1 1/4	12	2085
2500	17	4	20	24	28	81	42 1/2	23 1/4	3	7 5/16	3	1 1/2	12	2150
3000	20	4	20	24	28	81	42 1/2	24 1/8	3 1/2	7 5/16	3	1 1/2	12	2400
3500	17	6 1/2	20 1/2	24	27	90	42 1/2	24	4	7 5/16	4	2	12	2520
4000	17	6 1/2	20 1/2	24	27	90	42 1/2	24 1/2	4	7 5/16	4	2	12	2620

*Direct Vent/Sealed combustion option COG-Center of Gravity

Model	Required Ø for up to 100 ft. equiv. length for Direct Venting (in)	Vent connection Ø, as shipped (in)	Required Category IV, vent Ø up to 100 ft. equiv. length (in)	Required Category II vent Ø (in)	Blower air inlet Ø (in)
AR(N,P)-1000	6	6	6	7	5 3/8
AR(N,P)-1500	6	8	7	8	5 3/8
AR(N,P)-2000	8	9	8	10	5 3/8
AR(N,P)-2500	8	9	9	10	7 5/16
AR(N,P)-3000	10	10	9	10	7 5/16
AR(N,P)-3500	10	10	10	12	7 5/16
AR(N,P)-4000	10	10	10	12	7 5/16

Table 3A: Input / Output

Model	Input MBH		Gross Output MBH	Turn-Down
	Max	Min		
ARN-1000	1000	47	945	21:1
ARP-1000	1000	100	945	10:1
ARN-1500	1500	60	1,416	25:1
ARP-1500	1500	150	1,416	10:1
ARN-2000	2000	80	1,886	25:1
ARP-2000	2000	200	1,886	10:1
ARN-2500	2500	100	2,355	25:1
ARP-2500	2500	250	2,355	10:1
ARN-3000	3000	120	2,841	25:1
ARP-3000	3000	300	2,841	10:1
ARN-3500	3500	140	3,325	25:1
ARP-3500	3500	350	3,325	10:1
ARN-4000	4000	160	3,748	25:1
ARP-4000	4000	400	3,748	10:1

Table 3B: Water Content

Model	Volume (Gallon)
AR(N,P)-1000	55
AR(N,P)-1500	68
AR(N,P)-2000	96
AR(N,P)-2500	96
AR(N,P)-3000	107
AR(N,P)-3500	120
AR(N,P)-4000	120

Table 3C: Minimum Flow Rate at Maximum Fire Rate

Model	Flow (GPM)
AR(N,P)-1000	23.6
AR(N,P)-1500	35.4
AR(N,P)-2000	47.1
AR(N,P)-2500	58.8
AR(N,P)-3000	71.0
AR(N,P)-3500	83.1
AR(N,P)-4000	93.6

Based on maximum temperature rise of 80°F

Table 3D: Absolute Minimum Flow Rate

Model	Flow (GPM)
AR(N,P)-1000	7.9
AR(N,P)-1500	11.8
AR(N,P)-2000	15.7
AR(N,P)-2500	19.6
AR(N,P)-3000	23.7
AR(N,P)-3500	27.7
AR(N,P)-4000	31.2

PART 2 VENTING & AIR SUPPLY

DANGER

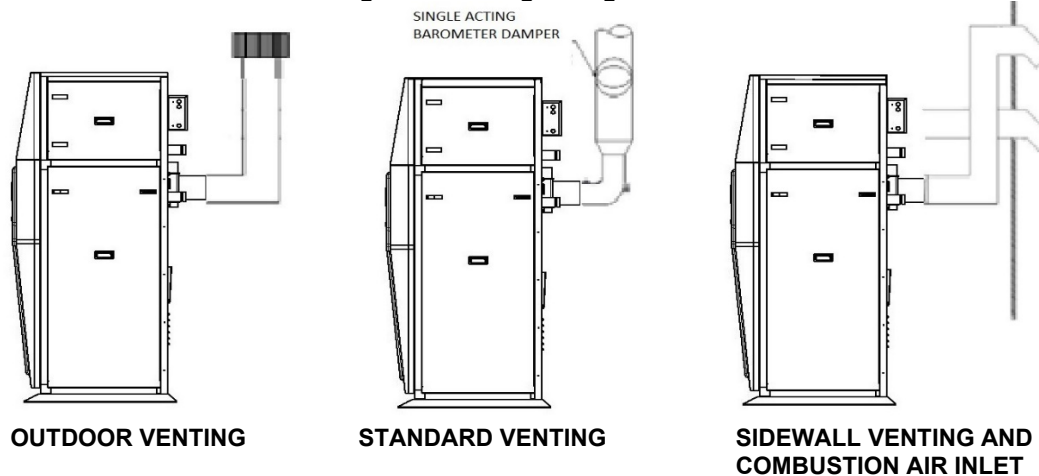
It is extremely important to follow these venting instructions carefully. Failure to do so can cause severe personal injury, death or substantial property damage.

DANGER

Use of cellular core PVC (ASTM F891), cellular core CPVC or Radel® (polyphenosulfone) in venting systems is prohibited

2.1 GENERAL VENTING GUIDE

Figure 5: Venting Configurations



- The Avenger may be vented with manufactured prefabricated UL/ULC listed vents of AL29-4C or 316L stainless steel or with plastic vent certified to UL/ULC S636, such as, IPEX System 636 CPVC or IPEX System 636 PP as permitted by local jurisdictions.
- The Avenger boiler must be vented and supplied with combustion and ventilation air as described in this section. Ensure that the venting and combustion air supply comply with these instructions regarding the vent system, air system, and combustion air quality.
- Vent installations for connection to gas vents or chimneys must be in accordance with Part 7, "Venting of Equipment" of the latest edition of the National Fuel Gas Code, ANSI Z223.1, in Canada, the latest edition of CAN/CGA Standard B149 Installation Codes for Gas Burning Appliances and Equipment or applicable provisions of the local building codes.
- The distance of the vent terminal from adjacent building, windows that open and building openings MUST comply with the latest edition of the National Fuel Gas Code, ANSI Z223.1, in Canada, the latest edition of CAN/CGA Standard B149 Installation Codes for Gas Burning Appliances and Equipment.
- Vent connection is made directly to the flue outlet opening on the back of the unit.
- For indoor installations, venting must be in accordance with Part 7, Venting of Equipment, of the National Fuel Gas Code, ANSI Z223.1, or Section 7, Venting of Equipment and Air Supply for Appliances, of the CAN/CGA B149, Installation Codes, or applicable provisions of the local building codes.
- Horizontal runs of vent pipe shall be securely supported (approximately every 4 feet) to prevent sagging and maintain a minimum upward slope of ¼" per foot from the appliance to the vent terminal.
- The weight of the venting system must not rest on the unit. Adequate support of the venting system must be provided in compliance with local codes and other applicable codes.
- All connections should be secured and sealed per the vent manufacturer's specifications. When a positive vent system is disconnected for any reason, the flue must be reassembled and resealed according to the vent manufacturer's instructions.
- Do not use an existing chimney as a raceway if another appliance or fireplace is vented through the chimney.
- This appliance shall not be connected to chimney flue serving a separate appliance, designed to burn solid fuel.

2.1.1 CATEGORY II AND CATEGORY IV VENTING

A Category II venting system operates with a negative pressure in the vent. A Category IV venting system operates with positive pressure generated by the internal combustion air fan which operates the combustion process and exhausts the flue products from the building.

- The Category II flues from multiple appliances can be combined into a common vent. This special venting system must be engineered by venting manufacturer and to be approved by local authority.
- The Category IV flues from multiple appliances **CAN NOT** be combined into a common vent.
- The Category IV flue must be a dedicated stack.
- The Category IV flue appliance must have all vent joints and seams sealed gas tight.
- The flue products in the vent system will be cooled below their dew point and will form condensate in the flue. Flue construction must be of AL29-4C, 316L Stainless, S636 CPVC, S636 PPE.
- The flue from a Category II and IV vent system must have a condensate drain with provisions to properly collect, neutralize and dispose of any condensate that may occur.

2.1.2 VENTING GUIDELINES FOR CATEGORY II AND/OR IV VENTING

- This installed length of the positive pressure flue from the appliance to the point of termination, outside of the building, must not exceed a maximum of 100 equivalent feet (30.5 m) in length. Depending on diameter and centerline radius subtract from 7 to 19 feet per 90° elbow using published venting manufacturers data. Subtract half this value for each 45° elbow.
- The flue may terminate either vertically at the roof top or horizontally on a sidewall. See the information about the specific vent termination location for recommended location and clearances.
- For direct vent applications, the maximum wall thickness must be between 0.5" – 12" (1.2 cm to 30 cm).

2.1.3 APPROVED VENTING MATERIALS

Exhaust Vent for Use for Avenger Category II or IV

Installations

1. Manufactured prefabricated UL/ULC listed vent of AL29-4C or equivalent, Single or Double wall.
2. 316L Stainless Steel is limited to use in applications where there is no possibility of contaminants in the air such as refrigerants, chlorine etc.
3. "BH" type.
4. PVC Schedule 40 or 80 approved to ULC S636, for low temperature applications only when the flue gas temperature does not exceed the "Maximum Flue Temperature" on Table 4.
5. CPVC Schedule 40 or 80 approved to ULC S636.
6. CPVC Schedule 40 approved to comply with ANSI/ASTM F441. (US Jurisdictions ONLY when permitted).
7. Polypropylene approved to comply with ULC S636 up to 12" diameter.

NOTE

- 1) Use of cellular core PVC (ASTM F891), cellular core CPVC or Radel® (polyphenosulfone) in venting systems is prohibited.
- 2) Covering non-metallic vent pipe and fittings with thermal insulation is prohibited.

Table 4: Maximum Flue Temperatures for Various Vent Materials

Vent Material	Maximum Flue Temperature (°F)
PVC	149
CPVC	194
Polypropylene	230
AL29-4C	300+, Limited only by rating of seals
316L Stainless Steel	300+, Limited only by rating of seals

Vent Material Selection

When selecting vent material, take into consideration that appliances installed near a corrosive or potentially corrosive air supply must be isolated from it or they will suffer damage to the appliance and the venting system.

The corrosion resistance of AL29-4C is typically higher than that of 316L. Always choose the venting system which best satisfies the requirements of the application.

This recommendation does not supersede local codes or the provision of the B149 in Canada or the National Fuel Gas Code in the United States.

NOTE

Air Intake material must be of a type listed by a nationally recognized testing agency

1. **PVC** Non-Foam Core Pipe.
2. **CPVC** Non-Foam Core Pipe.
3. **Polypropylene**
4. **ABS** (Acrylonitrile-Butadiene-Styrene)

Single Wall air intake pipes are to be insulated 5 feet from wall toward the interior of the building to minimize external sweating.

2.1.4 VENT TERMINATION CLEARANCES

- Do not terminate the vent in a window well, stairwell, alcove, courtyard or other recessed area. The vent cannot terminate below grade. The bottom of the vent terminal shall be located at least 12 inches (30 cm) above grade and above normal snow levels. In all cases, the appliance shall be installed in accordance with local codes.
- The vent outlet **MUST NOT** terminate below a forced air inlet at any distance.
- The vent cannot terminate below grade. Position the vent termination where vapors will not damage walls or plants or may otherwise be objectionable.
- The vent terminal shall not be installed closer than 3 feet (1 m) from an inside corner of an L-shaped structure, window well, stairwell, alcove, courtyard or other recessed area as wind eddies could affect boiler performance or cause recirculation.
- **DO NOT** terminate closer than 4 feet (1.25 m) horizontally and vertically from any electric meter, gas meter, regulator, relief valve, or other equipment. In all cases, local codes take precedence.
- Position terminations so they are not likely to be damaged by foreign objects or exposed to a build-up of debris.
- The vent piping must terminate in an elbow pointed outward or away from the air inlet.
- To avoid a blocked flue condition, keep the vent cap/terminal clear of snow, ice, leaves, debris etc.
- Flue gases from this appliance may contain large amounts of water vapor that will form a white plume in winter. Plume could obstruct a window view.
- Flue gas condensate can freeze on exterior walls or on the vent cap. Frozen condensate on the vent cap can result in a blocked flue condition. Some discoloration to exterior building surfaces can be expected. Adjacent brick or masonry surfaces should be protected with a rust resistant sheet metal plate.

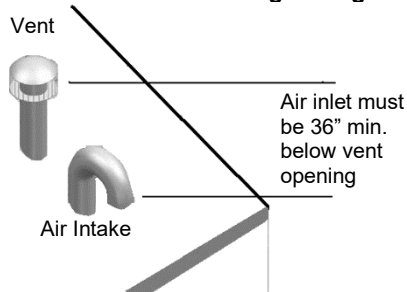
2.1.5 INLET CAP FOR ROOFTOP TERMINATION

The air inlet cap consists of two 90° elbows installed at the point of termination for the air inlet pipe. The first 90° elbow is installed on the rooftop at the highest vertical point of the air inlet pipe and turned horizontal; the second 90° elbow is screened and is installed on the horizontal outlet of the first elbow and turned down. A 90° elbow and a 90° street elbow may be used to make this assembly. If a straight piece of pipe is used between the two elbows, it should not exceed 6" (150 mm) in length.

2.1.6 LOCATION OF A ROOFTOP AIR INLET AND VENT CAPS

- The point of termination for the combustion air inlet cap **MUST** be at least 3 feet (0.91 m) below the point of flue gas termination (vent cap) if it is located within a 5 foot (1.5 m) radius of the flue outlet. Use care to ensure that the 90° elbow assembly is properly installed on the air inlet pipe.
- The termination point of the combustion air inlet cap must be installed at least 3 feet (0.91 m) above the rooftop and above normal snow levels.
- The vent cap assembly **MUST** be listed by nationally recognized agencies.
- The combustion air cap and vent cap **MUST** be located on the same roof top surface and in the same pressure zone.
- Combustion air supplied from outdoors must be free of contaminants. To prevent recirculation of flue products into the combustion air inlet, follow all instructions in this section.
- Incorrect installation and/or location of the air inlet cap can allow flue products to be drawn back into the appliance. This can result in incomplete combustion and potentially hazardous levels of carbon monoxide in the flue products. This will cause operational problems with the appliance and if left uncorrected, will lead to conditions that can cause personal injury or death.

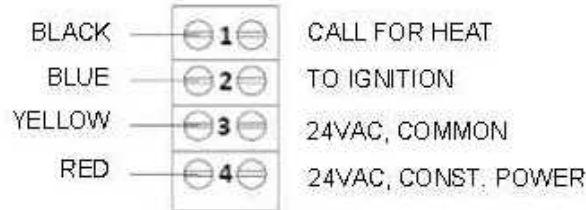
Figure 6: Vertical Direct Venting Configuration



2.1.7 AIR INLET DAMPER

In cold climates, it is essential to provide a motorized air Inlet Damper to control the supply of combustion air and prevent nuisance condensation. Each air Inlet Damper is designed to serve only one appliance and it must be electrically wired to the Air Inlet Damper Connection inside the junction box. All electrical wiring must be done in accordance with the requirements of the authority having jurisdiction or, in the absence of such requirements, with National Electrical Code, ANSI/NFPA70 and/or the Canadian Electrical Code part 1 CSA C22.1. A minimum clearance of not less than 6" (152 mm) between the air Inlet Damper and combustible construction must be maintained for service of the vent damper device.

Figure 7: Air Inlet Damper Connection inside J-Box



NOTE

Damper must be in open position when appliance main burner is operating.

2.1.8 MASONRY CHIMNEY INSULATIONS

Always follow local codes when venting this appliance into a masonry chimney. A standard masonry chimney must NOT be used to vent the products of combustion from the flue of a condensing, positive or negative pressure appliance (Category II or IV). If a masonry chimney is to be used, the chimney MUST use a sealed, corrosion resistant liner system to vent flue products from this high efficiency appliance. Sealed, metallic, corrosion resistant liner systems (AL29-4C or equivalent, single wall or double wall, or flexible or rigid metallic liners) must be rated for use with a high efficiency condensing, positive pressure vent system. Corrosion resistant chimney liner systems are typically made from a high grade of corrosion resistant stainless steel such as AL29-4C or equivalent. The corrosion resistant liner must be properly sized and fully sealed throughout the entire length. If the flue is contained within the masonry chimney, both the top and the bottom of the masonry chimney must be capped and sealed to provide a dead air space around the sealed corrosion resistant liner.

Consult with local code officials to determine code requirements or the advisability of using a masonry chimney with a sealed corrosion resistant liner system.

2.1.9 VERTICAL VENTING TERMINATION

- Follow Category II or IV vent termination and all General Instructions.
- The vent terminal should be vertical and exhaust outside the building at least 2 feet (0.61 m) above the highest point of the roof within 10 feet (3.05 m) radius of the termination.
- The vertical termination must be a minimum of 3 feet (0.91 m) above the point of exit.
- A vertical termination less than 10 feet (3.05 m) from a parapet wall must be a minimum of 2 feet (0.61 m) higher than the parapet wall.

2.1.10 COMBINED COMBUSTION AIR INLET

The air inlet pipes from multiple appliances can be combined to a single common connection if the common air inlet pipe has a cross sectional area equal to or larger than the total area of all air inlet pipes connected to the common air inlet pipe.

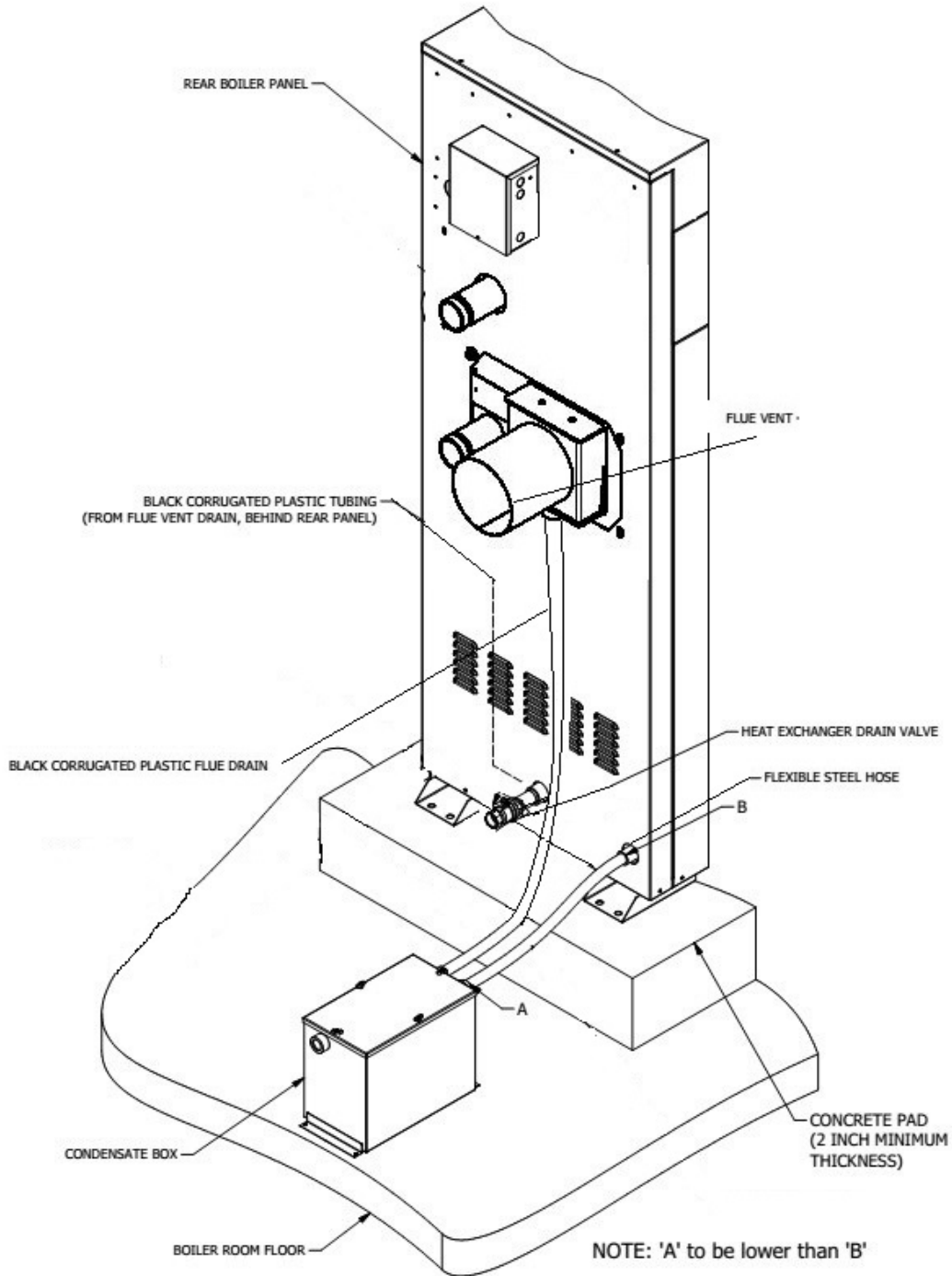
Equivalent pipe diameter = Sq Root $[(d_1)^2 + (d_2)^2 + (d_3)^2 + (d_4)^2 + \dots + (d_n)^2]$, d, pipe diameter

- Example: What is equivalent pipe diameter of three air inlet pipes, 8" (20.3 cm), 10" (25.4 cm) and 12" (30.5 cm)
 - Equivalent pipe diameter = Sq Root $[(8)^2 + (10)^2 + (12)^2] = \text{Sq Root } (308) = 17.5"$, Select 18" (45.7 cm) diameter pipe or larger.

The air inlet point for multiple boiler air inlets must be provided with an exterior opening which has a free area equal to or greater than the total area of all air inlet pipes connected to the common air inlet. This exterior opening for combustion air must connect directly to the outdoors. The total length of the combined air inlet pipe must not exceed a maximum of 100 equivalent feet (30.5 m). You must deduct the restriction in area provided by any screens, grills or louvers installed in the common air inlet point. Screens, grills or louvers installed in the common air inlet can reduce the free area of the opening from 25% to 75% based on the materials used. Calculate and compensate accordingly for the restriction.

2.1.11 DRAIN TEE

Figure 8: Drain "T" and Neutralizer Cartridge Installation



A drain line must be connected to the boiler condensate drain and to a tee installed in the vent pipe to collect and dispose of any condensate that may occur in the boiler and vent system. The drain tee should be installed at the point where the flue turns vertical for a roof top termination or as one of the first fittings in a horizontal flue that will terminate on a sidewall. Ensure that horizontal portions of the vent are properly sloped away from the appliance to allow condensate to be evacuated at the drain tee. Plastic drain tubing, sized per the vent manufacturer's instructions, shall be provided as a drain line from the tee and from the boiler condensate line. The drain tubing from the tee must have a trap provided by a 4" (10 cm) diameter circular trap loop in the drain tubing and the boiler drain shall be normal with no loop and tied into the tee drain tubing with a tee at a point after the 4" loop and before the neutralizer. Prime the trap loop by pouring a small quantity of water into the drain hose before assembly to the vent. Secure the trap loop in position with nylon ties. Use caution not to collapse or restrict the condensate drain line with the nylon wire ties. The common condensate drain must be routed to the condensate neutralization system or a suitable drain for the disposal of condensate that occurs in both the boiler and in the vent system. Ensure that the drain from the condensate tee is not exposed to freezing temperature.

2.2 CONVENTIONAL VENTING (INDOOR) INSTALLATIONS

- The Avenger is approved as a category II appliance and is approved for venting into a common chimney. On single appliance installations with dedicated chimney, if drafts are excessive (above negative 0.15 inches W.C.), a single acting barometric damper is recommended.
- A qualified professional using a proven vent-sizing program with input of accurate operating parameters must properly determine sizing of the venting system. In applications where flue gas temperatures are lower than can support a Category II with conventional negative draft, it will be determined at the venting design stage that a positive pressure will be developed in the vent. It will then be necessary to either provide separate vents as for Category IV, pressurize the room or to provide an extractor at the chimney outlet interlocked with the appliance operating circuit in order to maintain a negative draft in the chimney and allow common venting.
- Approval of the installation will be at the discretion of authorities having jurisdiction.

IN GENERAL

- The operation of exhaust fans, compressors, air handling units etc. can take away air from the room, creating a negative pressure condition leading to reversal of the natural draft action of the venting system. Under these circumstances, an engineered air supply is necessary.
- If the appliance is to be installed near a corrosive or potentially corrosive air supply, the appliance must be isolated from it and outside air should be supplied as per code.
- Potentially corrosive atmospheres will result from exposure to permanent wave solution, chlorinated waxes and cleaners, chlorine, water softening chemicals, carbon tetrachloride, halogen based refrigerants, Freon cleaning solvents, hydrochloric acid, cements and glues, masonry washing materials, antistatic fabric softeners, dry cleaning solvents, degreasing liquids, printing inks, paint removers, etc.
- The equipment room MUST be provided with properly sized openings to assure adequate combustion air and proper ventilation when the unit is installed with a proper venting system.

2.2.1 AIR REQUIRED FOR COMBUSTION AND VENTILATION

If air is taken directly from outside the building with no duct, provide two permanent openings:

- a) Net free area for combustion air opening shall be in accordance with all applicable codes. In the absence of such codes, provide combustion air opening with a minimum free area of one square inch per 30,000 Btuh input (1.3 cm per kW) of the total rated input of the power burner. This opening must be ducted no higher than 18" nor less than 6" above the floor. Provide a ventilation air opening located as high as practical in the room sized no less than 10% of the air supply opening.
- b) Provision for combustion and ventilation must be in accordance with:
 - Applicable sections of The National Fuel Gas Code ANSI Z223.1
 - Applicable sections of CAN/CGA B149 installation codes
 - Applicable provisions of the local building codes

NOTE
Outside air openings shall directly communicate with the outdoors

CAUTION
Under no circumstances should the mechanical room ever be under a negative pressure. Particular care should be taken where exhaust fan, attic fans, clothes dryers, compressors, air handling units, etc., may take away air from the unit.

2.2.2 EXHAUST FANS

Any fan or equipment which exhausts air from the equipment room may deplete the combustion air supply and/or cause a downdraft in the venting system through a barometric damper if installed. Spillage of flue products from the venting system into an occupied living space can cause a very hazardous condition that must be immediately corrected.

2.3 OUTDOOR VENTING (Pending)

The Avenger windproof cabinet protects the unit from weather, when fitted with the factory supplied air intake and UL approved vent cap (93.0298), it will be self-venting and suitable for outdoor installation.

1. Outdoor models must be installed outdoors and must use the air intake and vent cap supplied by *Camus Hydronics*.
2. Periodically check to ensure that air intake and vent cap are not obstructed.
3. Locate appliance at least 3 feet away from any overhang.
4. Locate appliance at least 10 feet away from building air intake.
5. Avoid installation in areas where runoff from adjacent building can spill onto appliance.

For outdoor installations, always consider the use of shelter such as a garden shed to prevent direct exposure of the appliance to the elements. The additional protection afforded by the shelter will help to minimize nuisance problems with electrical connections and will allow easier servicing of the appliance under severe weather conditions.

2.4 SIDEWALL VENTING

When fitted with vent terminals, the Avenger can vent up to 100 equivalent feet. Elbows can range from 7 to 19 feet in equivalent length depending on centerline radius. Refer to Table 3 for vent sizes.

Appliances may be installed with either a **horizontal sidewall vent** or **vertical roof top vent**. Use approved single wall or double wall vent. Terminals can be standard 45 degrees elbows for both air intake and exhaust or 90 degrees elbows for both air intake and exhaust for all models, except model ARP4000 which will only use 45 degrees elbows for both air intake and exhaust.

Periodically check to ensure that the vent terminal is unobstructed.

This venting system uses the appliance's internal combustion air fan to force the flue products out horizontally.

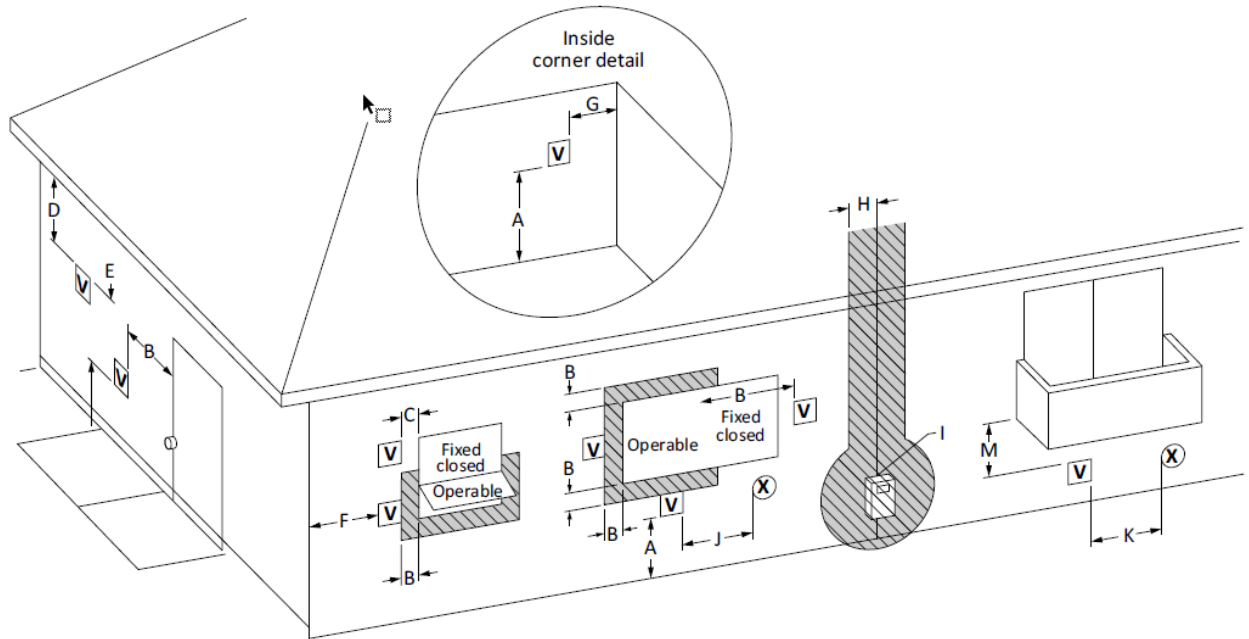
The Avenger fan generates a positive pressure in the flue. Combustion air is drawn from the equipment room. Refer to local codes for proper installation and location of vent terminals.

2.4.1 SIDEWALL VENT TERMINAL & SIDEWALL INTAKE AIR TERMINAL

- The opening through the wall for installation of the sidewall vent terminal must provide an air space clearance of 1 inch (2.5 cm) to combustible material around the flue pipe. The diameter of the opening for the air inlet will be the same as the nominal size of the pipe.
- Install the proper vent pipe to the approved vent terminal for Avenger boilers/water heaters.
- Follow all requirements in the General Venting sections for venting flue products to the outdoors.

2.4.2 LOCATION OF A SIDEWALL VENT TERMINATION

- The vent terminal shall terminate at least 3 feet (1 m) above any forced air inlet within 10 feet (3 m) horizontally.
- The vent terminal **MUST NOT** terminate below a forced air intake at any distance.
- Do not terminate the vent in a window well, stairwell, alcove, courtyard or other recessed area. The vent cannot terminate below grade.
- The vent shall not terminate near soffit vents or crawl space vents or other areas where condensate or vapor could create a nuisance or hazard or cause property damage.
- Do not terminate the vent where condensate or vapor could cause damage or could be detrimental to the operation of regulators, relief valves or other equipment.
- The vent shall not terminate over public walkways.
- The vent system shall terminate at least 3 feet (1 m) above normal snow levels and least 7 feet (2.15 m) above grade when located adjacent to public walkways.
- The vent terminal shall not be installed closer than 3 feet (1 m) from an inside corner of an L-shaped structure.
- The vent terminal should have a minimum clearance of 4 feet (1.25 m) horizontally from and in no case above or below, unless a 4 foot (1.25 m) horizontal distance is maintained from electric meters, gas meters, regulators and relief equipment. In all cases, local codes take precedence.
- Flue gas condensate can freeze on exterior walls or on the vent terminal. Frozen condensate on the vent cap can result in a blocked flue condition. Some discoloration to exterior building surfaces can be expected. Adjacent brick or masonry surfaces should be protected with a rust-resistant sheet metal plate.
- The vent shall not terminate where condensate vapor could cause damage or could be detrimental to the operation of regulators, relief valves, or other equipment



Direct Vent Terminal Clearances		Canadian Installations ¹	US Installations ²
A	Clearance above grade, veranda, porch, deck, or balcony	12" (30 cm)	12" (30 cm)
B	Clearance to window or door that may be opened	36" (91 cm)	12" (30 cm)
C	Clearance to window or door that may be opened	*	*
D	Clearance to permanently closed window	*	*
E	Clearance to unventilated soffit	*	*
F	Clearance to outside corner	*	*
G	Clearance to inside corner	*	*
H	Clearance to each side of center line extended above meter/regulator assembly	3' (91 cm) within a height of 15' (4.5 m) above the meter/regulator assembly	*
I	Clearance to service regulator vent outlet	36" (91 cm)	*
J	Clearance to non-mechanical air supply inlet to building or the combustion air inlet to any other appliance	36" (91 cm)	12" (30 cm)
K	Clearance to a mechanical air supply inlet	6' (1.83 m)	3' (91 cm) above if within 10' (3 m) horizontally
L	Clearance above paved sidewalk or paved driveway located on public property	7' (2.13 m) ^a	*
M	Clearance under veranda, porch deck, or balcony	12" (30 cm) ^β	*

¹ In accordance with the current CSA B149.1 Natural Gas and Propane Installation Code

² In accordance with ANSI Z223.1/ NFPA 54 National Fuel Gas Code

^a A vent shall not terminate directly above a sidewalk or paved driveway that is located between two single family dwellings and serves both dwellings

^β Permitted only if veranda, porch, deck, or balcony is fully open on a minimum of two sides beneath the floor.

* For clearances not specified in ANSI Z223.1/ NFPA 54 or CSA-B149.1. Clearance in accordance with local installation codes and the requirements of the gas supplier

Room Air, Vent Terminal Clearances		Canadian Installations ¹	US Installations ²
A	Clearance above grade, veranda, porch, deck, or balcony	12" (30 cm)	12 in (30 cm)
B	Clearance to window or door that may be opened	36" (91 cm)	4' (1.2 m) below or to side of opening; 1' (30 cm) above opening
C	Clearance to window or door that may be opened	*	*
D	Clearance to permanently closed window	*	*
E	Clearance to unventilated soffit	*	*
F	Clearance to outside corner	*	*
G	Clearance to inside corner	*	*
H	Clearance to each side of center line extended above meter/ regulator assembly	36" (91 cm) within a height of 15' (4.5 m) above the meter/ regulator assembly	*
I	Clearance to service regulator vent outlet	36" (91 cm)	*
J	Clearance to non-mechanical air supply inlet to building or the combustion air inlet to any other appliance	36" (91 cm)	4' (1.2 m) below or to side of opening; 1' (30 cm) above opening
K	Clearance to a mechanical air supply inlet	6' (1.83 m)	3' (91 cm) above if within 10' (3 m) horizontally
L	Clearance above paved sidewalk or paved driveway located on public property	7' (2.13 m) ^a	*
M	Clearance under veranda, porch deck, or balcony	12" (30 cm) ^b	*

¹ In accordance with the current CSA B149.1 Natural Gas and Propane Installation Code

² In accordance with ANSI Z223.1/ NFPA 54 National Fuel Gas Code

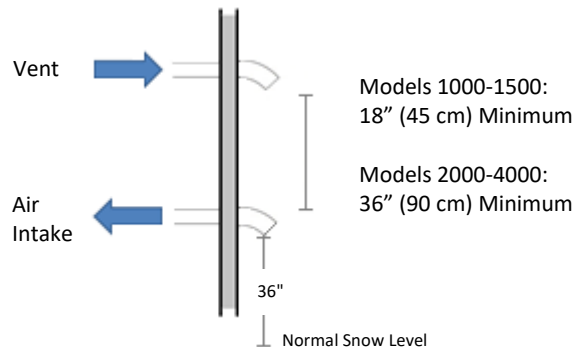
^a A vent shall not terminate directly above a sidewalk or paved driveway that is located between two single family dwellings and serves both dwellings

^b Permitted only if veranda, porch, deck, or balcony is fully open on a minimum of two sides beneath the floor.

* For clearances not specified in ANSI Z223.1/ NFPA 54 or CSA-B149.1. Clearance in accordance with local installation codes and the requirements of the gas supplier

2.4.3 LOCATION OF A SIDEWALL AIR INLET TERMINAL

- The termination point of the sidewall air inlet must be installed a minimum of 3 feet above normal levels of snow accumulation.
- **Models 1000 – 1500:** The point of termination for the sidewall combustion air inlet terminal MUST be located a minimum 18 inches (45 cm) below the point of flue gas termination (vent cap).
- **Models 2000 – 4000:** The point of termination for the sidewall combustion air inlet terminal MUST be located a minimum of 36" (90 cm) below the point of flue gas termination (vent cap).
- The sidewall vent and air termination must be purchased with the boiler to ensure reliable boiler operation.



2.4.4 LENGTH OF AIR INLET PIPE

The maximum total length of the sidewall or vertical roof top combustion air inlet pipe as installed from the appliance to the air inlet terminal must not exceed 100 equivalent feet (30.5 m) in length. Subtract 7 (2.13 m) to 19 feet (5.8 m) of equivalent length depending on centerline radius for each 90° elbow installed in the air inlet pipe system. Pressure drop in 45° elbow will be half as much.

PART 3 GAS CONNECTIONS

Verify that the appliance is supplied with the type of gas specified on the rating plate. Consult factory for installations at high altitude.

3.1 GAS CONNECTION

- Safe operation of unit requires properly sized gas supply piping. See gas line sizing data.
- Gas pipe size may be larger than appliance connection.
- Installation of a union at the appliance gas line connection is required for ease of service and removal of the gas train.
- Install a manual main gas shutoff valve, outside of the appliance gas connection as required by local codes.
- A trap (drip leg) MUST be provided in the inlet gas connection to the appliance.
- Optional gas controls may require routing of bleeds and vents to the atmosphere, outside the building when required by local codes.
- Larger models of this appliance may be supplied with a gas pressure relief valve. This valve is designed to relieve lockup pressure in excess of the high gas pressure switch setting. It must be piped to discharge excess gas pressure through the valve to a safe location in accordance with local codes. Follow table 5 for sizing the vent line.

Table 5: Gas Pressure Relief Valve – Vent Manifold Sizing Chart

Size of Combined Vent Line (Sch. 40 pipe)*		
Qty of Pressure Relief Valves being combined	Pressure Relief Valve Size – 3/4" NPT	Pressure Relief Valve Size - 1" NPT
1	3/4"	1"
2	1"	1 1/4"
3	1 1/4"	1 1/2"
4	1 1/4"	2"
5	1 1/2"	2"
6	1 1/2"	2"
7	2"	2 1/2"
8	2"	2 1/2"

*Up to 50 feet. Increase by one pipe size for every 50 feet or part thereof that the vent line extends beyond the initial 50 feet. The increase is to be made at the connection to the relief valve.

Table 6: Recommended Gas Pipe Size

Input Btu/Hr x 1000	0-100 feet		101-200 feet		201-300 feet	
	NAT.	L.P.	NAT.	L.P.	NAT.	L.P.
1000	2"	1 1/2"	2"	1 1/2"	2 1/2"	2"
1500	2 1/2"	2"	3"	2 1/2"	3"	2 1/2"
2000	2 1/2"	2"	3"	2 1/2"	3"	2 1/2"
2500	3"	2 1/2"	3"	2 1/2"	3 1/2"	3"
3000	3"	2 1/2"	3"	2 1/2"	3 1/2"	3"
3500	3"	2 1/2"	3 1/2"	3"	4"	3 1/2"
4000	3 1/2"	3"	4"	3 1/2"	4"	3 1/2"

Single Appliance Installation (For distance from natural gas meter or propane second stage regulator)

3.2 GAS PIPING

All gas connections must be made with pipe joint compound resistant to the properties of liquefied petroleum and natural gas. All piping must comply with local codes and ordinances.

3.3 INSTALL PIPING

- The gas line should be sufficient to handle the total installed capacity. Verify pipe size with gas supplier.
- Use new, properly threaded black iron pipe free from burrs. Avoid flexible gas connections. Internal diameter of flexible gas lines may not provide appliance with proper volume of gas.
- Install a manual main gas shutoff valve at the appliance gas inlet, outside of the appliance and before the gas valve. Install a joint union at the appliance gas line connection for ease of service and removal of the gas train.
- Run gas pipe to appliance gas inlet.
- Install a sediment trap in the supply line to the appliance gas inlet.
- Apply a moderate amount of good quality pipe compound.
- For LP gas, consult your LP gas supplier for expert installation.

The appliance and its individual gas shutoff valve must be disconnected from the supply piping when pressure testing the gas supply piping at pressures above 1/2 PSI.

Table 7: Gas Pressures at Inlet to Appliance

	PROPANE	NATURAL GAS
Minimum (inches W.C.)	8	4
Maximum (inches W.C.)	14*	14

*12.0 IN.W.C. for ARP-4000

The gas supply line must be of adequate size to prevent undue pressure drop and must never be smaller than the size of the connection on the appliance. Sizing based on Table 6 is recommended.

Before operating the appliance, the complete gas train and all connections must be tested using soap solution.

Verify that the appliance is supplied with the type of gas specified on the rating plate. Heating values of local natural gas are to be between 950 and 1010 Btu/ft³. Consult factory if heating values are outside this range or if a gas with a mixture of constituents is being used.

3.4 AIR/GAS RATIO VALVE

Avenger models utilize a dual seat negative pressure air/gas ratio control valve at the low end and an air/gas ratio control valve at the high end. This combination allows the Low-End Valve to fire down to the minimum input with high turn down ratio. At a pre-determined point, control is passed from the Low-End Valve to the High-End Valve and at the same time the fan air Inlet Damper is gradually opened. The High-End Valve controls the pressure difference across a flow orifice in the manifold supply line as a function of the pressure difference across the combustion air supply to the burner. The High-End Valve actuator maintains a matching 1:1 air to gas ratio as the volume of air changes based on the operation of the combustion air fan.

The air/gas ratio of both Low-End Valve and High-End Valve are preset at the factory and adjustment is not usually required if gas supply pressure is maintained within the specified range.

A reduction of up to 30% is permitted in the inlet gas pressure between light off and full fire conditions.

If the manifold differential pressure is to be measured, refer to section 3.8 Checking Differential Air and Gas Pressures for Proper Measurement.

Figure 9: 1:1 Negative Pressure Control Valve

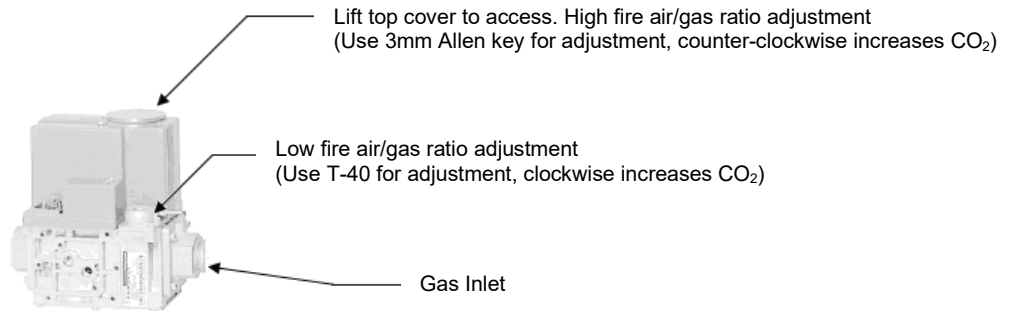
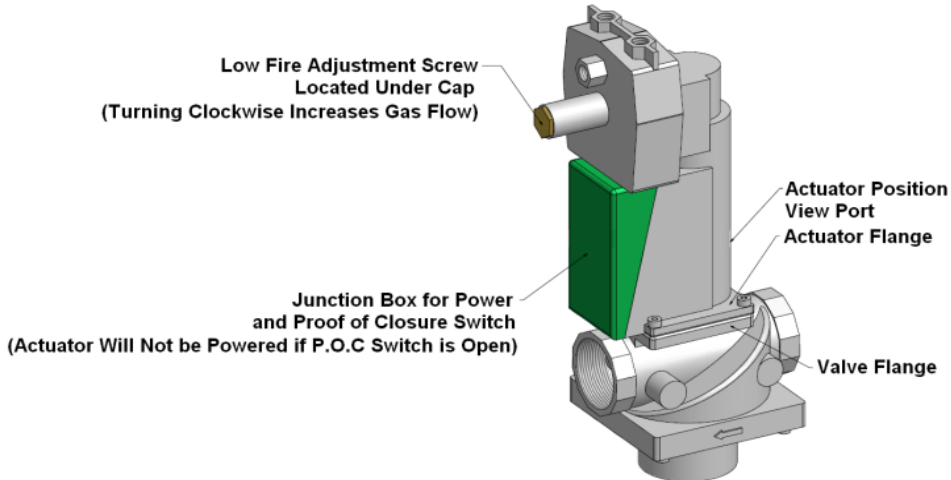


Figure 10: 1:1 Differential Air/Gas Ratio Control Valve



3.5 OPERATION OF NEGATIVE PRESSURE AND DIFFERENTIAL PRESSURE VALVES

- Avenger models utilize both a negative pressure gas valve and a 1:1 air/gas ratio control valve. At the low end, these models operate on the principle of negative pressure and at the high end they operate on the principle of differential pressure.
- The differential air pressure measurement is made between the high and low pressure taps across the fan discharge and the fan static discharge. There are two pressure taps at the fan discharge and care must be taken to tee into the correct line. The correct line may be identified by tracing it back to the ratio control valve where the identification of the tapping is stamped into the die cast actuator.
- The differential gas pressure measurement is made between the high and low pressure taps across the inline metering gas orifice. Check this value to confirm that it matches the differential air pressure while the appliance is firing.
- The controls on this appliance may fire the burner from 4.0% up to 100% of rated input.
- Differential manifold gas pressure will be reduced as burner input is reduced.
- All reference gas pressure measurements must be made at 100% of rated burner input.
- The differential gas manifold pressure is preset at the factory through the ratio gas valve. Adjustment of manifold pressure is not normally required for proper operation. It may be necessary to adjust the low fire adjustment screw located on the ratio control valve actuator in order to achieve acceptable light off under different field conditions.
- **Always check settings posted on boiler test label (ships with the unit).**

3.6 GAS MANIFOLD DIFFERENTIAL PRESSURE ADJUSTMENT

Tampering with gas valve adjustments after startup and commissioning will void the warranty on the gas valve assembly and the burner.

The appliance's manifold gas pressure **IS NOT** field adjustable after startup and commissioning. The gas valve pressure ratios have been factory set with an internal bias adjustment to ensure a 1:1 air/gas ratio on operation. Tampering with this adjustment will void the warranty on the gas valve assembly and the burner. An appliance supplied with a properly sized gas line, properly sized meter and a minimum gas supply pressure (see table 7 for minimum allowable inlet gas supply pressure) while firing at full rate will ensure full burner input. The manifold pressure supplied to the burner is a differential pressure. This pressure is the result of the difference in two gas pressure measurements. A differential manifold gas pressure measurement should not be made until you have measured the gas supply pressure. Gas supply pressure must be at least at minimum allowed with all appliances on the gas line firing at full rate before a manifold pressure measurement is made. Use the following procedure to check gas supply pressure with a manometer connected to the inlet pressure tap on the gas line connection at the rear of the appliance.

3.7 CHECKING GAS SUPPLY PRESSURE

- Turn the main power to the "OFF" position.
- Shut off gas supply at the manual gas cock in the gas piping to the appliance. If fuel supply is LP gas, shut off gas supply at the tank.
- The boiler and its individual shutoff valve must be disconnected from the gas supply piping system during any pressure testing of that system at test pressures in excess of ½ psi (3.5 kPa).
- The boiler must be isolated from the gas supply piping system by closing its individual manual shutoff valve during any pressure testing of the gas supply piping system at test pressure equal to or less than ½ psi (3.5 kPa).
- Remove the 1/8" hex plug from the gas pressure test port located on the inlet gas supply connection at the rear of the appliance. Install a fitting in the inlet pressure tapping suitable to connect to a manometer or magnehelic gauge. Range of scale should be 0 to 14 "W.C. or greater to check inlet pressure.
- Turn on gas supply at the field installed manual gas cock; turn on LP gas at tank if required.
- Turn the power switch to the "ON" position.
- Adjust the thermostat set point to call for heat.
- Observe the gas supply pressure as the burner fires at 100% of rated input.
- Ensure inlet pressure is within specified range. Minimum and maximum gas supply pressures are specified in Table 7.
- If gas pressure is out of range, contact the gas utility, gas supplier, qualified installer or service agency to determine necessary steps to provide proper gas pressure to the control.
- If gas supply pressure is within normal range, proceed to remove gas manometer and replace pressure tap fittings in the gas piping to the appliance.
- Turn on gas supply at the manual valve; turn on LP gas at tank if required.
- Turn the power switch to the "ON" position.
- Adjust the thermostat temperature set point to the desired water temperature so that the appliance will call for heat.
- Check appliance performance by cycling the system while you observe burner response. The burner should ignite promptly. Flame patterns should be stable, see "Maintenance-Normal Flame Pattern". Turn system off and allow burner to cool, then cycle burner again to ensure proper ignition and flame characteristics.

IMPORTANT

Upon completion of any testing on the gas system, leak test all gas connections with a soap solution while the main burner is firing. Immediately repair any leak found in the gas train or related components. DO NOT operate an appliance with a leak in the gas train, valves, or related gas piping.

3.7.1 REGULATED GAS SUPPLY PRESSURES FOR AVENGER BOILERS & WATER HEATERS

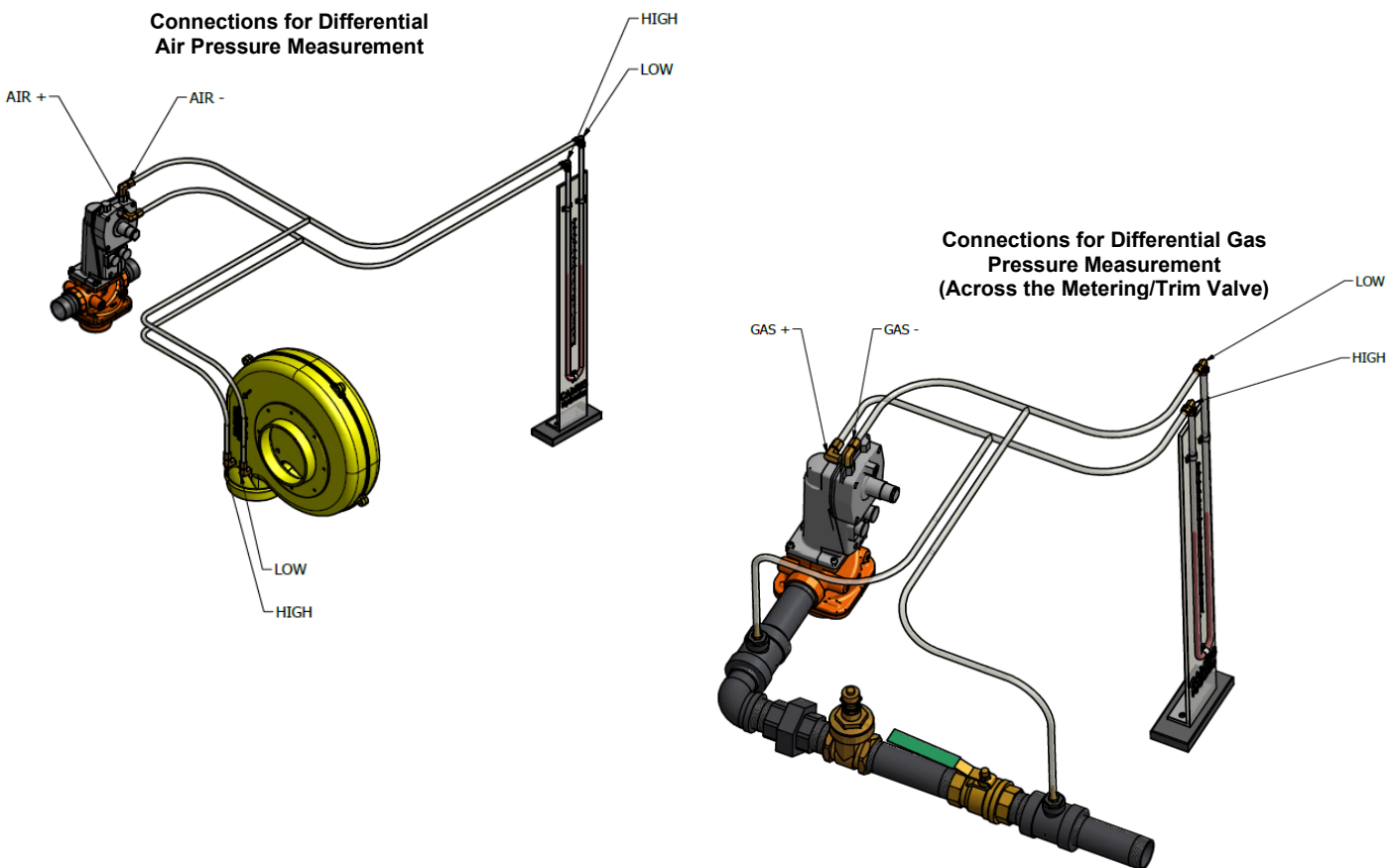
A stable gas supply pressure is important to avoid rough starts with gas appliances such as Avenger boilers and water heaters, which use a 1:1 ratio control valve for internal gas pressure regulation. Camus requires that all Avenger models be supplied with no more than 14" w.c. supply pressure. This means that lockup pressure must not exceed 14" w.c.

It is paramount that maximum lockup pressure be confirmed before any attempt is made to start up the appliance.

Operating the Avenger at lockup pressures exceeding 14" w.c. is not recommended and could lead to delayed ignitions and damage to the appliance.

3.8 CHECKING DIFFERENTIAL AIR AND DIFFERENTIAL GAS PRESSURES

Figure 11: Checking Differential Air and Differential Gas Pressures



The 1:1 air/gas ratio control actuator has embossed markings identifying + air, - air, + gas & - gas connections. Using a test hose assembly fitted with tees, connections can be made from the manometer to the appropriate ports on the actuator:

- Using tees connect a hose from the positive air and the negative air to each of the two sides of a monometer. This will allow the two pressure points to be measured while at the same time the actuator still receives the proper operating signal.
- If a second manometer is available, it can be connected to the appropriate gas ports. Typically, the gas signal will closely follow the air signal on all models. If the incoming gas pressure reduces significantly as the VFD accelerates to maximum speed, the gas signal may lag behind the air signal by up to 15%. This will occur once the actuator has driven downwards as far as it can go. The amount that the actuator has opened is registered by an indicator arm which is visible through the view window.
- As the appliance comes on and fires, record the maximum inches of water column which is achieved at maximum speed on the VFD using startup report form. To adjust this differential pressure when commissioning the appliance, use the adjusting screw on the air shutter to the fan. In all cases, the final adjustment is to be made using a combustion analyzer. Depending on field conditions differential pressures will have to be adjusted accordingly. Typically, with long lateral runs the differential signal as read will be reduced from the value shown on the rating plate. The opposite will occur with tall stacks where drafts exceed negative 0.15" w.c.
- If the appliance will not light off it will be necessary to adjust the low fire as explained in the detailed startup procedure.

3.9 GAS TRAIN AND CONTROLS

NOTE: Illustrations below do not reflect actual gas train assemblies on these models.

Figure 12: Typical Gas Train (Models AR1000-3000)

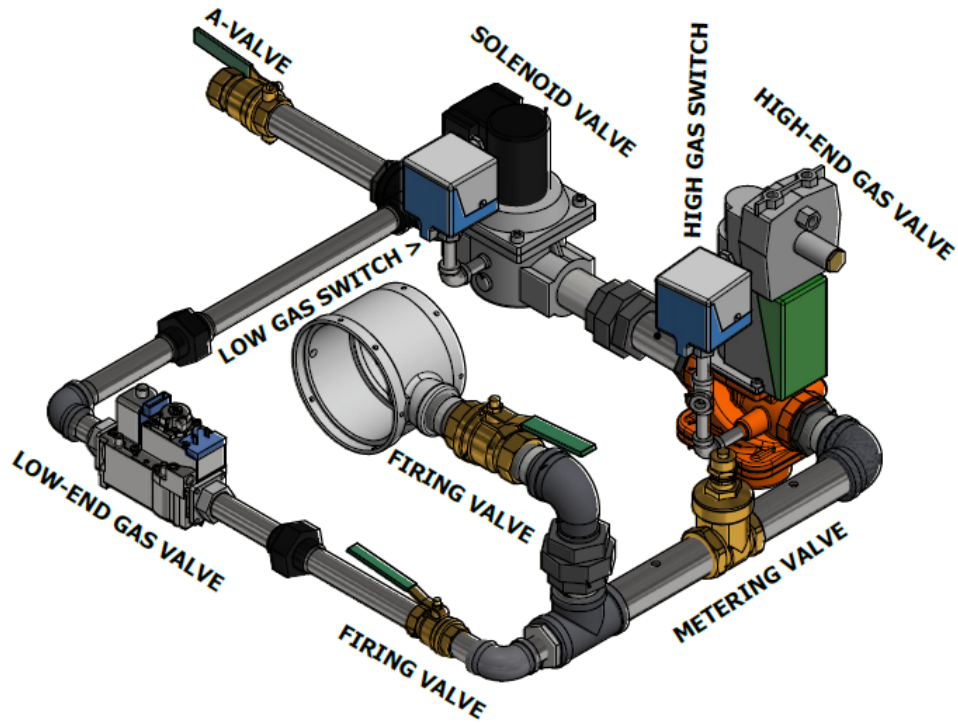
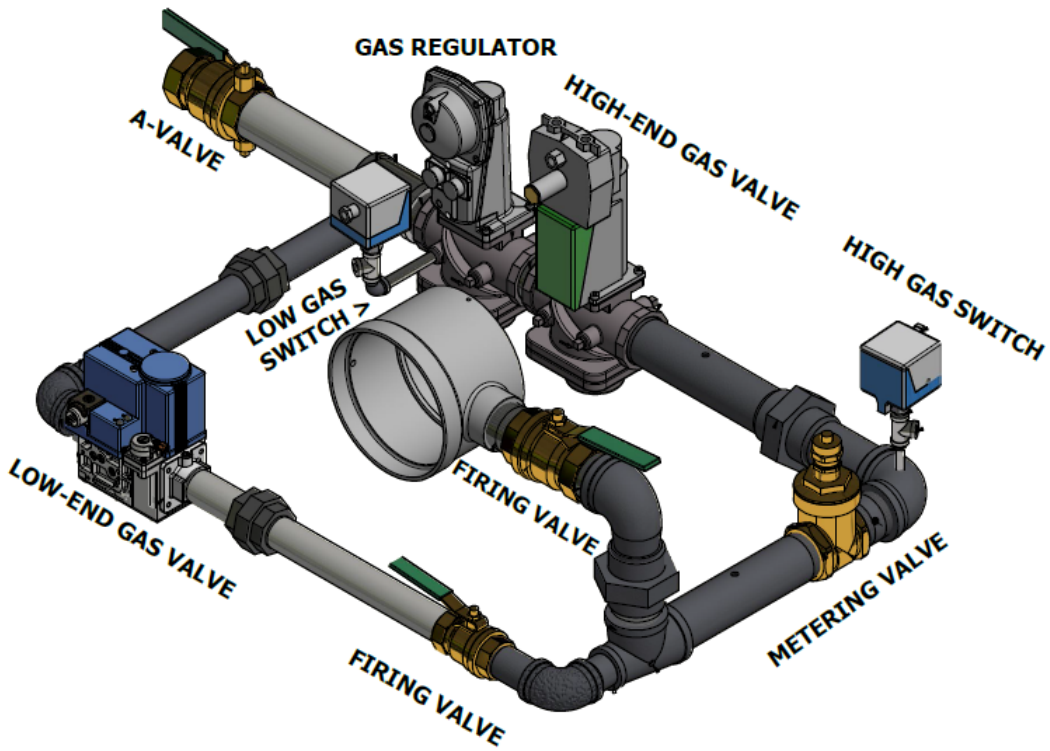


Figure 13: Typical Gas Train (Models AR3500-4000)

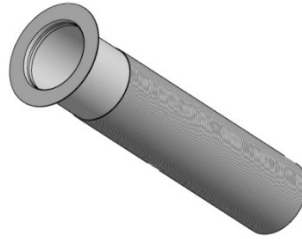


3.10 VENTING OF GAS VALVES AND PRESSURE SWITCHES

The optional gas pressure switches may be provided with threaded termination points to be vented to the atmosphere, outside the building. The gas pressure regulation function is provided by the ratio gas valve which does not require installation of a vent line. The optional gas pressure switches are installed in the upper chamber of the appliance. Threaded vent line connections from components requiring an external vent line are provided on the component. These vent line connection points may be accessed by removing the top of the appliance. Local codes may require the routing of these bleeds and vents to the atmosphere, outside the building. Proper routing of vent lines to the atmosphere from the factory supplied termination points is the responsibility of the installing contractor.

3.11 BURNER

Figure 14: Burner



This appliance uses a single cylindrical burner installed vertically into the opening located in the center of the heat exchanger. The burner consists of a round mounting flange welded to a mixing tube. The top side of the mixing tube provides the transition which mounts the discharge from the combustion air fan into the burner. The bottom side of the mixing tube is attached to a stainless steel perforated sleeve. This stainless steel sleeve is covered with a metal fiber alloy material that forms the burner port surface. The burner port material is a metal fiber material which is a unique alloy of iron, chrome, aluminum and several rare earth metals. This alloy is designed to operate stress free as a burner port surface. The burner port surface can sustain operation from a blue flame down to infrared conditions as the burner input varies. Infrared operation will occur only as turndown is increased.

Model 1000-2500: Utilizes direct ignition. The burner mounting flange provides a flame view port and the mounting point for the Hot Surface Igniter and the UV Scanner.

Model 3000-4000: Utilizes proven pilot ignition. The burner mounting flange provides a flame view port, the mounting point for the Hot Surface Igniter, a connection to the pilot tube and the UV Scanner.

The Hot Surface Igniter and UV Scanner are removable from the burner mounting flange without removing the burner assembly from the heat exchanger.

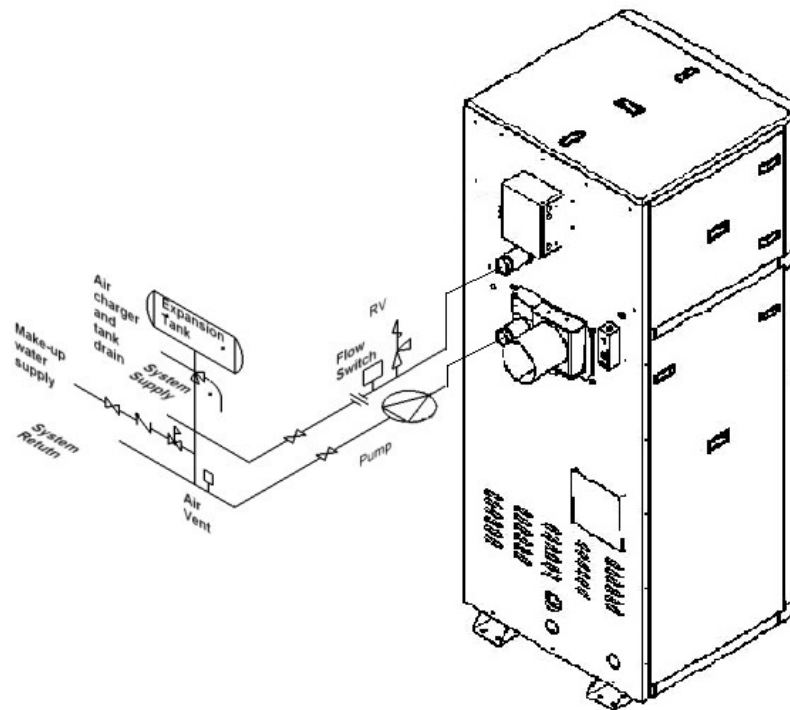
NOTE

Never use an open flame (match, lighter, etc.) to check gas connections, use a soap solution instead.
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PART 4 WATER CONNECTION

- Check all applicable local heating, plumbing and building safety codes before proceeding.
- If the appliance is installed above radiation level, it must be provided with a low water cut-off (LWCO) device at the time of appliance installation (available from factory). Some local codes require the installation of a low water cut off on all systems.
- A pressure relief valve is supplied with each Avenger model. The relief valve must be mounted in a vertical position and piped to the floor in a manner acceptable to the enforcing authority.
- **Minimum operating system water pressure should not drop below 12 PSIG.** A minimum water pressure relief valve setting of 50 PSIG is recommended.
- Be sure to provide unions and gate valves at inlet and outlet to the appliance so that it can be easily isolated for service. The provision of a flow setter valve at the appliance outlet will facilitate setting of the proper flow at the desired temperature rise at high fire.
- Special attention to minimum water flow rates will ensure that temperature rise is not excessive. See Table 8.
- To eliminate trapped air, install venting devices at high points in the system as well as in the piping on the suction of the pump and in the piping on the discharge of the appliance.
- Use suitable pipe hangers or floor stands to support the weight of all water and gas piping.
- Always pump toward the heat exchanger inlet. Never pump away from the exchanger since this will result in a low-pressure zone, which will allow localized boiling and result in heat exchanger damage.
- The Avenger must be installed so that the gas ignition system components are protected from water (dripping, spraying, rain, etc.) during appliance operation and service (circulator replacement, control replacement, etc.)

Figure 15: Typical Space Heating System



4.1 FREEZE PROTECTION

- Appliance installations are not recommended outdoors in areas where danger of freezing exists unless precautions are taken (outdoor models only). Maintaining a proper mixture of water and propylene glycol is the preferred method of freeze protection in hydronic systems. This mixture will protect the appliance to approximately -35°F (-37°C). To maintain the same temperature rise across the appliance increase the GPM flow by 15% and the head loss by 20%.

The following example demonstrates the procedure to follow for calculating the revised head for the heat exchanger when using a water/glycol mixture.

- Given that Camus is showing a heat exchanger flow and head loss of 100 gpm @ 10 feet
- Increasing the flow by 15% now results in a head loss of 13 feet at 115 gpm (from B&G system syzer). At this increased flow Camus now recommends increasing the head loss by 20%.

- The requirement for the heat exchanger with water / glycol mixture will now be 115 gpm @ 15.6 feet. (ie. 1.2 x 13 ft. = 15.6 ft.)
- A similar procedure must be followed to calculate the additional head loss in pipe and fittings in order to select the proper pump.

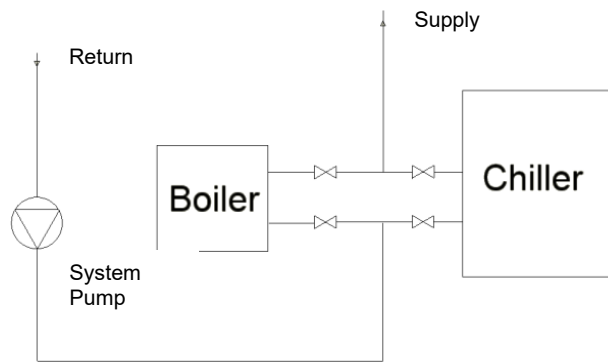
For outdoor installations in colder climates a snow screen should be installed to prevent snow and ice accumulation on and around the appliance. Regular inspections should be made to ensure that air intake and vent are free of snow and ice. Always consider the use of a shelter such as a garden shed in lieu of direct exposure of the appliance to the elements. The additional protection afforded by the shelter will help to minimize nuisance problems with electrical connections and will allow easier servicing of the appliance under severe weather conditions.

4.2 WARNING REGARDING CHILLED WATER AND HEATING COIL SYSTEMS

When an appliance is connected to a refrigeration system where the same water is used for heating and cooling, the chiller must be piped in parallel with the appliance. Appropriate flow control valves; manual or motorized must be provided to prevent the chilled water from entering the appliance.

The appliance piping system of a hot water boiler connected to heating coils located in air handling units where they may be exposed to refrigerated air circulation must be equipped with flow control valves or other automatic means to prevent gravity circulation of the boiler water during the cooling cycle.

Figure 16: Chilled Water System



4.3 INLET AND OUTLET CONNECTIONS

- All water connections are groove-lock fittings.
- For ease of service, install unions on inlet and outlet of the appliance. The connection to the appliance marked "Inlet" on the header should be used for "Return" from the system. The connection on the header marked "Outlet" is to be connected to the "Supply" side of the system.

4.4 MINIMUM PIPE SIZE REQUIREMENTS

The equivalent number of straight feet of pipe for each valve and fitting in the connecting piping must be considered to properly arrive at the total equivalent feet of straight pipe in the field installed piping to the appliance. See the piping requirements in Part 11 - Installation section of this manual. Consult factory if longer piping distances are required for a specific application.

4.5 HEAT EXCHANGER

The heat exchanger is of fully welded construction and is cylindrical in appearance. The heat exchanger is a vertical, two-pass, counter-flow, fire-tube design and consists of an integral combustion chamber with an inner tube bundle for primary heat transfer and an outer tube bundle to extract latent heat from flue gases. This heat exchanger is designed to withstand maximum of 160 PSIG working pressure.

A factory recommended circulating pump ensures proper water flow during burner operation so as not to exceed maximum recommended temperature rise. Scale formation in the heat exchanger is controlled by proper water treatment.

4.6 LOW WATER TEMPERATURE SYSTEMS

In applications where the heating system requires supply water temperatures below 110°F, connections may be made directly to the Avenger. At incoming temperatures of 120°F or lower the Avenger achieves maximum efficiency. Inlet temperatures must not drop below 40°F to prevent freezing.

4.7 INSTANTANEOUS WATER HEATER

An instantaneous water heater is designed to deliver hot water without the use of a storage tank. It is suitable for applications with variable load such as restaurants, condominiums, apartments and motels and typically used in conjunction with tempering valves to achieve temperature control. In some applications it may be appropriate to provide a flow through tank to act as a buffer. Consult factory for recommendations. (See Figure 17)

Figure 17: Typical Instantaneous Water Heating System

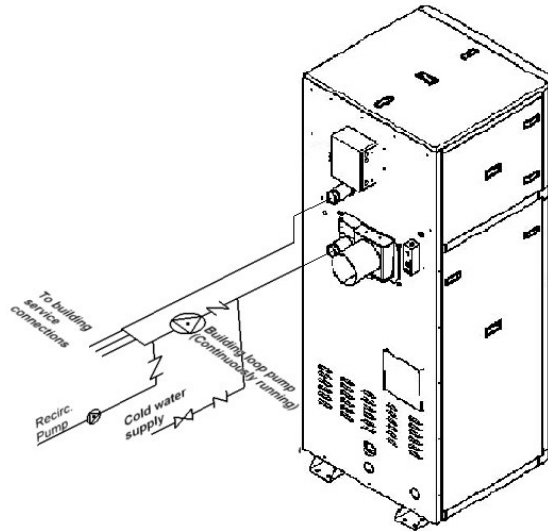


Table 8: Flow and Pressure Drop (Ft.) at a Given Temperature Rise

Heat Exchanger Head Loss and Flow

Model	20°F		40°F		60°F	
	US GPM	ΔP-FT	US GPM	ΔP-FT	US GPM	ΔP-FT
AR(N,P)-1000	94.4	22	47.2	5.8	31.5	3.1
AR(N,P)-1500	141.6	11.5	70.8	3.7	47.2	2.4
AR(N,P)-2000	188.6	4.37	94.3	1.46	62.87	0.94
AR(N,P)-2500	235.5	6.63	117.75	1.93	78.5	1.18
AR(N,P)-3000	284.1	4.9	142.05	2.17	94.7	1.15
AR(N,P)-3500	332.2	6.9	166.1	1.8	110.7	1.1
AR(N,P)-4000	374.5	9.0	187.2	2.1	124.8	1.2

4.8 WATER HEATER THERMOSTAT SETTING

1. This appliance is provided with an electronic temperature controller as detailed in Section 6.
2. The maximum setting for this water heater is 140°F.
3. There is a hot water scald potential if the temperature controller is set too high.

4.9 WATER FLOW SWITCH

A water Flow Switch (ships loose) is to be installed in the outlet piping on all heating boilers and hot water supply boilers. The Flow Switch is wired in series with the 24VAC safety control circuit.

4.10 LOW WATER CUTOFF

If this boiler is installed above radiation level, a Low Water Cut-Off (LWCO) device must be installed at the time of boiler installation. Some local codes require the installation of a Low Water Cut-Off on all systems. Electronic Low Water Cut-Offs are available as a factory supplied option on all models. Low Water Cut-Offs should be tested every six months, including flushing of float types. The normally open switch contact of the Low Water Cut-Off is to be wired in series with the flow switch. A *Hold* condition message will be indicated on the control display on a low flow condition.

Caution

Remove jumper when connecting to 24 VAC circuit.

Figure 18: Low Water Cut Off Electrical Connections (Safgard)

Connection detail for placing L.W.C.O in 24V circuit

WARNING: Be sure to remove the jumper between H and P1

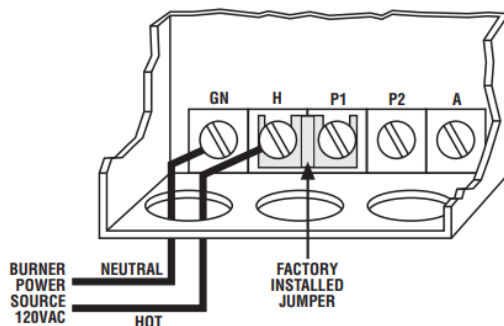
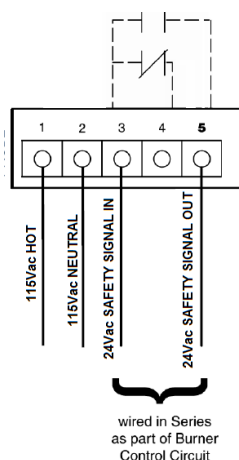


Figure 19: Low Water Cut Off Electrical Connections (ITT)



4.11 RELIEF VALVE

This appliance is supplied with a relief valve sized in accordance with ASME Boiler and Pressure Vessel Code, Section IV (“Heating Boilers”). The relief valve is to be installed in the vertical position and mounted in the hot water outlet. No valve is to be placed between the relief valve, and the appliance. To prevent water damage, the discharge from the relief valve shall be piped to a suitable floor drain for disposal when relief occurs. No reducing couplings or other restrictions shall be installed in the discharge line. The discharge line shall allow complete drainage of the valve and line. Relief valves should be manually operated at least once a year. If a relief valve discharges periodically, this may be due to thermal expansion in a closed water supply system. Contact the water supplier or local plumbing inspector on how to correct this situation. Do not plug the relief valve.

CAUTION

Avoid contact with hot discharge water

4.12 CIRCULATING PUMP SELECTION

The appliance has a stainless steel heat exchanger for fast response and high heat absorption. Selecting the proper pump will ensure that temperature rise does not exceed the maximum recommended for the application.

4.12.1 CIRCULATING PUMP OPERATION OF HEAT EXCHANGER

MOST IMPORTANT

This appliance is designed for continuous pump operation when the burner is firing. The pump control option allows the appliance circulating pump to be cycled “ON” prior to the burner firing and cycled “OFF” sometime after the set point is satisfied.

The operation of the circulating pump is controlled by the Avenger temperature control (SOLA). When the appliance is activated by a remote operating signal the pump will start and run for the operating cycle and for a post purge period based on temperature difference between inlet and outlet connections to the appliance. The SOLA can directly operate pumps up to 1/6 HP. Larger pumps will require a separate relay or contactor.

To select the proper pump, it is strongly recommended to consider the following:

- Need to know the required flow (GPM) and pressure drop for your appliance (see Table 8).
- Type of application: Hydronic Heating or Domestic Hot Water (DHW).
- For Hydronic Heating and DHW applications with normal water hardness choose a pump which will result in a temperature rise across the main heat exchanger of 20°F to 40°F (11.1°C - 22.2°C) depending on the size of the heater. If necessary, use a flow setter valve to achieve the desired temperature rise.
- For DHW applications with other than normal water hardness, consult the factory for recommendations.

NOTE	
The use of a system sensor is required in lead lag operation	
1.	When variable speed main circulators ARE NOT used, the system sensor is to be placed into the return system piping.
2.	When variable speed main circulators are used, the system sensor is to be placed into the supply system piping.

4.13 ΔT HEAT EXCHANGER ALGORITHM

The Avenger is constantly monitoring the inlet and outlet water temperatures. When the ΔT approaches 70°F the burner will modulate down to prevent tripping of the high limit.

Figure 20: Recommended Piping with Variable Primary/Secondary

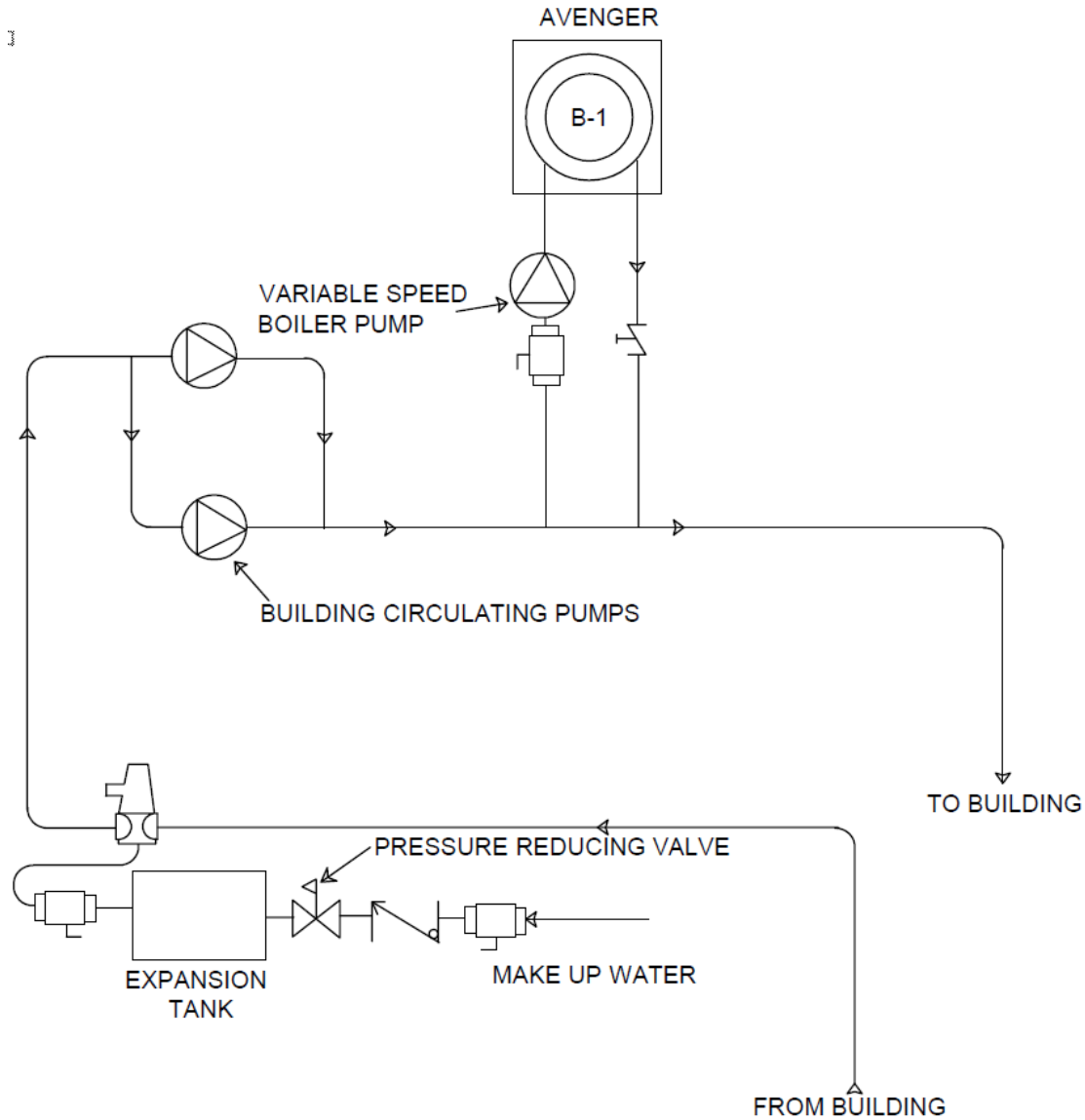
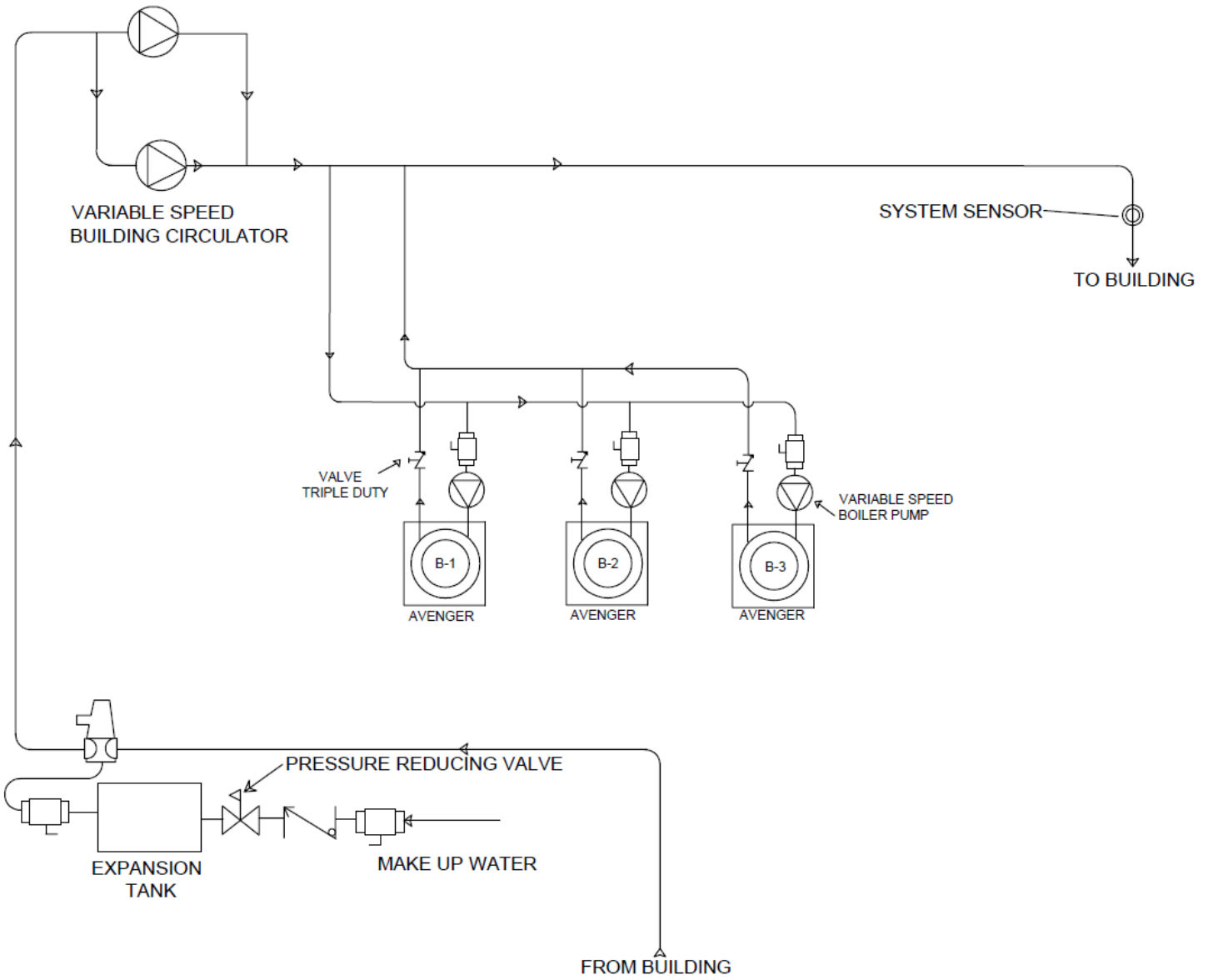


Figure 21: Recommended Piping with Reverse/Return and Variable Primary Flow



PART 5 ELECTRICAL & CONTROLS

DANGER
IT IS EXTREMELY IMPORTANT THAT THIS UNIT BE PROPERLY GROUNDED

5.1 ELECTRICAL CONNECTIONS

Table 9: Minimum Power Requirements

Model	Voltage Requirement	Maximum Over Current Protection	Full Load Amps
		[Amperes]	[Amperes]
1000 – 2000	115VAC, 60Hz	15	8.0
1000 – 2000 ^Δ	208/230VAC, 60Hz, 1 Phase*	15	9.5
2500 – 3500	208/230VAC, 60Hz, 1 Phase*	30	20
1000 - 3500 ^Δ	208/230VAC, 60Hz, 3 Phase**	20	12.0
4000	208/230VAC, 60Hz, 3 Phase**	30	18.0

*This is a 4-wire power supply requiring two (2) lives, a neutral and a ground

**This is a 5-wire power supply requiring three (3) lives, a neutral and a ground

^Δ Optional power supply

Avenger boilers supplied at 460/3/60 voltage, differ from the standard unit per the following:

CAUTION
While working with 460V circuits, it is imperative that extra precautions be taken
<ul style="list-style-type: none"> • Ensure that lock-out/tag-out procedures are strictly enforced • Only properly trained and authorized personnel should be permitted to work on live electrical circuits • All electrical workers should be trained in electrical rescue techniques and CPR

Each unit has a back mounted 500VA transformer to supply the single leg 115V necessary for the ignition circuit, which is factory mounted. The boiler itself is a single point power connection. A 460V/3/60 variable frequency drive replaces the standard VFD, and the combustion blower fan has been configured to operate at 460/3/60V (using the standard fan). Part numbers as well as FLA and MOCPP information is below.

500VA transformer: DC0500UH

VFD:
 ESV751N04TXB
 ESV112N04TXB
 ESV222N02YXB
 ESV402N02TXB

Model Range:
 AR1000 – AR1500 (1hp)
 AR2000 (1.5hp)
 AR2500 – AR3500 (3hp)
 AR4000 (5hp)



Model	Voltage Requirement	Maximum Over Current Protection	Full Load Amps
		(Amperes)	(Amperes)
1000	460VAC, 60Hz, 3 Phase	15	N/A
1500			1.4
2000			2.1
2500			3.3
3000			6.0
3500 – 4000			9.0

The combustion air fan motor operates on 230 VAC, 3 phase, 60Hz on models AR1000-4000. Three phase voltage is generated by the VFD and supplied directly to the fan motor. Refer to Table 9 for appropriate supply voltage to the appliance. The appliance, when installed, must be electrically grounded in accordance with the requirements of the authority having jurisdiction or in the absence of such requirements, with the latest edition of the National Electrical Code ANSI/NFPA No. 70. When the unit is installed in Canada, it must conform to the Canadian Electrical Code, C22.1, Part 1 and/or local Electrical Codes.

- All wiring between the appliance and field installed devices shall be made with wire having minimum 220°F (105°C) rating.
- Line voltage wire external to the appliance must be enclosed in approved conduit or approved metal clad cable.
- The pump must run continuously when appliance is firing.

- To avoid serious damage, **DO NOT ENERGIZE** the appliance until the system is full of water. Ensure that all air is removed from the heat exchanger pump housing and piping before beginning initial operation. Serious damage may result if the appliance is operated prior to purging of all air.
- Provide the appliance with proper overload protection.

5.2 VARIABLE FREQUENCY DRIVE

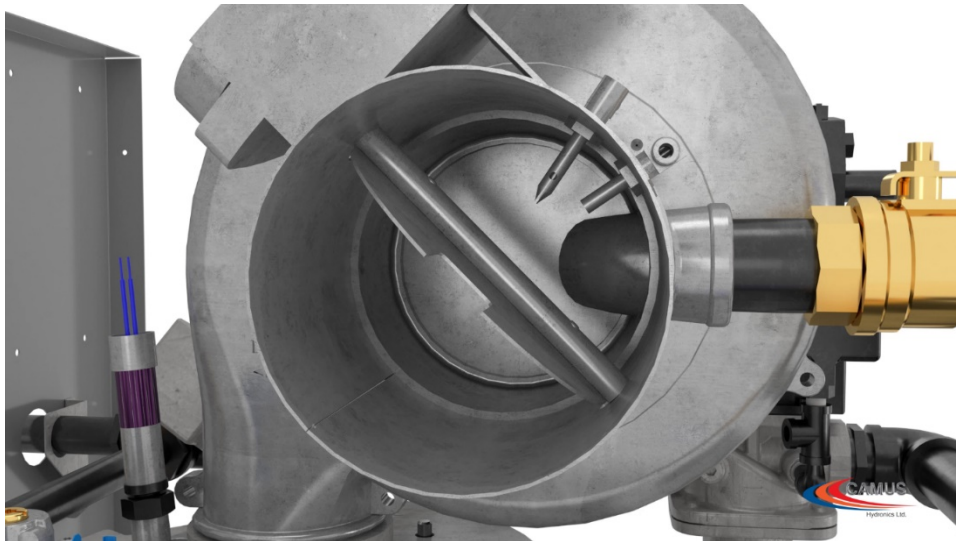
This appliance uses a VFD which provides power to the combustion fan. The fan motor operates on 230VAC 3 phase power. This three phase voltage is generated by the VFD and supplied directly to the fan motor. The VFD receives a 4-20mA modulating signal from the SOLA to vary the frequency of the voltage supplied to the fan motor. This varies the output of the combustion air fan from 4% up to 100% of capacity corresponding to the same variation in burner input. Once the 'self-checks' are completed by the SOLA, the VFD is provided with a signal to operate at soft start level for initial burner ignition. After main burner ignition is established, the modulating signal is generated by the VFD to vary fan speed based on desired water temperature set point.

CAUTION

The voltage output from the variable frequency drive to the combustion air fan is 230VAC, 3 Phase. **AVOID** contact with high voltage wiring.

5.3 ELECTRONIC LOW AIR PRESSURE SWITCH (DIFFERENTIAL)

A pressure transducer coupled with an electronic controller is used to prove operation of the combustion air fan on. The pressure switch sensing points are installed at the fan intake. One point measures total pressure (+air) and is connected to a pitot tube facing the flow. The other point measures static pressure. Differential pressure at the switch will be affected by blockages in the intake pipe or at the flue discharge. A minimum differential pressure across the sensing points of the pressure switch proves operation of the combustion air fan.



The diagnostics display will exhibit a status of an open Interrupted Air Switch (LCI OFF) when the differential pressure switch detects a sustained low air condition. This condition could be caused by several factors including:

- Sensing line broken or loose fitting
- Dirty filter or blocked vent
- Steady high wind condition
- Incorrectly set switch

The staging relay utilizes 4 individual relays:

Relay 1: operates the High-End Gas Valve and the air inlet damper.

Relay 2 and 3: activate/deactivate the hot surface igniter during the gas valve transition sequence.

Relay 4: is dedicated to low air switch operation and ensures that if a low air condition occurs the control will enter into an automatic reset error.



Figure 122: Electronic Low Air Switch



- Large red numbers indicate actual real-time differential air pressure reading
- Small green numbers indicate differential air pressure setting
- "1" indicates air switch is open



5.4 BLOCKED FLUE SWITCH

All models use a normally closed automatic reset blocked flue switch to shut down the appliance under the following conditions:

1. Air intake 50% blocked
2. Vent outlet 80% blocked

When the blocked flue switch has tripped, check the venting and/or air intake piping for obstructions before placing the unit into operation. Power must be shut off to the boiler and gas supply to the appliance must be closed before attempting to investigate reason for blocked flue condition. If the boiler cannot be restored to normal operating condition after removal of obstruction, please contact a qualified service agency.

Figure 23: Blocked Flue Switch



5.5 HIGH AND LOW GAS PRESSURE SWITCHES

A manual reset high gas pressure switch is standard on AR3000-AR4000 models and available as an option on AR1000-AR2500 models. If gas pressure exceeds the maximum setting of the pressure switch, the appliance will shut down and an open gas pressure switch will be shown on the display. A low gas pressure switch is standard and monitors the minimum incoming gas supply pressure supplied to the gas train. If gas pressure falls below the minimum setting of the pressure switch, the appliance will shut down and an open gas pressure switch will be shown on the display.

5.6 HIGH LIMIT

A high limit Aquastat control is located at the back of the appliance and the control bulb is installed in a dry well in the heat exchanger header outlet. The setting of this control limits maximum discharge water temperature. A manual reset high limit will have a red reset button which must be pushed whenever water temperature has exceeded the set point of the manual reset limit. The temperature of the water in the heat exchanger must drop a minimum of 15°F (8.3°C) below the setting of the high limit control before the reset function can be activated. Whenever an appliance is supplied with both an auto reset and manual reset high limit, always set the auto reset limit 10°F (5.5°C) below the manual reset limit to prevent nuisance tripping.

5.7 AVENGER SOLA

Avenger models utilize a Hot Surface ignition system. AR3000-AR4000 models utilize a proven pilot. The ignition control proves the presence of the flame using a flame rectification voltage (0.8Vdc), energizes the main gas valve, proves the presence of main burner flame, and provides for lockouts. The alarm light will be lit on the ignition control module in the event of a fault.

Figure 24: Ignition Module



5.7.1 SERVICE PARTS

The electronic ignition module is not repairable. Any modification or repairs will invalidate the warranty and may create hazardous conditions that result in property damage, personal injury, fire, explosion and/or toxic gases. A faulty Hot Surface Igniter or ignition module **MUST BE** replaced with a new factory approved unit only. A factory approved igniter, ignition control module and UV Scanner for this specific unit is available from your local distributor. **DO NOT** use general purpose field replacement ignition modules, igniters or UV Scanners. Each appliance has one ignition module, one Hot Surface Igniter and one UV Scanner.

5.7.2 IGNITION MODULE LOCKOUT FUNCTIONS

The ignition module may lockout in either a hard lockout condition requiring pushing of the reset button to recycle the control for a CSD-1 requirement or a soft lockout condition, which may be reset automatically once the error clears. A typical hard lockout fault can occur with a single trial for ignition CSD-1 module. Pushing the reset button on the ignition control is the only way to reset an ignition module that is in a hard lockout condition. The reset button is located on the ignition module. Turning the main power “OFF” and “ON” or cycling the thermostat will not reset a hard lockout condition. Wait until the display shows the temperatures on screen before pushing the reset button when the ignition module is in a hard lockout.

5.8 AVENGER CONTROLLER

Table 10: Connector Description

Connector	Connector Description
J1	UV Scanner, Ground
J3	Display, Lead Lag, Modbus Communication
J4	24VAC Power, Pump, VFD
J5	Gas Valve, Safety Interlock String
J6	Safety Annunciation, Remote Operator
J8	24 VAC Power, Inlet, Outlet Sensor
J9	DHW, Stack Sensor

5.9 ERROR TABLE

The following Tables provide a description of all the possible errors with the Avenger appliance. Errors can be divided into two groups. Lockout errors (can only be reset by pressing the RESET button) and alert errors (will disappear when the cause of error is cleared).

When the control is in error, the pump will be running. This is done to prevent the freezing of the central heating circuit when the boiler is in error during the winter period. For some non-volatile lockouts, the pump will not be running. See table below for more details.

Table 11: Lockout Codes

#	Description
1	Unconfigured safety data
2	Waiting for safety data verification
3-46, 58-60, 97-99, 143-148, 172-178	Internal Fault. Replace SOLA Controller
47	Flame rod to ground leakage
48	Static Flame
49	24VAC low/high
50	Modulation Fault
64	Fan speed not proved, ignition failure
67	Interlock Off, safety circuit is open
79	Heater Outlet high limit tripped
82	Stack limit tripped (PVC: 149°F, CPVC: 194°F, 250°F)
105	Flame detected out of sequence
106	Flame lost if Main Flame Establishing Period (MFEP)
107	Flame lost early in run
108	Flame lost in run
109, 110	Ignition failed
112	Pilot test flame timeout
113	Flame circuit timeout
137	Interlock failed to close, safety circuit is open
149	Flame detected

Figure 25: Lockout Condition (Home screen)

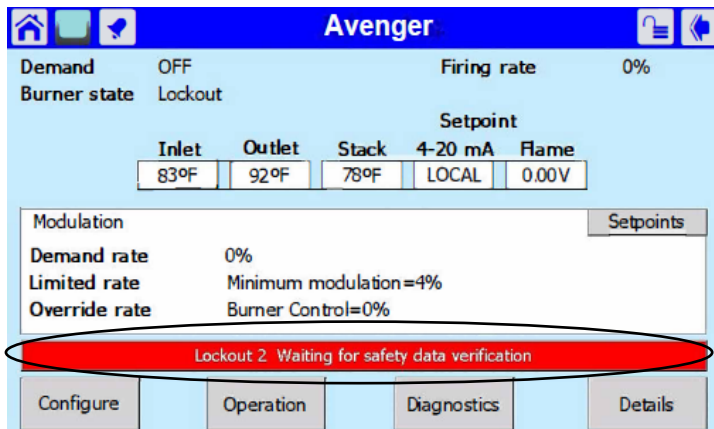
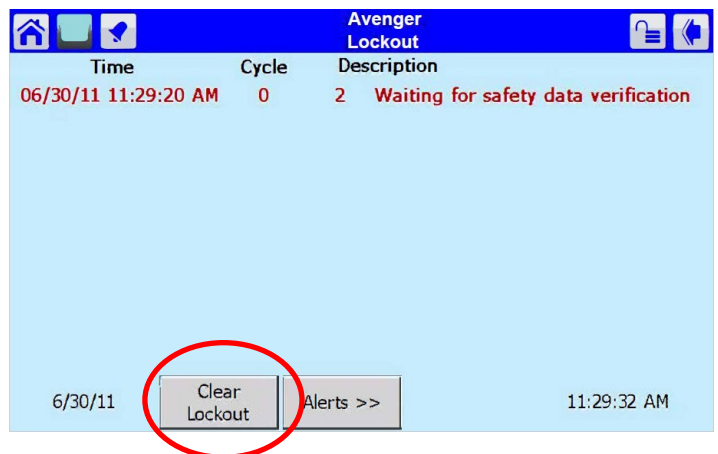


Figure 26: Lockout Condition (Lockout screen)



To eliminate the lockout error,

1. Press the red bar, as circled above
2. Press the [Lockouts] button
3. Press [Clear Lockout]

Table 12: Alert Codes

#	Description
29	Burner switch turned OFF
30	Burner switch turned ON
61	Anti-short Cycle
62	Fan speed not proved
63	LCI off, safety circuit is open
68	Setpoint was overridden due to sensor fault
69	Modulation was overridden due to sensor fault
81	Delta-T limit exceeded (70°F)
110	Ignition failure occurred
123	Modulation rate was limited due to outlet limit
124	Modulation rate was limited due to Delta-T limit
215	No Lead Lag slaves available to service demand
219	Using backup Lead Lag header sensor due to sensor failure
229	Lead lag slave communication timeout.
275-281	LCI off, safety circuit is open
283	Demand off during measured purge time
291	Abnormal Recycle: Flame was not on at end of Ignition period
292	Abnormal Recycle: Flame was lost during Main Flame Establishing Period
293	Abnormal Recycle: Flame was lost early in Run
294	Abnormal Recycle: Flame was lost during Run
303-310 ⁺	Interlock Off, safety circuit is open
324, 374-379	Hardware flame bias. Flame sensor wire needs to be re-routed.
352 ⁺	Stack sensor fault
355 ⁺	Outlet sensor fault
357 ⁺	DHW sensor fault
359 ⁺	Inlet sensor fault
460	LCI lost in run
550	Delta T inlet/outlet limit was exceeded
614	Lead boiler was rotated due to measured run time

* If an internal hardware fault is detected, contact Camus Technical Support for troubleshooting procedure.

⁺ The alarm LED and alarm contacts closed and remain closed until the 'RESET' button is pressed.

PART 6 CONTROL PANEL

6.1 APPLIANCE TEMPERATURE CONTROLLER

The appliance is provided with a control panel at the front. Operating controls are installed inside the control box and are accessible by undoing the (2) slotted screws and swinging the door open. The diagnostic information center as well as the on/off switch and the appliance temperature controls reside on the control box door. The ignition module, VFD, transformer and relays are mounted on the internal panel.

Figur: Control Panel Front



The SOLA icons will appear in one of four colors indicating the boiler status:

- Blue: Normal operation
- Red: Lockout Condition
- Yellow: Holding Mode
- Grey: Communication Error

The Boiler Temperature Controller for this appliance is the Honeywell SOLA. It initiates the local call for heat and sets the target return (appliance inlet) water temperature. This controller offers a range of operation modes that provides set point as well as modulating control. It provides the following:

- Readings of inlet and outlet water temperatures as well as flame signal.
- Operation as an auto reset limit.
- Operation as a control for inlet water temperature, outlet temperature, system temperature.
- ΔT heat exchanger protection algorithm.
- Available storage tank mounted sensor used in conjunction with inlet sensor.
- Adjustable: target temp, inter-stage differential, on delay between stages, minimum on time per stage, minimum off time per stage.
- Display of run hours for maintenance purposes. Counter wraps around at 10000 hours.
- Flame failure signal.
- JST and Molex connectors for ease of service.
- Error message display in text.
- Manual override of boiler input rate for combustion.
- Pump exercising feature runs pump 10 seconds every three days in the event of no pump operation.

Levels of access

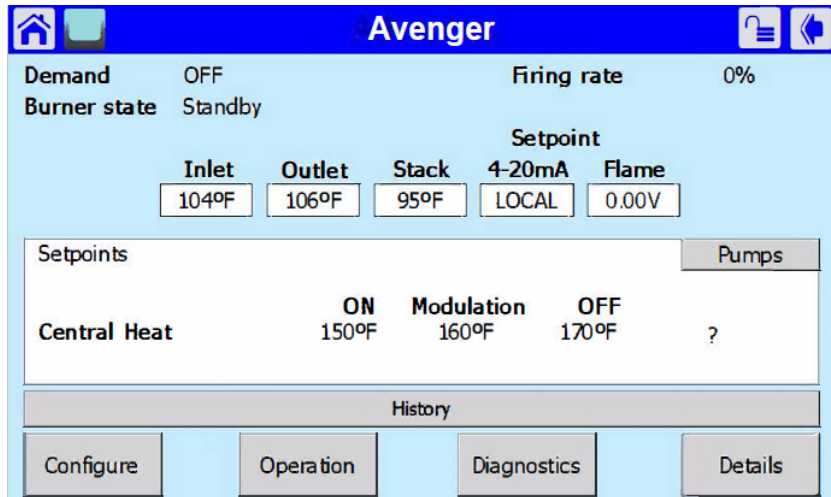
Two levels of access to simplify the use of the boiler.

User: Access to general boiler and display settings and adjustments to the central heating, domestic hot water, and lead lag setpoint.

Installer: Access to all user parameters and allows for changes to additional boiler parameters to allow for ease of startup and serviceability.

NOTE
Due to the sensitivity of the touchscreen controller, using a stylus is recommended for accuracy

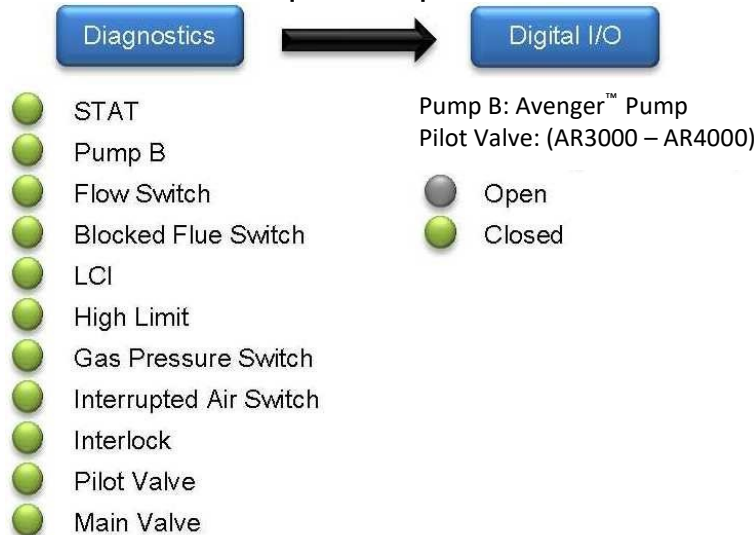
Figure 28: Home Screen



Parameter	Description
Demand	Central Heating (ARH)
	Domestic Hot Water (ARW)
	Lead Lag
Burner State	Current Status of Avenger
Firing Rate	Target Firing Rate
Inlet	Inlet Water Temperature [°F]
Outlet	Outlet Water Temperature [°F]
Stack	Stack Temperature [°F]
DHW	DHW Temperature [°F], if equipped
Header	Header Temperature [°F], if equipped
Outdoor	Outdoor Temperature [°F], if equipped

Button	Description
Configure	Access Avenger parameters (CH Parameters, DHW Parameters, Outdoor Reset, Pump Configuration etc.)
Operation	Details of Boiler Operation (Set point, Firing Rate, Pump Status, Safety Circuit)
Diagnostics	Manual Firing Rate, Analog/Digital Status
Details	History, Pump Status, Outlet Temperature

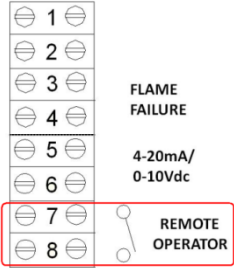
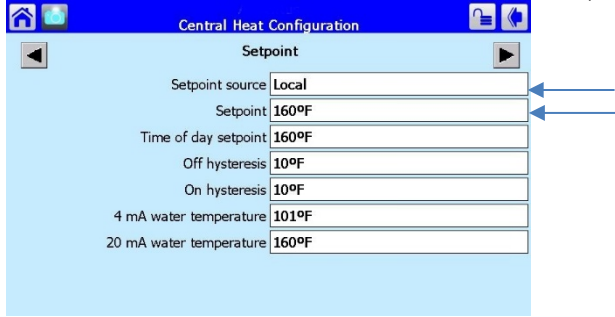
Sequence of Operation



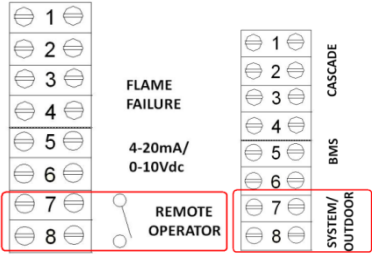
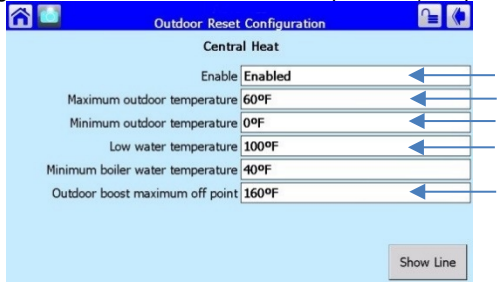
Flow Switch: Flow Switch, Water Pressure Switch (12 PSIG), Low Water Cut Off (if equipped)
Gas Pressure Switch: Low Gas Pressure Switch (4.5" w.c., N/O), High Gas Pressure Switch (14" w.c, N/C)
Interrupted Air Switch: Air Proving Switch (N/O)

Hydronic Heating

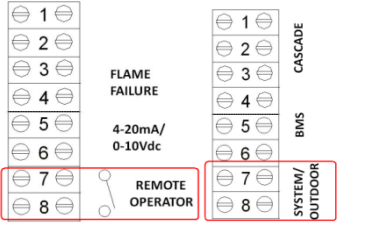
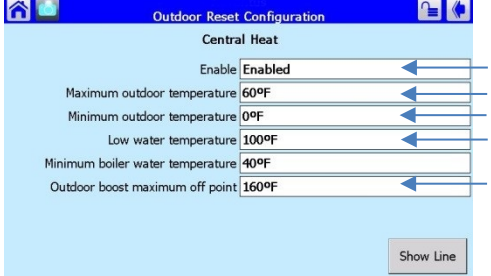
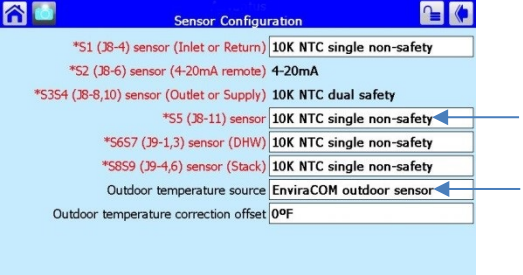
Modulation: Boiler Inlet, Boiler Fixed Setpoint Operation (Standalone)

Description	Electrical Connection(s)	Programming Instructions
<ul style="list-style-type: none"> Boiler operates at a fixed CH setpoint Modulates on boiler inlet sensor (default) Heat demand is generated when inlet temperature drops below setpoint minus on hysteresis If set to local enable constant pumping is required For remote enable intermittent pumping is allowed. 		<ol style="list-style-type: none"> Place toggle switch to LOCAL Press Configure and Login Press [CH – Central Heat Configuration] Press the ▶ to arrive at Setpoint Select Setpoint source: Local Enter desired Setpoint Place toggle switch to REMOTE for remote enable operation (if required) 

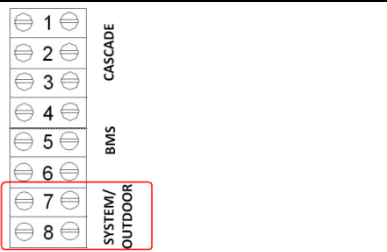
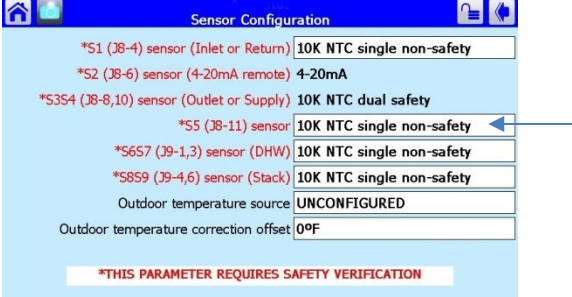
Modulation: Boiler Inlet, Outdoor Reset Operation (Standalone)

Description	Electrical Connection(s)	Programming Instructions
<ul style="list-style-type: none"> Boiler operates with variable setpoint determined by outdoor reset curve Modulates on inlet sensor (default) Heat demand is generated when inlet temperature drops below setpoint minus on hysteresis 		<ol style="list-style-type: none"> Connect outdoor sensor to System/Outdoor contacts Place toggle switch to LOCAL Press Configure and Login Press Outdoor Reset Configuration Select Enable: Enable Select Maximum outdoor temperature (WWSD) Select Minimum outdoor temperature (Outdoor Design) Select Low Water Temperature (Min. Water Temp.) Select Outdoor boost maximum off point (Design Max.) Press [CH – Central Heat Configuration] Select Outdoor Reset = Enabled Set CH Setpoint = Outdoor boost maximum off point Press Sensor Configuration Select Outdoor temperature source = S5 (J8-11) sensor Place toggle switch to REMOTE for remote operation (if required) 

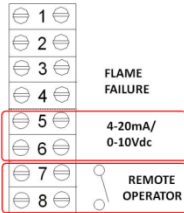
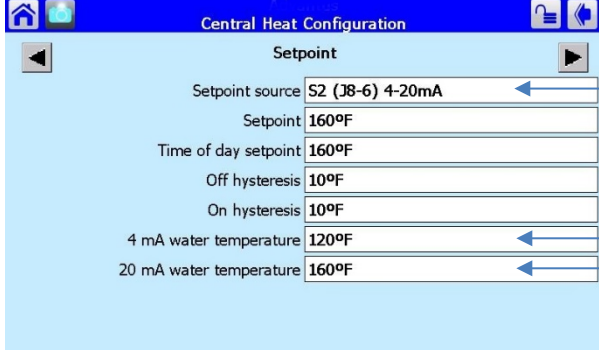
Modulation: System Sensor, Outdoor Reset Operation (Standalone) NOTE: Outdoor Reset Module required (PN: W8735S1000)

Description	Electrical Connection(s)	Programming Instructions
<ul style="list-style-type: none"> Boiler operates with variable setpoint determined by outdoor reset curve Modulates on system sensor Heat demand is generated when system temperature drops below setpoint minus on hysteresis 		<ol style="list-style-type: none"> 1) Connect Remote Operator 2) Connect System sensor to System/Outdoor contacts 3) Connect Outdoor Sensor to J3 ECOM connector 4) Place toggle switch in LOCAL 5) Press Configure and Login 6) Press Outdoor Reset Configuration 7) Select Enable: Enable 8) Select Maximum outdoor temperature (WWSD) 9) Select Minimum outdoor temperature (Outdoor Design) 10) Select Low Water Temperature (Min. Water Temp.) 11) Select Outdoor boost maximum off point (Design Max.)  <ol style="list-style-type: none"> 12) Press [Show Line] to confirm reset curve 13) Press Sensor Configuration 14) Select S5 (J8-11) sensor: 10K NTC single non-safety 15) Select Outdoor temperature source = EnviraCOM outdoor sensor 16) Place toggle switch to REMOTE for remote enable operation (if required) 

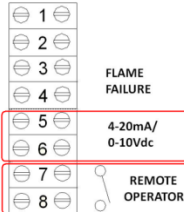
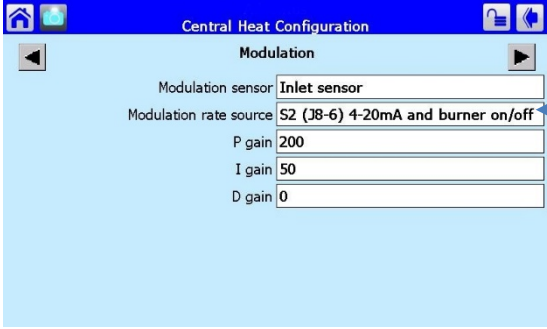
System Sensor Enable (Standalone)

Description	Electrical Connection(s)	Programming Instructions
<ul style="list-style-type: none"> Method to enable system sensor for Standalone applications 		<ol style="list-style-type: none"> 1) Press Configure and Login 2) Press [Sensor Configuration] 3) Select S5 (J8-11) Sensor: 10K NTC Single Non-Safety 4) The control will proceed into a Lockout 2 condition 5) Press [Verify] > [Begin] > [Yes] 6) Press the reset button on the ignition control within the allotted time 

4-20mA/ 0-10Vdc Setpoint Operation (Standalone)

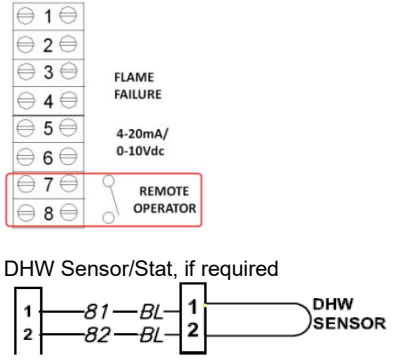
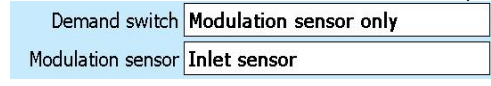
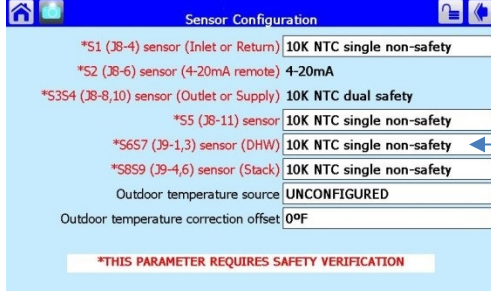
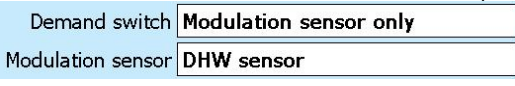
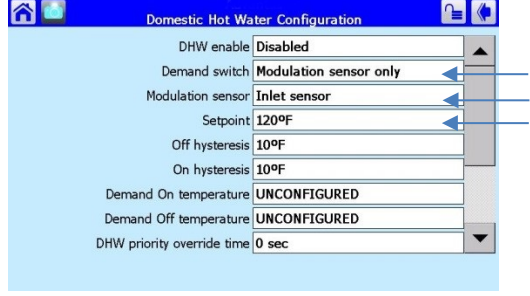
Description	Electrical Connection(s)	Programming Instructions
<ul style="list-style-type: none"> Boiler operates with variable setpoint determined by 4-20mA incoming signal Modulates on boiler inlet sensor (default) Heat demand is generated when inlet temperature drops below setpoint minus on hysteresis and 4-20mA or 0-10Vdc signal is present. If set to local enable constant pumping is required For remote enable intermittent pumping is allowed. 		<ol style="list-style-type: none"> Place toggle switch to LOCAL Press Configure and Login Press [CH – Central Heat Configuration] Press the ▶ to arrive at Setpoint Select Setpoint Source = S2 (J8-6) 4-20mA Select 4mA water temperature Select 20mA water temperature Place toggle switch to REMOTE for remote operation (if required) 

4-20mA/ 0-10Vdc Firing Rate Operation (Standalone)

Description	Electrical Connection(s)	Programming Instructions
<ul style="list-style-type: none"> Boiler operates with variable firing rate determined by 4-20mA incoming signal Modulates on boiler inlet sensor (default) Heat demand is generated when inlet temperature drops below setpoint minus on hysteresis and 4-20mA or 0-10Vdc signal is present. If set to local enable constant pumping is required For remote enable intermittent pumping is allowed. 		<ol style="list-style-type: none"> Place toggle switch to LOCAL Press Configure and Login Press [CH – Central Heat Configuration] Press the ▶ to arrive at Modulation Select Modulation Rate Source = S2 (J8-6) 4-20mA and burner on/off Place toggle switch to REMOTE for remote operation (if required) 

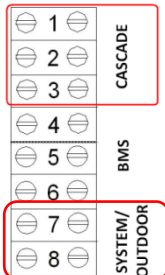
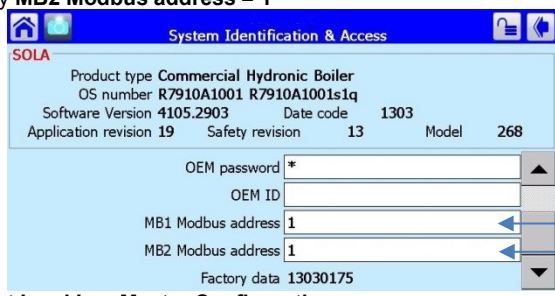
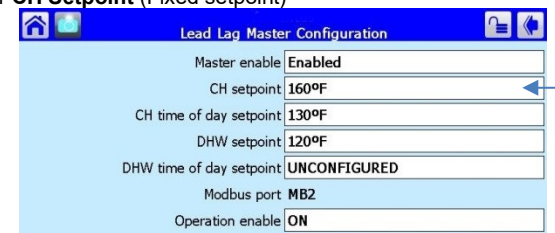
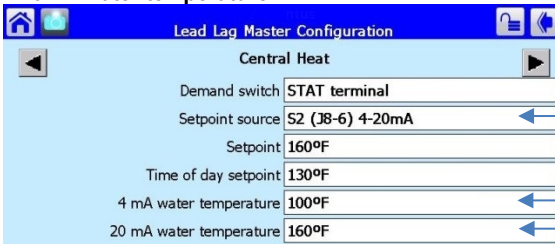
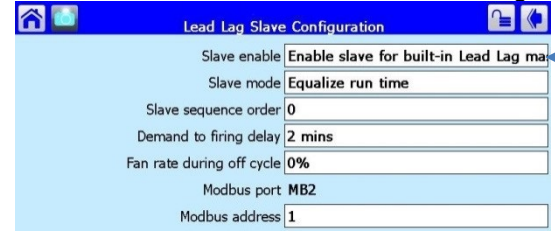
DHW (Domestic Hot Water)

Modulation: Boiler Inlet or DHW Sensor, Fixed Setpoint Operation (Standalone)

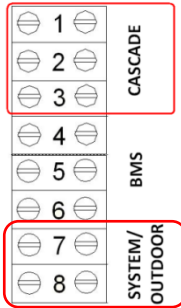
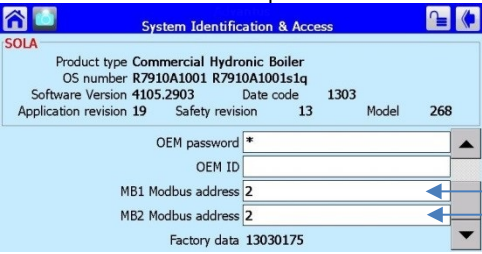
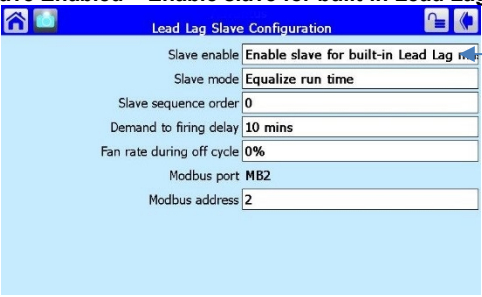
Description	Electrical Connection(s)	Programming Instructions
<ul style="list-style-type: none"> Boiler operates at a fixed DHW setpoint Modulates on boiler inlet sensor (default) Heat demand is generated when inlet temperature drops below setpoint minus on hysteresis. For inlet sensor operation constant pumping is required For DHW sensor/Aquastat operation intermittent pumping is allowed 		<ol style="list-style-type: none"> Place toggle switch to LOCAL Press Configure and Login <p>Inlet Sensor operation</p> <ol style="list-style-type: none"> Press [DHW – Domestic Hot Water Configuration] Select Demand Switch: Modulation sensor only Select Modulation sensor: Inlet Sensor. Proceed to Step 17  <p>DHW Sensor/Stat operation</p> <ol style="list-style-type: none"> Press [Sensor Configuration] Select S6S7 (J9-1,3) Sensor (DHW): 10K NTC Single Non-Safety The control will proceed into a Lockout 2 condition Press [Verify] > [Begin] > [Yes] Press the reset button on the ignition control within the allotted time  <p>DHW Sensor operation</p> <ol style="list-style-type: none"> Press [DHW – Domestic Hot Water Configuration] Select Demand Switch: Modulation sensor only Select Modulation sensor: DHW Sensor. Proceed to Step 17  <p>DHW Stat operation</p> <ol style="list-style-type: none"> Press [DHW – Domestic Hot Water Configuration] Select Demand Switch: DHW (S6) switch Select Modulation sensor: Inlet sensor Enter desired Setpoint (Maximum setpoint is Limited to 140°F) 

AR(H,W) Lead lag Operation

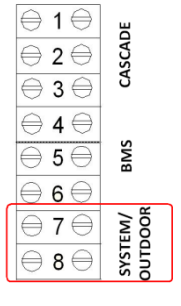
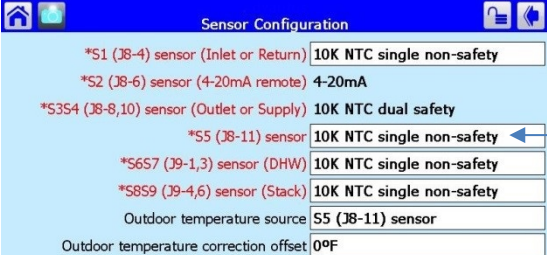
Master Boiler

Description	Electrical Connection(s)	Programming Instructions
<ul style="list-style-type: none"> Master boiler lead lag setup Modulates on system sensor connected to master boiler System temperature sensor must be connected to boiler #1. Outdoor temperature sensor must be connected to boiler #2. 		<ol style="list-style-type: none"> Place toggle switch to LOCAL Press Configure and Login Select System Identification & Access Verify MB1 Modbus address = 1 Verify MB2 Modbus address = 1
		 <ol style="list-style-type: none"> Select Lead Lag Master Configuration Select Master Enabled = Enabled
		<p><u>Fixed Setpoint operation</u></p> <ol style="list-style-type: none"> Enter CH Setpoint (Fixed setpoint) 
		<p><u>4-20mA/ 0-10Vdc setpoint operation</u></p> <ol style="list-style-type: none"> Select [Advanced Settings >] Press the ▶ to arrive at Central Heat Select Setpoint Source = S2 (J8-6) 4-20mA Select 4mA water temperature Select 20mA water temperature
		 <ol style="list-style-type: none"> Select Lead Lag Slave Configuration Select Slave enabled = Enable slave for built-in Lead Lag master
		

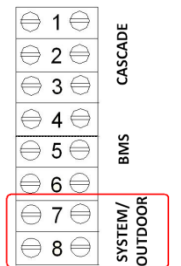
Slave Boiler

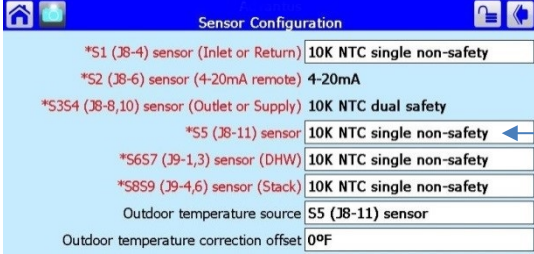
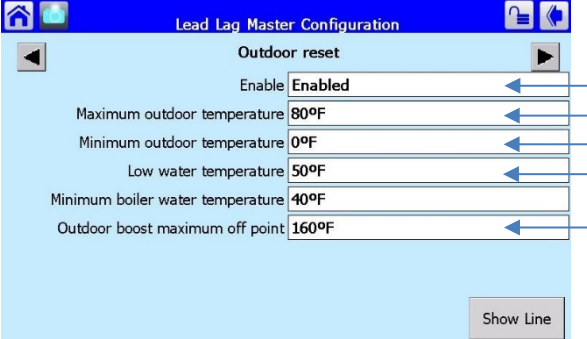

Description	Electrical Connection(s)	Programming Instructions
<ul style="list-style-type: none"> Slave boiler lead lag setup System temperature sensor must be connected to boiler #1. Outdoor temperature sensor must be connected to boiler #2. 		<ol style="list-style-type: none"> Place toggle switch to LOCAL Press Configure and Login Select System Identification & Access Verify Modbus address. To be in sequential order  Select Lead Lag Slave Configuration Select Slave Enabled = Enable slave for built-in Lead Lag master  <p><i>The following steps are performed at the factory and verifying on site will be sufficient:</i></p> <ol style="list-style-type: none"> Select Pump Configuration Press [Advanced Options >>] Press the ▶ to arrive at Central Heat Pump or DHW Pump On Options: <input checked="" type="checkbox"/> Local burner demand On Options: Local Lead Lag <input checked="" type="checkbox"/> Service Active Force On: <input checked="" type="checkbox"/> Outlet high limit

Master Boiler, System Sensor (Connected to Master Boiler #1)

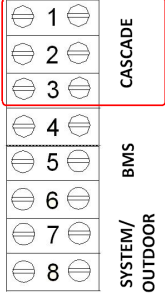
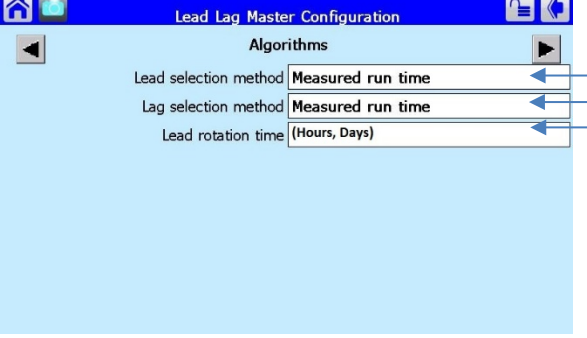
Description	Electrical Connection(s)	Programming Instructions
<ul style="list-style-type: none"> Master boiler system sensor configuration System temperature sensor must be connected to boiler #1. Outdoor temperature sensor must be connected to boiler #2. 		<ol style="list-style-type: none"> Press Configure and Login Press [Sensor Configuration] Select S5 (J8-11) Sensor Connector Type: 10K NTC Single Non-Safety  <ol style="list-style-type: none"> The control will proceed into a Lockout 2 condition Press [Verify] > [Begin] > [Yes] Press the reset button on the ignition control within the allotted time

Outdoor Sensor Connected to Slave Boiler 2 (ARH ONLY)

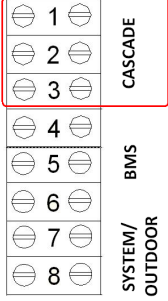
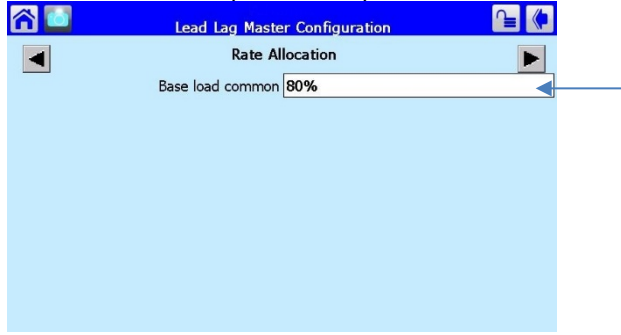
Description	Electrical Connection(s)	Programming Instructions
<ul style="list-style-type: none"> Slave boiler outdoor sensor configuration Outdoor temperature sensor must be connected to boiler #2. When done correctly, the outdoor temperature will be shown on the Master boiler 		<p>Slave Boiler</p> <ol style="list-style-type: none"> Press Configure and Login Press Sensor Configuration Select S5 (J8-11) Sensor Select Connector type = 10K single non-safety

		 <ol style="list-style-type: none"> 5) The control will proceed into a Lockout 2 condition 6) Press [Verify] > [Begin] > [Yes] 7) Press the reset button on the ignition control within the allotted time <p>Master Boiler</p> <ol style="list-style-type: none"> 8) Press Configure and Login 9) Press [Lead Lag Master Configuration] 10) Press [Advanced Settings >] 11) Press the ▶ to arrive at Outdoor Reset 12) Select Enable: Enabled 13) Select Maximum outdoor temperature (WWSD) 14) Select Minimum outdoor temperature (Outdoor design) 15) Select Low Water Temperature (Min. water temp) 16) Select Outdoor boost maximum off point (Design max.)  <ol style="list-style-type: none"> 17) Press [Show Line] to confirm reset curve 18) Press the ▶ to arrive at Warm Weather Shutdown 19) Select Enable = Shutdown after demand ends 
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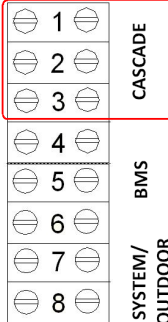
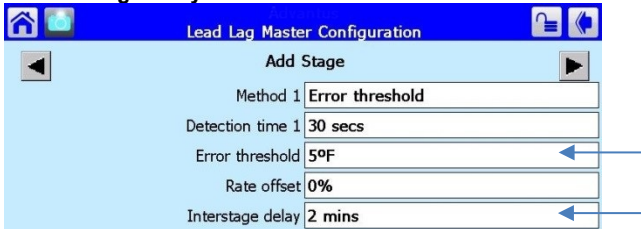
Rotation Schedule Adjustment

Description	Electrical Connection(s)	Programming Instructions
<ul style="list-style-type: none"> • Standard rotation schedule is based on equalizing run time on a 1-hour schedule • To vary the rotation to a fixed schedule based on (hours, days) 		<ol style="list-style-type: none"> 1) Press Configure and Login 2) Press [Lead Lag Master Configuration] 3) Press [Advanced Settings >] 4) Press the ▶ to arrive at Algorithms 5) Select Lead selection method: Sequence order 6) Select Lag selection method: Sequence order 7) Select Lead rotation time: (user defined) 

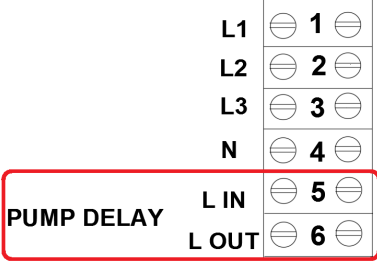
Base Load Rate Adjustment

Description	Electrical Connection(s)	Programming Instructions
<ul style="list-style-type: none"> Upon a call for heat the lead boiler will fire up to the specified base load rate (80%). If the temperature is not within Error threshold (5°F) of setpoint after Interstage delay (2 minutes) a lag boiler will be brought online and will also fire up to the base load rate specified. Modulation of boilers will only occur after all boilers in the Lead Lag system are firing up to the specified base load rate (80%). 		<ol style="list-style-type: none"> Press Configure and Login Press [Lead Lag Master Configuration] Press [Advanced Settings >] Press the ▶ to arrive at Rate Allocation Select Base load common: (user defined) 

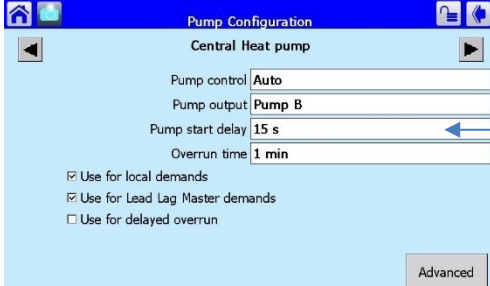
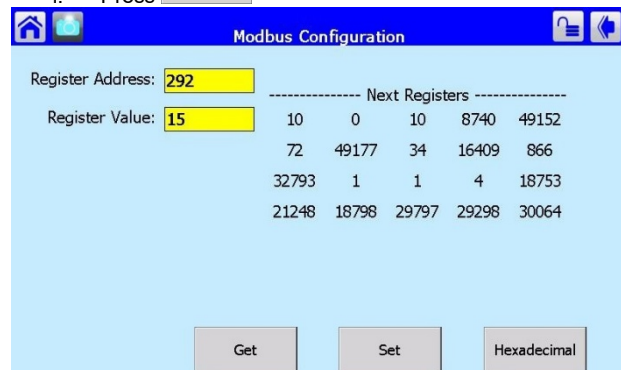
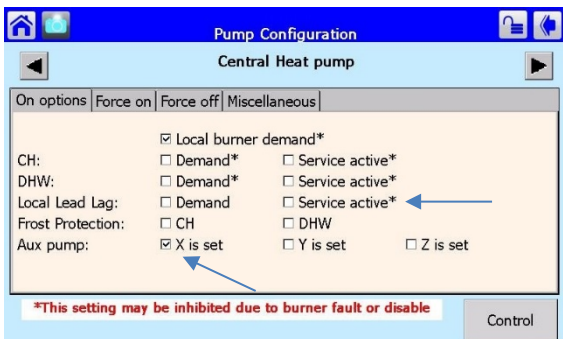
Adjust Staging of Boilers

Description	Electrical Connection(s)	Programming Instructions
<ul style="list-style-type: none"> Upon a call for heat the lead boiler will fire up to the specified base load rate (80%). If the temperature is not within Error threshold (5°F) of setpoint after Interstage delay (2 minutes) a lag boiler will be brought online and will also fire up to the base load rate specified. This method will then be repeated for the next lag boiler, if available. 		<ol style="list-style-type: none"> Press Configure and Login Press [Lead Lag Master Configuration] Press [Advanced Settings >] Press the ▶ to arrive at Add Stage Select Error threshold Select Interstage delay 

Boiler Pump Operation (ALL Boilers)

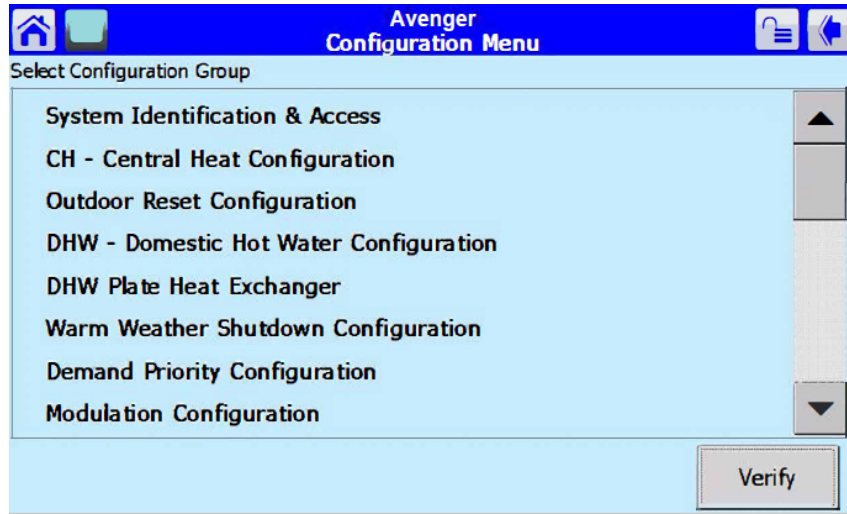
Description	Electrical Connection(s)	Programming Instructions
<ul style="list-style-type: none"> To activate the boiler pump on a call for heat. This function also includes a post pump feature. 		<ol style="list-style-type: none"> Select Pump Configuration Press [Advanced Options >>] Press the ▶ to arrive at Central Heat Pump or DHW Pump On Options: <input checked="" type="checkbox"/> Local burner demand On Options: Local Lead Lag <input checked="" type="checkbox"/> Service Active Force On: <input checked="" type="checkbox"/> Outlet high limit

Isolation Valve Operation (ALL Boilers)

Description	Electrical Connection(s)	Programming Instructions																											
<ul style="list-style-type: none"> Building pump varies flow through boiler based on demand Sequence of operation where two or more boilers or programmed to operate in lead lag <ol style="list-style-type: none"> Lead isolation valve is opened using Pump B (Central Heat Pump) contacts Remote Operator closes to initiate call for heat Prepurge, Honeywell SOLA checks that all boiler safeties are closed before ignition attempt Lead boiler fires up to base load rate (Default: 80%) for a period of time (Add Stage: Interstage delay) An additional boiler is needed when: Lead lag temp < (Lead lag setpoint – Add stage Error threshold) AND (Interstage delay timer has expired) Lag boiler is called to start 15-second delay exists between a call for heat and closure of Pump B contacts Lag boiler performs prepurge, Honeywell SOLA checks that all boiler safeties are closed before ignition attempt Lead boiler fires up to base load rate and both boilers modulate in unison up to 100% or as low as 4% based on heating demand Lag boiler shuts down first when: Lead lag temp > (Lead lag setpoint + Drop stage Error threshold) Lag boiler isolation valve remains open for overrun time (Default: 1 minute) All boilers off: Lead lag temp > (Lead lag setpoint + off hysteresis) Lead boiler isolation valve remains open for overrun time (Default: 1 minute). Lag boiler isolation valve also opens for overrun time to remove any residual heat that may have accumulated inside boiler. Lag boiler electronic isolation valve is closed, and lead boiler electronic isolation valve remains open 	<table border="1"> <tr> <td>L1</td> <td>1</td> </tr> <tr> <td>L2</td> <td>2</td> </tr> <tr> <td>L3</td> <td>3</td> </tr> <tr> <td>N</td> <td>4</td> </tr> <tr> <td>PUMP DELAY L IN</td> <td>5</td> </tr> <tr> <td>L OUT</td> <td>6</td> </tr> </table>	L1	1	L2	2	L3	3	N	4	PUMP DELAY L IN	5	L OUT	6	<ol style="list-style-type: none"> Press Configure and Login Select Pump Configuration Scroll to Central Heat Pump Select Pump start delay. Change this to 15 seconds  <ol style="list-style-type: none"> If the Pump start delay parameter does not appear on screen, use the following steps: Go to the Home Screen Press Setup Press Control Setup Press Modbus Configuration Enter Register Address: 292 Press Get Enter Register Value: 15 Press Set  <table border="1"> <thead> <tr> <th>Register Address</th> <th>Register Value</th> <th>Next Registers</th> </tr> </thead> <tbody> <tr> <td>10</td> <td>0</td> <td>10 8740 49152</td> </tr> <tr> <td>72</td> <td>49177</td> <td>34 16409 866</td> </tr> <tr> <td>32793</td> <td>1</td> <td>1 4 18753</td> </tr> <tr> <td>21248</td> <td>18798</td> <td>29797 29298 30064</td> </tr> </tbody> </table> <ol style="list-style-type: none"> Select Advanced Uncheck <input type="checkbox"/> CH: Demand* Uncheck <input type="checkbox"/> CH: Service Active* Uncheck <input type="checkbox"/> Local Lead Lag: Service Active* <input checked="" type="checkbox"/> Aux pump: X is set 	Register Address	Register Value	Next Registers	10	0	10 8740 49152	72	49177	34 16409 866	32793	1	1 4 18753	21248	18798	29797 29298 30064
L1	1																												
L2	2																												
L3	3																												
N	4																												
PUMP DELAY L IN	5																												
L OUT	6																												
Register Address	Register Value	Next Registers																											
10	0	10 8740 49152																											
72	49177	34 16409 866																											
32793	1	1 4 18753																											
21248	18798	29797 29298 30064																											

6.2 CONFIGURE MENU

Figure 29: Configure Menu



6.2.1 SYSTEM IDENTIFICATION & ACCESS

Menu Group Selection	Parameter	Description
System Identification & Access	Product Type	Commercial Hydronic Boiler
	OS number	Part Number of SOLA Controller
	Software Version	Software Version
	Date Code:	Release Date of Software
	Boiler Name	Avenger Model Number

6.2.2 PUMP CONFIGURATION

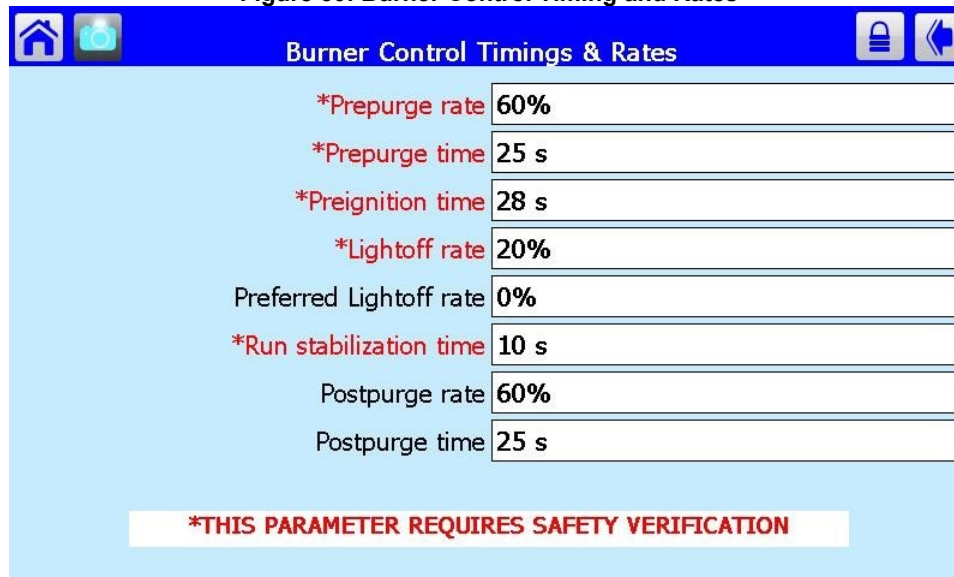
Pump Configuration	Central Heat Pump	Pump Control	Auto	Assigns the method for SOLA to control a Central Heating pump (Default: Auto, Pump is activated whenever a call for heat is present)
			ON	ON: Pump is constantly powered
		Pump Output	Pump B	Specify pump contact
		Over run time	1.5 min	Post pump time (Default: 1 min)
		Use for local (Stand-alone) demands	✓	
	Use for Lead Lag Master demands	✓		
	Boiler Pump	Pump Control	Auto	Refer to above (Default)
			ON	Refer to above
		Pump Output	Pump A	Specify pump contact
		Over run time	1.5 min	Post pump time (Default: 1 min)
Use for local (Stand-alone) demands		✓		
Use for Lead Lag Master demands	✓			
Pump Configuration	DHW Pump	Pump Control	Auto	Refer to above (Default)
			ON	ON: Pump is constantly powered
		Pump Output	Pump B	Specify pump contact
		Over run time	1.5 min	Post pump time (Default: 1 min)

6.2.3 STATISTICS CONFIGURATION

Menu Group Selection	Sub-Menu Group Selection	Parameter	Selection	Description
Statistics Configuration		Boiler pump cycles		Displays the number of cycles the boiler pump has been activated
		Burner cycles		Displays the number of cycles the burner has been activated
		Burner run time		Displays burner run time in hours
		CH pump cycles		Displays the number of cycles the CH pump has been activated
		DHW pump cycles		Displays the number of cycles the DHW pump has been activated

6.2.4 BURNER CONTROL TIMING AND RATES

Figure 30: Burner Control Timing and Rates



Menu Group Selection	Sub-Menu Group Selection	Parameter	Selection	Description
Burner Control Timing and Rates		Prepurge rate	3000 RPM	Prepurge fan speed (Default: AR1000-AR4000: 60.0%)
		Prepurge time	25 sec..5 mins	Prepurge time (Default: 25 sec)
		Run Stabilization Time	10 sec	Main flame establishing period
		Postpurge rate	3000 RPM	Postpurge fan speed (Default: AR1000-AR4000: 60.0%)
		Postpurge time	25 sec..5 mins	Postpurge time (Default 25 sec)

6.2.5 BURNER CONTROL IGNITION

Menu Group Selection	Sub-Menu Group Selection	Parameter	Selection	Description
Burner Control Ignition		Light-off rate	AR1000-AR4000: Refer to factory test sticker	Ignition Fan Speed

6.2.6 SENSOR CONFIGURATION

Menu Group Selection	Sub-Menu Group Selection	Parameter	Selection	Description
Sensor Configuration		S1 (J8-4) sensor	10K NTC single non-safety	Inlet Sensor
		S2 (J8-6) sensor	4-20mA	4-20mA Input Signal
		S3S4 (J8-8, 10) sensor	10K NTC dual safety	Outlet Sensor
		S5 (J8-11) sensor	10K NTC single non-safety	Outdoor Sensor: Standalone boiler or Slave boiler Header sensor: Master boiler
		S6S7 (J9-1,3) sensor	10K NTC single non-safety	DHW Sensor (ARW Only)
		S8S9 (J9-4,6) sensor	10K NTC single non-safety	Stack Sensor

6.3 LEAD LAG SETUP

All SOLA controllers are programmed with a default address of 1. The address of the slave controllers in the system must have a unique address (1..8).

Sequence of Operation:

When a boiler is set as Lead Lag Master = Enabled and Modbus address =1, the controller of this boiler will drive the lead lag operation.

The outdoor temperature sensor connected to the slave boiler 2 (ie. B-2) will be the outdoor sensor for the lead lag system.

- The system temperature sensor connected to boiler 1 (the master) in terminals labeled “Outdr/Sys” in the junction box will be the control sensor for lead lag operation.
- The start/stop signal connected to boiler 1 (the master) at terminals labeled “Remote Operator” will be the enable signal for lead lag operation.

When the enable signal is present and there is a heat demand, the lead boiler will start and uses the lead lag parameters for boiler modulation. After a period of “Interstage delay” the master boiler compares the lead lag temperature with the lead lag set point and will check if:

1. **An additional boiler is needed:** Lead lag temperature < Lead lag setpoint – Add stage Error Threshold
2. **Number of boilers remain the same:** Lead lag temperature > Lead lag setpoint – Add Stage Error Threshold **AND** Lead lag < Lead lag setpoint + Drop Stage Error Threshold
3. **A boiler should stop:** Lead lag temperature > Lead lag setpoint + Drop Stage Error Threshold
4. **All boilers off:** Lead lag temperature > Lead lag setpoint + Off Hysteresis

If the lead lag master system is interrupted, the remaining boilers will operate as standalone boilers based on the Central Heat or DHW parameters when set to “Enabled”.

Rotation

Rotation time is configurable based on equalized run time (default) or a fixed rotation schedule.

Interstage Delay

The length of time to wait between requesting a slave SOLA to fire. (Default: 2 minutes)

Base Load Rate

When a call for heat is initiated the lead boiler runs up to the desired base load rate (default: 80%) and continues to operate in this fashion based on the above 4 scenarios. If the lead lag temperature is not satisfied a second boiler is fired and they would both operate up to 80% fire rate.

Slave State

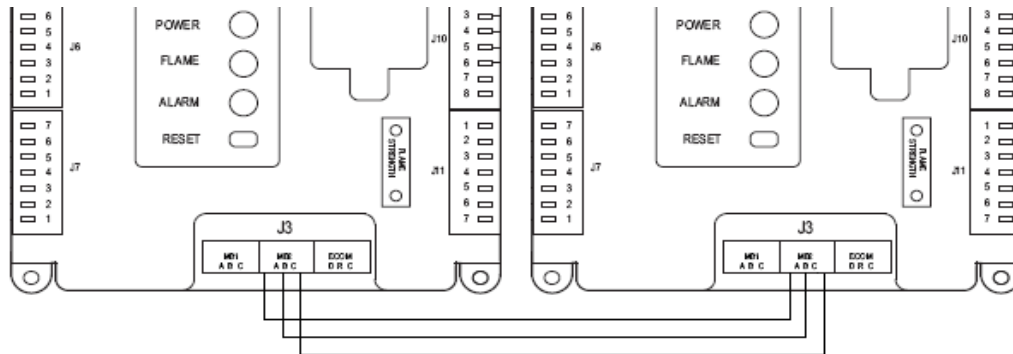
Slave Status Manager	
Unknown	Table entry is unused or empty
Available	Slave is operational and ready to use
Add Stage	Stage is getting ready to fire
Suspend Stage	Stage was getting ready but is not needed
Disabled	Slave is locked out or disabled
Recovering	Slave is in time delay to verify that it is operational before considered to be available

Wiring the Lead Lag Setup

Use Cascade terminals in the junction box to wire lead lag appliances.

	Master	Slave 2	..	Slave 7
J3, MB2	A	A	..	A
	B	B	..	B
	C	C	..	C

Figure 31: Lead Lag Wiring Setup (Left: Master, Right: Slave)



NOTE

Recycle power on all boilers after programming is complete if lag boilers are not discovered automatically

NOTE

CH Setpoint or DHW Setpoint must match Setpoint located in Lead Lag Master Configuration, for the system to operate correctly.

NOTE

The Local/Remote switch must be set in the "Local" position on ALL lag boilers.

6.4 LOCAL/REMOTE SWITCH

The local remote switch mounted inside the control box is designed to deliver an enable signal either relying on an external contact closure (Remote) or enabling the boiler locally (Local). When Remote is selected via the DPDT switch, the Remote Operator contacts must close to deliver an enable signal. When Local is selected via the DPDT switch, a constant enable signal is present. When troubleshooting the Avenger, it is recommended to switch to Local mode.

6.5 MODBUS, BACNET IP, BACNET MSTP, LONWORKS, METASYSN2 INTEGRATION




For detailed instructions on interfacing with Modbus/Bacnet/LonWorks/Metasys N2 Network, refer to Camus Hydronics website.

6.6 VARIABLE FREQUENCY DRIVE

The VFD has 50 parameters, which can be adjusted. At present, only the following are pertinent:

Table 13: Variable Frequency Drive Parameters

Parameter #	Function	Settings
100	Sets terminal strip as start/stop control	01
101	Sets 4-20 mA as standard reference source	02
102	Min Freq.	Refer to factory test sticker/report
103	Max Freq.	Refer to factory test sticker/report
104	Acceleration time	Depending on the model: preset at factory
105	Deceleration time	Depending on the model: preset at factory
111	Stop method – will use value in Parameter #105	02
150	Follows 0-10Vdc output freq.	01
160	Speed at minimum signal	Refer to factory test sticker/report
161	Speed at maximum signal	Refer to factory test sticker/report
181	Skip Frequency 1	Refer to factory test report
184	Skip Frequency Bandwidth	Refer to factory test report

- 1) To enter/exit parameter menu use 
- 2) Use  and  to arrive desired parameter and adjust value
- 2) If stop activated in run condition, must reset power to clear stop

6.7 FROST PROTECTION

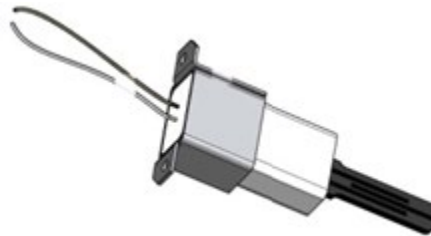
The Avenger is equipped with a heat exchanger frost protection algorithm where if the boiler inlet or outlet temperature sensors drop below 41°F (5°C) the boiler pump is enabled. If the temperature continues to drop to 38°F (3.3°C) the burner will be fired to bring the inlet and outlet temperatures to 50°F (10°C) to prevent freezing of the heat exchanger.

PART 7 COMPONENTS

7.1 HOT SURFACE IGNITOR

The silicon carbide igniter is inserted directly through the fan flange and held in place by two screws. A hold down bracket as well as sealing gasket above and below the igniter assures a good seal. Care must be taken when removing and/or installing the igniter since the silicon carbide element is brittle. Always remove the igniter prior to removing the fan assembly for inspection of the burner and heat exchanger. A properly prepared igniter will have a bead of silicone sealing the end mounting bracket to the ceramic shaft. Ceramic gaskets above and below the metal flange prevent the escape of hot combustion products.

Figure 32: Hot Surface Ignitor



During trial for ignition a properly operating igniter will generate 3.2+/-0.2A which is above the current required for reliable ignition. It is recommended that the Hot Surface Igniter be replaced every 4,000 hours of appliance operation to maintain peak ignition efficiency.

7.2 UV SCANNER

The UV Scanner is screwed on a 1/2" NPT pipe nipple and is screwed into the fan flange. Care must be taken when installing the UV Scanner, to align it parallel to the 1/2" NPT pipe nipple and not to over tighten. Always remove the UV Scanner prior to removing the fan assembly for inspection of the burner and heat exchanger.

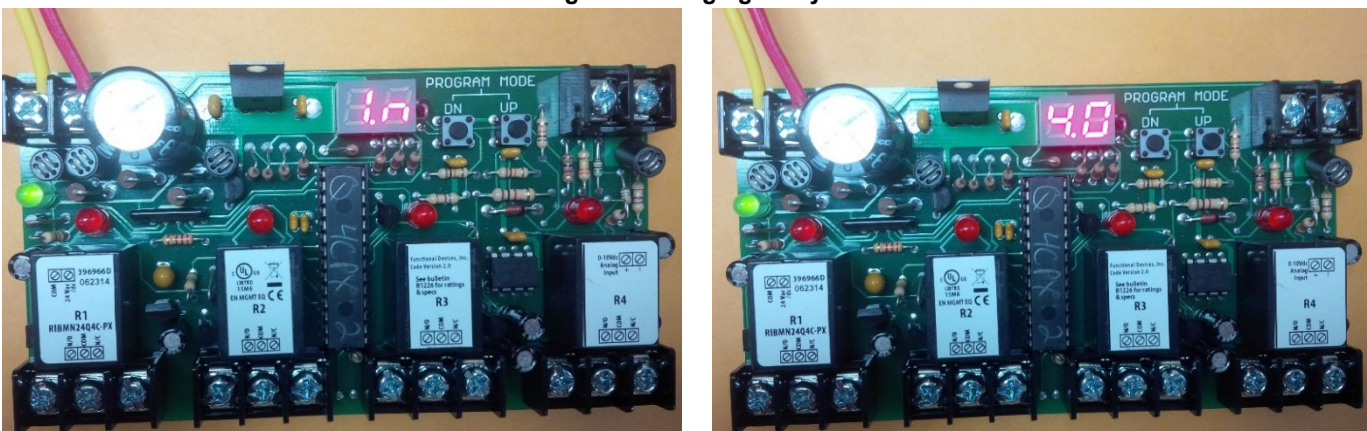
Figure 33: UV Scanner



The ignition module relies on the UV Scanner to provide a flame rectification signal. Oxide deposits, improper placement or damaged ceramic insulator will result in insufficient signal leading to ignition module lock out. For proper operation minimum 0.8 Vdc must be fed back to the module. Oxide deposit on the detector window must be removed with a soft, clean cloth. The inside of the sight pipe must be cleaned before re-installing the UV Scanner. The UV Scanner has a life expectancy of 40,000 hours.

7.3 STAGING RELAY

Figure 34: Staging Relay



Avenger models feature a staging relay card which provides additional logic to open and close relays at factory set pre-determined points based on a Vdc signal provided by the VFD. These relays provide a means to activate/deactivate at various points in the boiler operation:

- 1) Low-End and High-End Gas Valves (R1)
- 2) Re-light Hot Surface Igniter (R2 & R3)
- 3) Electronic Air Switch (R4)

To maintain longevity and reliable operation of the hot surface igniter (HSI), the HSI is only activated during the transition from one gas valve to another using R2 and R3 relays.

7.4 OUTER JACKET

The outer jacket assembly is constructed from galvanized steel with silver and black color/texture. The frames are constructed from Aluminum. This setup ensures light weight and long life for the jacket assembly, with full integrity. Removable panels have been incorporated to the design for ease of service.

7.5 VENTING TRANSITION

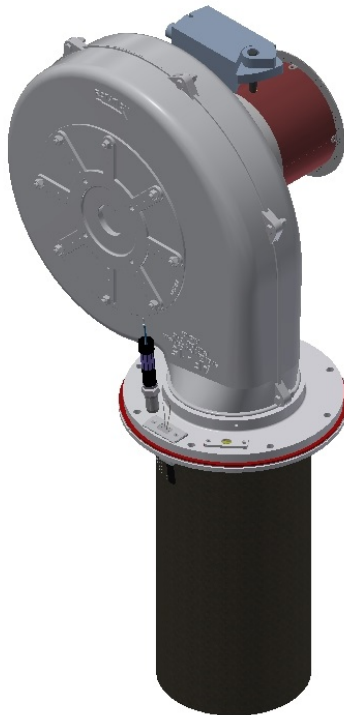
All appliances are shipped with a female vent outlet pipe. Depending on the appliance category (II or IV), an increaser will be required for the proper vent configuration. Please refer to Table 3 dimensions and specifications.

7.6 CONDENSATION COLLECTION

Depending on water temperatures and firing rate there may be large volumes of condensate generated. At high fire with condensing inlet water temperatures less than 130°F, condensate will be ejected from the vent outlet pipe and into the vent. It is recommended that provisions be made for collection and disposal of condensate from the vent. At low fire with condensing inlet water temperature, condensate will be generated within the secondary pass of the heat exchanger and will fall into the bottom collection pan. This condensate will be collected in the condensate box provided with the Avenger. The condensate box provided with the Avenger has two connections. One connection (flex metal) removes condensate from the bottom pan and the other connection (flexible plastic) removes condensate from the vent outlet pipe.

7.7 COMBUSTION AIR FAN

Figure 35: Fan, Burner, Hot Surface Igniter and UV Scanner Arrangement



Avenger uses a sealed air fan to provide combustible air/gas mix to the burner and push the products of combustion through the heat exchanger and venting system. The fan assembly consists of a sealed housing and fan wheel constructed from spark resistant cast aluminum. The fan is operated by a fully enclosed 230 VAC, 3-phase electric motor. The fan housing and motor assembly is fully sealed and SHOULD NOT be field serviced. The power draw of the motor is proportional to the modulated gas input rate of the appliance.

PART 8 FIELD STARTUP PROCEDURES

8.1 CHECKING THE INSTALLATION

- Inspect the connections for water, gas and electricity.
- Confirm that water is being pumped toward the heat exchanger inlet (return). Never pump away from the heat exchanger since this will result in a low-pressure zone, which will allow localized boiling and result in heat exchanger damage.
- Power to the boiler and pump must be from the same circuit to prevent the boiler firing in case the pump is accidentally shut off.
- Vent all air from the heat exchanger prior to firing using the two air vents provided on the heat exchanger. The air vent located on the outlet of the unit is a **manual air vent** and the air vent located close to the inlet of the unit is an **automatic air vent**. Both air vents can be accessed by removing the top cover and they are located on top portion of the Avenger heat exchanger.
- Inlet gas pressure must be a minimum of 4.0" W.C. for natural gas and 8.0" W.C. for propane.
- With the boiler off, open the main gas supply valve and vent the trapped air from the piping leading to the boiler. Confirm that all gas connections to the unit are tight and that there are no missing test plugs.
- Connect a manometer to obtain the differential air pressure between negative and positive ports, See Figure 11.
- The air/gas ratio controller automatically adjusts to match the air signal on the gas side. In this way true mass flow control of air/gas mix is achieved. All boilers are test fired and factory set. A test sheet with actual reading is affixed to the unit.

CAUTION

When venting air from heat exchanger, position the manual air vent tube so that system fluid is directed **away** from operating personnel. **Always open bleed valve slowly**. Some fluid weepage will occur when the valves are opened. Operating personnel must take suitable measures to protect themselves from exposure to system fluids.

CAUTION

When venting air from heat exchanger, make sure to **close the bleed after the air has been removed from the unit**. Failure to do so can cause water leakage, flooding and safety issues.

8.2 CHECKING THE CONSTRUCTION

- Check the boiler wiring to see that it agrees with the wiring diagram supplied.
- Confirm that all terminal strips and field connections are identified.
- Confirm that the Avenger controller is set in the proper mode. Auto reset limits are fixed in all modes.
- With the low-end firing valve in the off position, switch on power to the boiler. The fan motor will accelerate until the Interrupted Air Switch icon becomes green.
- Once all lights past the STAT are green, the SOLA will try for ignition. When the igniter is hot enough, the gas valve actuator is energized and if ignition is accomplished the Burner State will show "Run". If ignition is not accomplished, the Burner State will show "Safe Startup". It is normal during initial startup, when air is being purged from the piping, to require two to three tries before successful ignition.
- With the boiler running, check for flue gas leaks around the flue outlet. Some minor leakage is acceptable.
- Repair any major leaks prior to the next step.
- At the factory adjustments were made to achieve proper input and combustion at maximum and minimum inputs.

8.3 GAS VALVE ADJUSTMENT PROCEDURE

Table 14: Combustion Values

	Combustion Values			
	Natural Gas		Propane	
	CO ₂	CO	CO ₂	CO
Max Fire	9.0% - 9.8%	<100 PPM	10.5% - 11.5%	<100 PPM
Min Fire	7.8% - 8.5%	<100 PPM	10.0% - 10.5%	<100 PPM

If adjustment of the gas valve is required, use the following procedure.

It is imperative that the coldest system water temperature possible is used when setting up low fire combustion. These cold system temperatures create large amounts of flue condensate resulting in large amounts of condensate build up on the stainless steel heat transfer tubes. These conditions create the highest back pressure through the boiler and makes for the most critical combustion set up point when running at low fire. This set up must be achieved quickly to ensure low system temperatures are maintained throughout the setup of single or multiple boiler installations.

Procedure for Combustion Adjustment

In order to perform adjustments to the gas valve, the Avenger must be firing before proceeding. Light off the boiler and make the initial adjustment to the Low-End Gas Valve to obtain the specified CO₂, CO, at minimum gas input.

Once the interface relay has switched to the High-End Valve, while maintaining the lowest possible water temperature, observe the differential gas pressure when running with the High-End Valve. The differential gas pressure must not drop below a minimum of 0.25" W.C. Once the boiler has run for at least 5 minutes with cold water, there should be a maximum amount of condensate in the heat exchanger. At this point adjust the combustion for CO₂.

The boiler must continue to run with stable combustion without making any harmonics noise which usually happens from an overly rich mixture. Once settings are complete at low fire, continue to run the machine for at least 5 more minutes and record the final low fire input and the combustion data.

To ensure the coldest possible water temperatures for set up on multiple boiler systems, the low fire combustion should be established on all boilers before setting any boiler high fire combustion rates.

Figure 36: AR1000 Low End Gas Valve

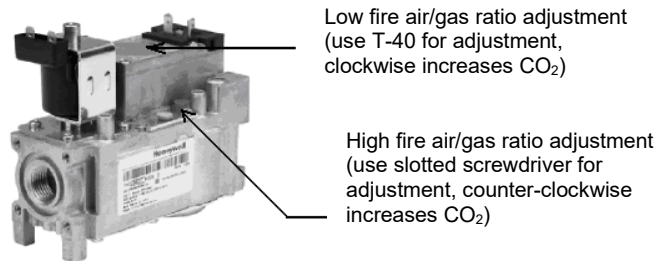
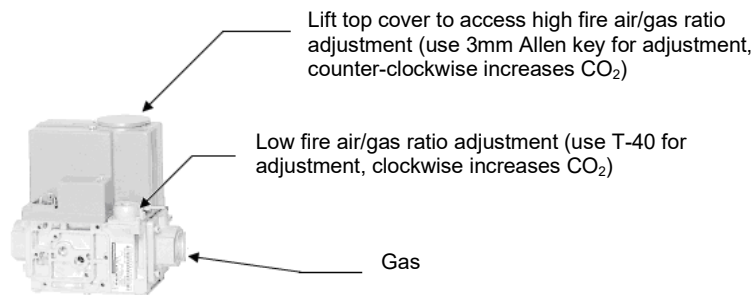


Figure 37: AR1500 – AR4000 Low End Gas Valve



Adjusting the low fire setting of the Low-End Valve

Use the Avenger Control Panel

1. Press **[DIAGNOSTICS]** button
2. Press **[Diagnostic Tests]** button
3. Move the firing rate slider to firing rate (%) indicated on test reports.
4. Press **[Start Test]** to operate the boiler at this firing rate for 5 minutes.

	Increase CO ₂	Decrease CO ₂
Low Fire Adjustment	⌚	⌚
	Clockwise	Counter-Clockwise

After adjusting the screw, wait a moment for the combustion levels to stabilize before attempting to make any further adjustments. Continue this procedure until combustion levels are satisfied.

When the correct combustion values are achieved replace the screw cap back on to the gas valve.

Adjusting the high fire setting of the Low-End Valve

The high fire setting of the Low-End Gas Valve must be set at a point just before the Siemens gas valve is activated. This will vary from model to model and the installer will need to monitor at which point on the VFD that the transition occurs. Set the High-End Gas Valve at 2 Hz below where the transition occurs. This transition has been set and tested at the factory and should normally not require adjustment.

Use the Avenger Control Panel

1. Press **[DIAGNOSTICS]** button
2. Press **[Diagnostic Tests]** button

3. Move the firing rate slider to firing rate (%) indicated on test reports.
4. Press **[Start Test]** to operate the boiler at this firing rate for 5 minutes.

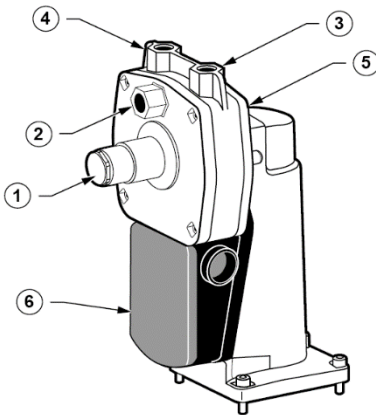
	Increase CO ₂	Decrease CO ₂
High Fire Adjustment	↻	↻
	Counter-Clockwise	Clockwise

After adjusting the screw, wait a moment for the combustion levels to stabilize before attempting to make any further adjustments. Continue this procedure until combustion levels are satisfied.

When the correct combustion values are achieved replace the screw cap back on to the gas valve.

Adjusting the low fire setting of the High-End Valve

Figure 38: SKP55 Gas Valve



1. Adjustment of low fire bias
2. Connection for air pressure (+) sensing line
3. Connection for the air pressure (-) sensing line
4. Connection for the gas pressure (-) sensing line
5. Connection for the gas pressure (+) sensing line
6. Position indicator

All these connections are stamped on the aluminum casting

Use the Avenger Control Panel

- 1) Press **[DIAGNOSTICS]** button
- 2) Press **[Diagnostic Tests]** button
- 3) Move the firing rate slider to firing rate (%) indicated on test reports.
- 4) Press **[Start Test]** to operate the boiler at max fire for 5 minutes.

	Increase CO ₂	Decrease CO ₂
Low Fire Adjustment	↻	↻
	Clockwise	Counter-Clockwise

When the correct combustion values are achieved replace the screw cap back on to the gas valve.

Adjusting the high fire setting of the High-End Valve

Two manometers should be connected to the Avenger before proceeding to the next step to simultaneously monitor the air and gas signal. Refer to Section 3.8 of this manual for details on connecting manometers.

After the low fire settings are stable, ramp the boiler firing rate to 100% using the boiler control and bring the system temperatures up to 130°F or to highest system design temperatures to minimize or eliminate condensate.

Use the Avenger Control Panel:

- 1) Press **[DIAGNOSTICS]** button
- 2) Press **[Diagnostic Tests]** button
- 3) Press **[Maximum Modulation]** button
- 4) Press **[Start Test]** to operate the boiler at max fire for 5 minutes.

	Increase CO ₂	Decrease CO ₂
High Fire Adjustment	↻	↻
	Counter-Clockwise	Clockwise

Turn the metering valve 1/8 turn in either way for each adjustment to keep track of the adjustments. After adjusting the valve wait a moment for the combustion levels to stabilize before attempting to make any further adjustments. Continue this procedure until combustion levels are satisfied. **NOTE:** Metering valve is factory set and should not normally require adjustment.

NOTE: Illustrations below do not reflect actual gas train assemblies on these models.

Figure 39: Typical Gas Train (Models AR1000-AR3000)

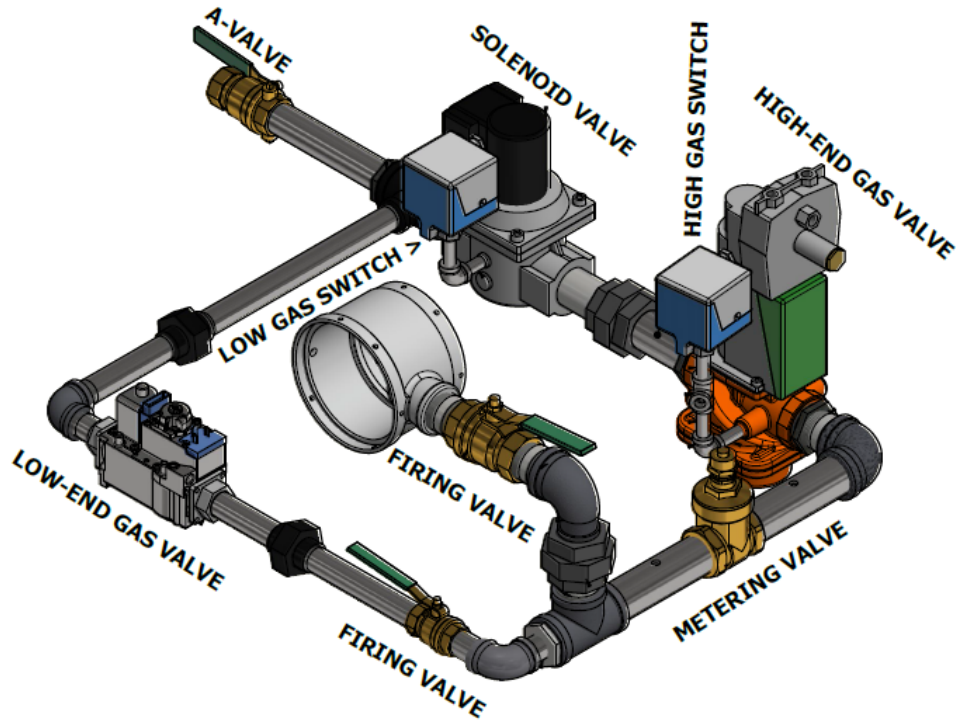
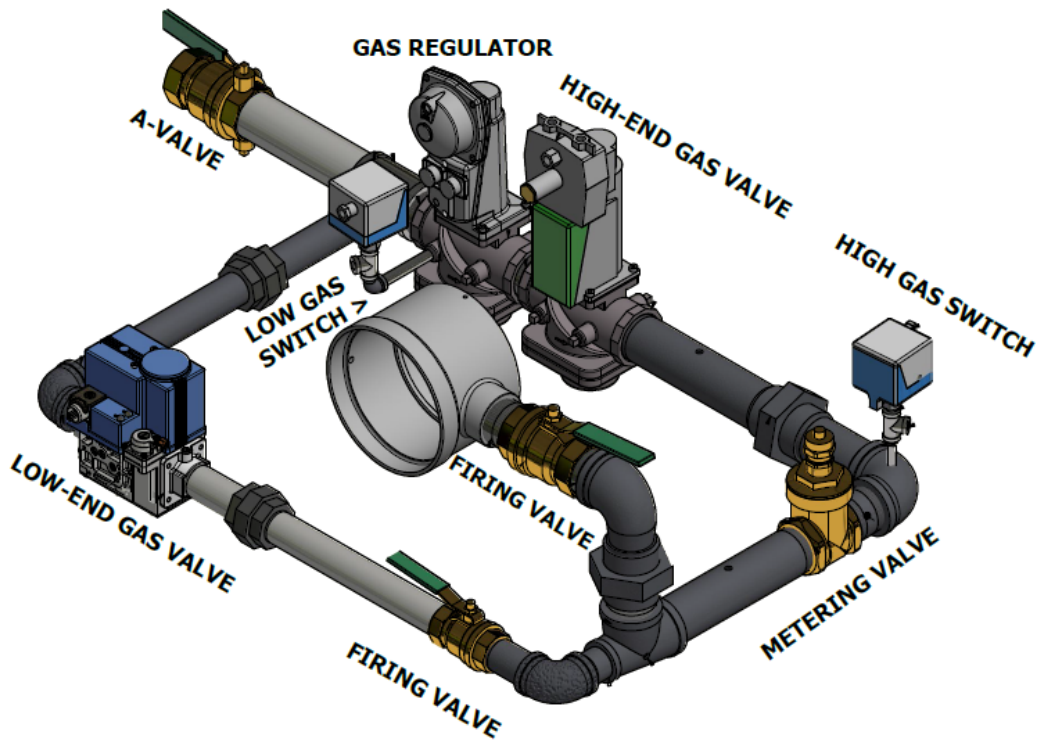


Figure 40: Typical Gas Train (Models AR3500-AR4000)



- This boiler is designed for low fire soft start. At the start of trial for ignition the fan will decelerate to minimum fire and will light off at soft start speed before ramping up towards full input through the 4-20mA from the controller.
- Shut power off to the heater and open the firing valve. Switch power back on and allow the burner to fire. Ignition should be smooth. Normally the differential gas pressure will be identical to the differential air pressure. Actual differential pressure may vary from the numbers on the test label due to the field conditions and sample variations. Always make adjustments to meet the recommended CO₂ levels. Adjust high fire first followed by low fire adjustment.
- Allow the water temperature to rise so that the heater cycles on the operator.
- Check the temperature rise across the heat exchanger. This will be indicated by taking a difference between the inlet and outlet temperatures on the Avenger control.

- Allow the unit to cycle on the limit. This can be done by gradually restricting outlet water flow to raise outlet temperature and then slowly rotating the limit dial. The auto reset limits are set at 200°F for domestic hot water and hydronic heating.
- At full fire, block 50% of the fan inlet opening. The display should show 'LCI OFF'. If it does not, slowly turn the adjustment on the normally closed blocked flue switch counter-clockwise until the blocked flue switch light goes out.
- Check the air proving switch. Remove the restriction from the fan inlet and reset the power on the control panel. A properly set air proving switch will permit the boiler to continue running when it is running at minimum fire.
- Check the ignition retries circuit.
- Shut the main gas off to the unit and allow it to try for ignition. Trial for ignition should commence within 30 seconds.

8.4 COMISSIONING APPLIANCE

- Remove manometers and replace inlet gas pressure test plug.
- Fill out start up report for each heater. Be sure to record all settings and readings. Retain a copy of report for future reference.
- Startup is now complete, and heater may be placed into service.

PART 9 TROUBLESHOOTING

COMPONENT	FAILURE MODE	ANALYSIS
Incoming Power	<ul style="list-style-type: none"> • Two wires interchanged 	<ul style="list-style-type: none"> • No effect on safety • Live and Neutral wires are interchanged
Transformer Tripped	<ul style="list-style-type: none"> • The 24 Volts and 120 Volts wired are interchanged • Alert: 49 • Lockout: 53 	<ul style="list-style-type: none"> • Breaker on transformer trips
Relief Valve	<ul style="list-style-type: none"> • System pressure exceeds relief valve setting 	<ul style="list-style-type: none"> • Replace the standard relief valve with a higher rated valve up to the maximum pressure of the heat exchanger • Improperly sized expansion tank
Flow Switch	<ul style="list-style-type: none"> • Flow Switch contacts are open • Alert: 63, 275-281, 460 • LCI OFF 	<ul style="list-style-type: none"> • Ensure pump is operating • Ensure all valves are open and there is no obstruction in boiler piping • Ensure all air has been purged from the system • Verify that wiring is correct
Water Pressure Switch	<ul style="list-style-type: none"> • Pressure Switch contacts are open • Alert: 63, 275-281, 460 • LCI OFF 	<ul style="list-style-type: none"> • Verify that minimum water pressure exceeds 12 PSI • Ensure pump is operating • Ensure all valves are open and there is no obstruction in boiler piping • Ensure all air has been purged from the system • Verify that wiring is correct
Flame Failure	<ul style="list-style-type: none"> • The boiler has failed to ignite the burner • Alert: 110, 291-294 	<ul style="list-style-type: none"> • To reset the module, refer to section 5.9 • Verify that all air has been purged from gas line • Inspect Hot Surface Igniter and related wiring for damage and connection errors • AR1000-2500: Verify igniter is glowing • AR3000-4000: Verify pilot is lit • Inspect UV Scanner and associated wiring. Replace if necessary • Remove the detector and clean the viewing window with a soft, clean cloth • Clean the inside of the sight pipe before re-installing the detector • Verify that boiler is properly grounded • Verify incoming gas supply pressure and that it coincides with Table 7 • Verify that the vent/air inlet piping (if equipped) are correctly installed and obstructions are not present • Verify 24 VAC is being supplied to the Low-End Gas Valve relay from the Avenger Controller during ignition. Check wiring from Avenger Controller and Gas Valve Relay. If a signal cannot be detected, the Avenger Controller needs to be replaced • If 24 VAC is present, check the outlet of the valve to ensure that gas is flowing. When the valve is energized a change in pressure should occur, if no change is detected the gas valve has failed to open or it is passing insufficient amount of gas. If this is an initial startup increase the low fire gas setting by ¼ turn clockwise • Inspect the burner. Refer to Burner Maintenance in section 10.5 • Replace the Controller, if necessary
Flame Disappears During a Run Cycle	<ul style="list-style-type: none"> • The Avenger boiler was running, and flame signal suddenly disappeared. • Lockout: 106, 107, 108, 109 	<ul style="list-style-type: none"> • Verify that all air has been purged from gas line • Verify that boiler is properly grounded • Inspect UV Scanner and associated wiring. Replace if necessary • Remove the detector and clean the viewing window with a soft, clean cloth • Clean the inside of the sight pipe before re-installing the detector • Adjust the blocked flue switch. Turn clockwise to reduce sensitivity • Verify incoming gas supply pressure and that it coincides with Table 7 • Verify that the gas line connections to the boiler are adequate. Refer to Table 6 • Verify that the vent/air inlet piping (if equipped) are correctly installed and obstructions are not present • Verify that 24 VAC is being supplied to the Low-End Gas Valve during operation. If a signal cannot be detected, the transformer needs to be replaced • Verify that 115 VAC is being supplied to the High-End Gas Valve during operation • Inspect the burner. Refer to Burner Maintenance in section 10.5 • Replace the Avenger Controller, if necessary

COMPONENT	FAILURE MODE	ANALYSIS
Noisy Operation	<ul style="list-style-type: none"> Supply Gas Issue 	<ul style="list-style-type: none"> Refer to Part 3 Gas Connection in this manual Natural Gas Pressure reads between 4" w.c. and 14" w.c. L.P. Gas Pressure reads between 8" w.c. and 14" w.c.
	<ul style="list-style-type: none"> Air/Gas Mixture Issue 	<ul style="list-style-type: none"> Refer to Section 8.3 Gas Valve Adjustment Procedure for proper combustion setting
	<ul style="list-style-type: none"> Air Inlet and/or Vent configuration 	<ul style="list-style-type: none"> Refer to Part 2 Venting and Air Supply
	<ul style="list-style-type: none"> Dirty/ Damaged Burner 	<ul style="list-style-type: none"> Refer to Burner Maintenance in section 10.5 of this manual for the burner removal and inspection procedure. Clean or replace the burner, if required
	<ul style="list-style-type: none"> Air in the piping system 	<ul style="list-style-type: none"> Purge all air from the piping system
Auto Reset High Limit Trips	<ul style="list-style-type: none"> The outlet temperature has exceeded the set point temperature specified. Alert: 67, 79, 137, 303-310 ILK OFF 	<ul style="list-style-type: none"> Verify that the system is full of water and that all air has been properly purged from the system Verify that ΔT does not exceed 60°F across the heat exchanger Verify that the boiler is piped properly Verify that 120VAC is being supplied to the boiler pump on a call for heat. If voltage cannot be detected check wiring Verify that the pump is circulating when 120VAC is detected. If not, pump impeller may be stuck If 120VAC is present during a call for heat, but the pump still does not circulate, replace the pump Check outlet sensor for proper functionality. At 77°F (25°C) the sensor will show 10kΩ of resistance
Manual Reset High Limit Trips (if equipped)	<ul style="list-style-type: none"> Manual Reset Safety High Limit tripped, outlet temperature in excess of 210°F Alert: 67, 79, 137, 303-309 ILK OFF 	<ul style="list-style-type: none"> Verify that the system is full of water and that all air has been properly purged from the system Verify that the boiler is piped properly Verify that 120VAC is being supplied to the boiler pump on a call for heat. If voltage cannot be detected check wiring Verify that the pump is circulating when 120VAC is supplied. If so, pump impeller may be stuck. Use a flat head screwdriver on face of pump to turn impeller manually If 120VAC is present during a call for heat, but the pump still does not circulate, replace pump
Delta-T Limit Tripped	<ul style="list-style-type: none"> Inlet and Outlet temperature has exceeded 70°F Alert: 124 	<ul style="list-style-type: none"> Verify that the system is full of water and that all air has been properly purged from the system Verify that the boiler is piped properly Verify that 120VAC is being supplied to the boiler pump on a call for heat. If voltage cannot be detected check wiring Verify that the pump is circulating when 120VAC is detected. If not, pump impeller may be stuck If 120VAC is present during a call for heat, but the pump still does not circulate, replace the pump Purge all air from the piping Verify boiler water pressure exceeds 12 PSI
Temperature Overshoot	<ul style="list-style-type: none"> Stack temperature has exceeded the limit temperature. Alert: 125 	<ul style="list-style-type: none"> The stack temperature has exceeded the maximum temperature allowed. CPVC: 194°F PPE: 230°F AL29-4C, Stainless Steel: 300°F+ Measure the resistance of the flue sensor at room temperature, it should be approximately 10kΩ
	<ul style="list-style-type: none"> Outlet temperature has exceeded target temperature. Alert: 67, 79, 137, 303-309 ILK OFF 	<ul style="list-style-type: none"> Check outlet sensor. It should be firmly inserted in well Water flow may be too low and allows burner to run longer than required creating a reservoir of hot water in the center of the heat exchanger. Check Central Heat and/or DHW PID parameters P=60, I= 20, D=0 provides quickest response Lower target to modulate burner off sooner If modulating pump is supplied, increase the pump speed to prevent outlet temperature overshoot
Sensor Not Connected	<ul style="list-style-type: none"> Inlet sensor, Alert: 91 Outlet sensor, Alert: 92 DHW sensor, Alert: 93 Flue sensor, Alert: 95 Outdoor sensor, Alert: 96 	<ul style="list-style-type: none"> Verify sensors are connected Verify wiring Measure resistance of sensors at room temperature, 10kΩ sensors Replace sensor if necessary

COMPONENT	FAILURE MODE	ANALYSIS
Fan Not Turning	<ul style="list-style-type: none"> • Fan does not rotate • Alert: 122, 123, 128, 129, 130, 131, 132 	<ul style="list-style-type: none"> • Check fan power wires • Fan signal wires are interchanged • Minimum fan speed must be greater than 800 RPM
Air Proving Switch	<ul style="list-style-type: none"> • Interrupted Air Switch error • Alert: 63, 275-281, 460 • LCI OFF 	<ul style="list-style-type: none"> • Air Switch wire(s) is/are loose • Air Switch is set too tight • Check that the electronic air switch returns to 0.000" w.c. when the blower is off. If not, contact factory for further information
Blocked Flue Switch opens at full speed	<ul style="list-style-type: none"> • Alert: 63, 137, 276-281 • LCI OFF 	<ul style="list-style-type: none"> • Check for blockage in the vent and/or air intake, if applicable • Remove restriction from vent and /or air intake • Blocked Flue Switch wire(s) is/are loose • Blocked Flue Switch is set too sensitive, reduce sensitivity by turning screw ¼ turn clockwise
Flame Detection is out of Sync	<ul style="list-style-type: none"> • Flame detection is present when no visible signs of a flame exist • Lockout: 105, 158 	<ul style="list-style-type: none"> • Verify supply voltage for proper polarity. • Check external wiring for voltage feedback • Check internal wiring for proper connections • Check the UV Scanner and verify that viewing window is clean and scanner is not flashing • Replace scanner
Blank Display Screen	<ul style="list-style-type: none"> • Blank display screen 	<ul style="list-style-type: none"> • Check wire connections from Avenger Controller to touchscreen display
Internal Fault	<ul style="list-style-type: none"> • Lockout: 3-46, 58-60, 97-99, 143-148, 172-178 	<ul style="list-style-type: none"> • Reset SOLA • If fault persists, replace SOLA

Table 16: Lockout Codes

#	Description
1	Unconfigured safety data
2	Waiting for safety data verification
3-46, 58-60, 97-99, 143-148, 172-178*	Internal Fault. Replace SOLA Controller
47	Flame rod to ground leakage
48	Static Flame
49	24VAC low/high
50	Modulation Fault
64	Fan speed not proved, ignition failure
67	Interlock Off, safety circuit is open
79	Heater Outlet high limit tripped
82	Stack limit tripped (PVC: 149°F, CPVC: 194°F, 250°F)
105	Flame detected out of sequence
106	Flame lost if Main Flame Establishing Period (MFEP)
107	Flame lost early in run
108	Flame lost in run
109, 110	Ignition failed
112	Pilot test flame timeout
113	Flame circuit timeout
137	Interlock failed to close, safety circuit is open
149	Flame detected

* If an internal hardware error is detected contact Camus technical support for troubleshooting procedure.

Table 17: Alert Codes

#	Description
29	Burner switch turned OFF
30	Burner switch turned ON
50	Modulation Fault
61	Anti-short Cycle
62	Fan speed not proved
63	LCI off, safety circuit is open
68	Setpoint was overridden due to sensor fault
69	Modulation was overridden due to sensor fault
81	Delta-T limit exceeded (70°F)
110	Ignition failure occurred
123	Modulation rate was Limited due to outlet limit
124	Modulation rate was Limited due to Delta-T limit
215	No Lead Lag slaves available to service demand
219	Using backup Lead Lag header sensor due to sensor failure
229	Lead lag slave communication timeout.
275-281	LCI off, safety circuit is open
283	Demand off during measured purge time
291	Abnormal Recycle: Flame was not on at end of Ignition period
292	Abnormal Recycle: Flame was lost during Main Flame Establishing Period
293	Abnormal Recycle: Flame was lost early in Run
294	Abnormal Recycle: Flame was lost during Run
303-310+	Interlock Off, safety circuit is open
324, 374-379	Hardware flame bias. Flame sensor wire needs to be re-routed.
352+	Stack sensor fault
355+	Outlet sensor fault
357+	DHW sensor fault
359+	Inlet sensor fault
460	LCI lost in run
550	Delta T inlet/outlet limit was exceeded
614	Lead boiler was rotated due to measured run time

* The alarm LED and alarm contacts are closed and will remain closed until the 'RESET' button is pressed.

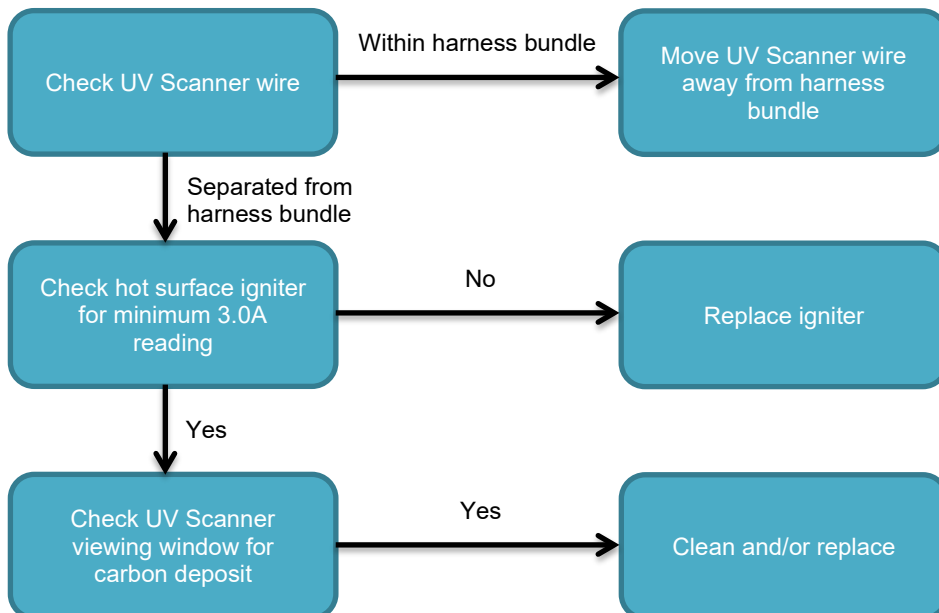
Alert 291: Abnormal Recycle: Flame was not ON at the end of ignition

Alert 294: Abnormal Recycle: Flame was lost during Run

Alert 324: Abnormal Recycle: Hardware flame bias

Alert 377: Abnormal Recycle: Hardware flame bias delta

These errors occur when a flame signal is not detected by the UV Scanner. A minimum signal of 0.8Vdc must be detected by the UV Scanner to prove the flame.



For High-End Valve, staging relay switch over is factory set and normally does not require field adjustment.

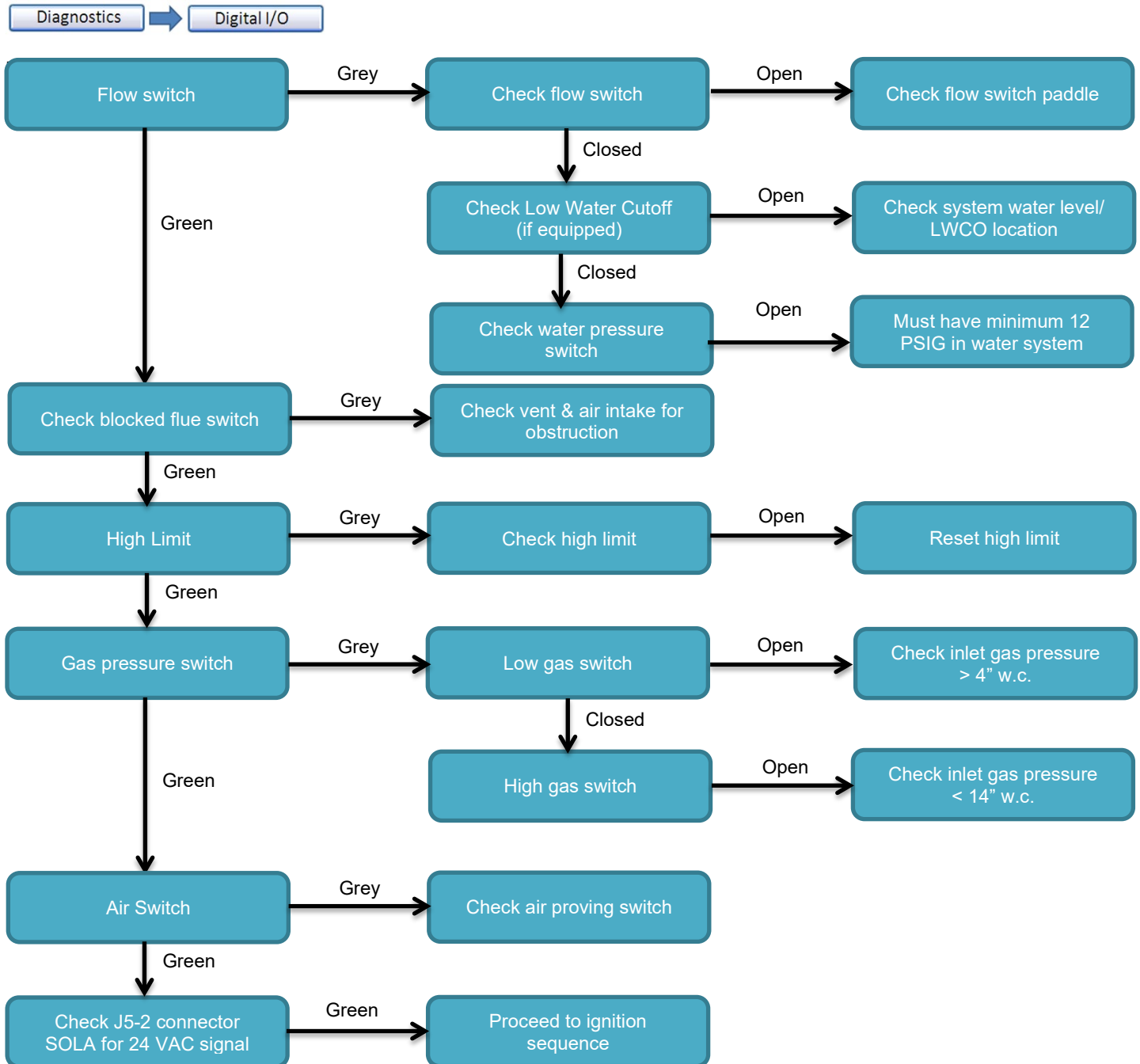
Hold 63: LCI OFF (Load Control Input, Flow Switch, Interrupted Air Switch Blocked Flue Switch)

Hold 67: ILK OFF (High Limit, Gas Pressure Switch)

Alert 303-310: Abnormal Recycle: ILK off

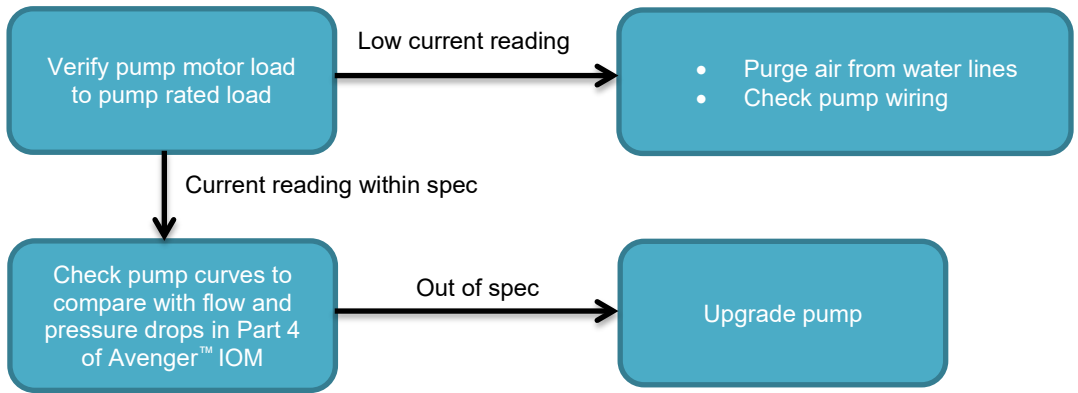
Alert 460: LCI lost in run

These errors occur when one or more of the boiler safety switches are in an open condition when it is to be in a closed condition before the ignition sequence is allowed to proceed.



Alert 354: Abnormal Recycle Delta-T limit

This safety was breached as the inlet and outlet temperature difference exceeded 70°F. This is done to prevent damage to the heat exchanger. Before this error appears, the combustion air blower would have slowed down in an effort to prevent such an error from occurring.



PART 10 MAINTENANCE

CAUTION

It is important that all gas appliances to be serviced by a Camus trained service technician. It is in your own interest and that of safety to ensure that all local codes, and all the "NOTES" and "WARNINGS" in this manual are complied with. To service or adjust this appliance, it is imperative that the Camus trained service technician utilizes a combustion analyzer to read CO₂, CO and flue pressure according to *Camus Hydronics* recommendation.

CAUTION

Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation, verify proper operation after servicing.

Listed below are items that must be checked to ensure safe reliable operations. Verify proper operation after servicing.

10.1 EXAMINE THE VENTING SYSTEM

Examine the venting system at least once a year. Check more often in the first year to determine inspection interval. Check all joints and pipe connections for tightness, corrosion or deterioration. Flush the condensate drain hose with water to clean. Clean screens in the venting air intake system as required. Have the entire system, including the venting system, periodically inspected by a qualified service agency.

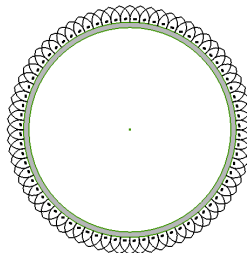
10.2 VISUALLY CHECK MAIN BURNER FLAMES

Visually check the burner flame at each start up after long shutdown periods or at least every six months. A burner view port is located on the burner mounting flange.

CAUTION

The area around the burner view port is hot. Avoid direct contact to this area.

Figure 131: Normal Burner Flame Profile (short dense and blue at full fire, infrared at low fire)



- Normal Flame: A normal flame at 100% of burner input is blue, with slight yellow tips and a well-defined flame, no flame lifting.
- Yellow Tip: Yellow tipping can be caused by blockage or partial obstruction of air flow to the burner.
- Yellow Flames: Yellow flames can be caused by blockage of primary air flow to the burner or excessive gas input. This condition **MUST** be corrected immediately.
- Lifting Flames: Lifting flames can be caused by over firing the burner, excessive primary air or high draft in excess of negative 0.15" w.c.

If improper flame is observed, examine the venting system; ensure proper gas supply and adequate supply of combustion and ventilation air. Periodic visual check of pilot and burner flame is recommended to ensure trouble-free operation.

10.3 FLUE GAS PASSAGEWAYS CLEANING PROCEDURES

Any sign of soot around the flue pipe connections, burner or in the combustion chamber indicates a need for cleaning. The cleaning procedure must only be performed by a Camus trained service technician. Proper service is required to maintain safe operation. Properly installed and adjusted units seldom need flue cleaning.

NOTE

All gaskets/sealant on disassembled components or jacket panels must be replaced with new gaskets/sealant on re-assembly. Gasket and sealant kits are available from the factory.

CAUTION

When the vent system is disconnected for any reason it must be reassembled and resealed according to vent manufacturer's instruction.

10.4 CONDENSATION TREATMENT

This high efficiency appliance may operate as a condensing appliance for extended periods of time based on return water temperatures. Condensate occurs when the products of combustion are cooled below their dew point in the heat transfer process. The liquid condensate formed from this high efficiency heat transfer process is mildly acidic. The condensate will typically have a pH ranging from 4.0 to 5.0 as it is discharged from the condensate drain at the rear of the appliance. The neutralizer/condensate box, where condensate is collected, is constructed from a corrosion resistant stainless steel and it contains neutralizer medium that must be replaced periodically. All materials external to the appliance in contact with the condensate must be corrosion resistant. This is typically accomplished by using PVC or CPVC plastic pipe and synthetic tubing. Condensate must be able to flow freely from the appliance. All condensate flow is accomplished by gravity requiring a minimum downward slope of 1/4" per foot (21 mm/m) to ensure proper flow to the condensate management system and/or a suitable drain. The neutralizer condensate box **MUST** always be mounted lower than the bottom of the appliance cabinet. This can be achieved by placing the boiler on a concrete pad and placing the neutralizer condensate box on the floor. All condensate piping and connections must be easily accessible for routine maintenance and inspection.

10.4.1 CONDENSATE VOLUME

There are several factors affecting the amount of condensation created by the appliance however for rough approximation, the following formula can be used: Condensation Volume, US Gallon/Hr = Input, MBH/1000 x 5.0.

Many codes will require the acidic condensate to be neutralized before it can be placed in a drain system. An additional supplementary neutralizer to control the pH of the liquid discharged to a drain system is recommended with every appliance. The neutralizer consists of an industrial grade, non-corrosive reservoir for additional treatment of the condensate. As the reservoir fills, it provides an extended residency time to neutralize the condensate. The neutralized condensate exits from the reservoir outlet. The neutralizer/ condensate box supplied with the Avenger provides a 'P' trap to prevent flue gas escape as well as initial neutralization of the condensate.

When the condensate level in the reservoir rises to the drain, it spills out into the condensate bin and from there exits to the external neutralizer. As the pH number increases in numerical value, the relative acidity of the discharge decreases. The neutralized condensate may then be discharged into a suitable drain system without fear of damaging the drain system. Always check with local codes for specific pH requirements. Neutralizers may be used in series to raise pH.

10.5 BURNER MAINTENANCE

The burner should be removed for inspection and cleaning on an annual basis. An appliance installed in a dust or dirt contaminated environment will require inspection and cleaning on a more frequent schedule. The fan assisted combustion process may force airborne dust and dirt contaminants, contained in the combustion air, into the burner. With sustained operation, non-combustible contaminants may reduce burner port area, reduce burner input or cause non-warrantable damage to the burner.

Airborne contaminants such as dust, dirt, concrete dust or dry wall dust can be drawn into the burner with the combustion air and block the burner port area. An external combustion air filter is recommended to be used with the appliance. This filter should be checked and cleaned at the time of appliance commissioning and on a six-month interval or more often in a contaminated environment.

10.5.1 BURNER REMOVAL

Check torque on fan mounting nuts using a torque wrench. AR1000-AR4000: 25 lb-ft
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Access to the burner will require the following steps:

- Turn off main electrical power to the appliance.
- Turn off main manual gas shutoff to the appliance.
- Remove the top covers and top side panels.
- Disconnect the gas supply connection to the fan inlet.
- Disconnect the fan motor power wires at the harness.
- Remove the Hot Surface Igniter and the UV Scanner.
- Remove the sensing tubes from the air ratio gas valve to the combustion air fan.
- Remove the nuts holding the fan assembly to the heat exchanger and remove the fan assembly. On occasion the red silicone gasket may adhere to the underside of the fan's flange. Carefully pry the flange away from the gasket prior to removing the fan assembly.
- The burner can now be lifted vertically out of the heat exchanger cavity. A graphite backed ceramic paper gasket is located directly under the burner flange. This gasket must be replaced if it is damaged. A solid black graphite gasket sits directly on the heat exchanger top plate.
- Use care to prevent damage to the knitted metal fiber of the burner surface.
- Check all gaskets and replace as necessary. Gaskets affected by heat will not reseal properly and must be replaced.
- Replace the burner in the reverse order that it was removed. Insert the igniter and UV Scanner before doing the final tightening on the fan mounting nuts. Evenly tighten the nuts to 25 ft-lbs.

NOTE

When the combustion air fan is removed for any reason, the inlet to the burner must be covered to prevent further foreign objects from falling into the burner. Always look inside the burner to check for dents. Do not place a burner back into operation if the inner distribution screen has been dented during the service operation, call the factory for recommendations. Use care when removing and handling the burner. Sharp objects or impact may damage or tear the metal fiber surface rendering the burner unfit for service.

10.5.2 BURNER CLEANING PROCEDURE

Remove any visible dust or dirt blockage from the surface of the burner using water from a garden hose. Wash the burner with low pressure water. Never wipe or brush the surface of the burner nor use high pressure water or air.

The burner may best be cleaned by immersing the burner port area in a solution of dishwashing detergent and hot water. Allow the burner to remain in the solution for a short period of time to remove dust, dirt and oil or grease laden contaminants. Rinse the burner thoroughly with clean water to remove any residue from the detergent cleaner. The burner should be air dried after removal from the cleaning solution and rinsing. **DO NOT** use chlorine-based solvents or cleaning agents on the burner.

10.6 CHANGING THE HOT SURFACE IGNITER

10.6.1 REMOVING THE IGNITER

- The Hot Surface Igniter is to be checked at least after every 4000 hours of operation and more frequently under high cycling conditions. This will maintain peak ignition efficiency.
- Turn off main electrical power to the appliance.
- Turn off main manual gas shutoff to the appliance.
- Locate the Hot Surface Igniter.
- Disconnect the two power leads to the Hot Surface Igniter.
- Loosen and remove the two screws that hold the igniter.
- Lift the igniter vertically out of the burner mounting flange. Use care to not hit or break the silicon carbide igniter. **DO NOT** pull out by leads.

10.6.2 RE-INSTALLING THE IGNITER

- Confirm that the end of the replacement igniter has a bead of silicone sealing the gap between the metal mounting flange and the ceramic shaft of the igniter.
- Ensure that the ceramic paper gaskets, used to seal the base and top of the igniter, are reinstalled on the new igniter.
- Carefully insert the igniter into the mounting point on the burner flange and push into position on top of the fan's flange.
- Reinstall the two mounting head screws and tighten them, do not over tighten these screws.
- Ensure that the igniter ceramic paper gaskets are properly installed and seal the point of contact between the igniter and fan mounting flange to prevent flue gases escaping from this area.
- Reconnect the power leads to the igniter.
- Turn ON main gas supply.
- Turn ON main power.
- Test fire the appliance to ensure proper operation.
- The igniter must generate minimum 3A to reliably light the main burner (AR1000 – AR2500) or pilot (AR3000 – AR4000).

10.7 HEAT EXCHANGER INSPECTION

- The heat exchanger should be inspected at the time of burner maintenance.
- Turn OFF all power to the appliance.
- Turn OFF main gas to the appliance.
- Remove top cover and top side panels.
- Remove fan assembly and burner as detailed in the Burner Removal and Burner Cleaning sections.
- Check the heat exchanger tubes and combustion chamber. If soot is present, heat exchanger must be cleaned.
- Remove the front outer panels, if necessary.
- Use detergent water pressure wash to remove soot from heat exchanger tubes and combustion chamber.
- Disconnect condensate/neutralizer box and allow dirty water, coming from flue passes, to drain away.
- Reinstall the burner and fan assembly.
- Reassemble all gas piping. Test for gas leaks.
- Reassemble outer jacket panels. Keep top cover off.
- Cycle unit and check for proper operation.
- Once proper operation is confirmed replace the top cover.

10.8 RE-INSTALL HEAT EXCHANGER

- Carefully reinstall the heat exchanger if removed from the appliance.
- Cycle unit and check for proper operation.
- Re-install any panels, which were previously removed.

10.9 COMBUSTION AIR FAN

Combustion air fan should be checked every 6 months. Clean the inlet screen and damper plate as required when installed in a dust or dirt contaminated location. The motor and bearings on the combustion air fan are sealed and permanently lubricated requiring no addition of oil or lubricants.

10.10 COMBUSTION AND VENTILATION AIR

Check frequently to be sure that the flow of combustion and ventilation air to the appliance is not obstructed. Combustion and ventilation air must be provided to the mechanical room with openings sized per the requirements of the B149 or National Fuel Gas Code. The optional outdoor air kit brings combustion air from the outdoors directly to the appliance.

10.11 CONTROL CIRCUIT VOLTAGE

This appliance uses a transformer to supply a low voltage control circuit. The voltage on the secondary side should be 24 to 28VAC when measured with a voltmeter. A secondary voltage of 21VAC or less supplied to 24VAC components may cause operational problems. A 4A circuit breaker is provided on the secondary side of the transformer. A tripped circuit breaker indicates a short in the 24VAC controls and must be corrected.

10.12 COMBUSTIBLE MATERIALS

CAUTION
Keep appliance clear from combustible materials; do not store GASOLINE and other flammable vapors and liquids in the proximity of the appliance.

10.13 FREEZE PROTECTION

Installations are not recommended in areas where the danger of freezing exists. Proper freeze protection must be provided for appliances installed outdoors, in unheated mechanical rooms or where temperatures may drop to the freezing point or lower. If freeze protection is not provided for the system, a low ambient temperature alarm is recommended for the mechanical room. Damage to the appliance by freezing is non-warrantable.

- **Location** - Heating boilers, hot water supply boilers or water heaters must be located in a room having a temperature of at least 50°F (10°C)
- **Caution** - A mechanical room operating under a negative pressure may experience a downdraft in the flue of an appliance that is not firing. The cold outside air may be pulled down the flue and freeze a heat exchanger. This condition must be corrected to provide adequate freeze protection.
- Freeze protection for the appliance using an indirect coil can be provided by using hydronic system antifreeze. Follow the manufacturer's instructions. **DO NOT** use undiluted or automotive type antifreeze.
- **Shut-down and draining** - If for any reason, the unit is to be shut off where danger of freezing exists, the following precautionary measures must be taken:
 - Shut off gas supply
 - Shut off water supply
 - Shut off electrical supply
 - Drain the heat exchanger completely
 - Ensure the pump and connecting piping are fully drained

10.14 FREEZE PROTECTION FOR A HEATING BOILER SYSTEM (Optional)

- Use only properly diluted inhibited glycol antifreeze designed for hydronic systems.
- Follow the instructions from the antifreeze manufacturer. Quantity of antifreeze required is based on total system volume including expansion tank volume.
- Antifreeze is denser than water and changes the viscosity of the system. The addition of antifreeze will decrease heat transfer and increase frictional loss in the boiler and related piping. Where antifreeze has been used, to maintain the temperature rise across the appliance confirm that the recommended GPM for pure water has been increased by 15% and the head loss by 20%.
- Local codes may require a back-flow preventer or actual disconnect from city water supply when antifreeze is added to the system.
- When filling or topping-up the system with water mixed with the antifreeze always used distilled or RO (reverse osmosis) water. This will prevent the reaction of the water with antifreeze which can create sludge.

PART 11 INSTALLATIONS

WARNING

Before starting the boiler smell near the floor, the interior of the boiler and around the boiler for any gas odors or any unusual odor. If there is any sign of a gas leak, do not proceed with startup. Repair all the leaks before attempting to start the boiler.

WARNING

Propane boilers **ONLY** – Your local propane supplier adds an odorant to the propane gas to allow for propane gas leak detection. In some cases, the added odorant can fade and the gas may not give off any noticeable odor. Before startup, have the local propane supplier check for the correct odorant level in the gas.

11.1 CHECKING THE INSTALLATION

- Inspect the connections for water, gas and electricity.
- Inlet gas pressure should be 7" W.C. for natural gas and 11" W.C. for propane.
- With the boiler off, open the main gas supply valve and vent the trapped air from the piping leading to the boiler. Confirm that all gas connections to the heater are tight and that there are no missing test plugs.
- Refer to Section 8.3 Gas Valve Adjustment Procedure of this IOM for recommendations on setting combustion characteristics.
- Check the boiler wiring to see that it agrees with the wiring diagram supplied.
- Confirm that all terminal strips and field connections are identified.
- With the boiler running, check for flue gas leaks around the flue outlet.
- Repair any leaks prior to proceeding to the next step.
- At the factory, adjustments were made to achieve proper input and acceptable burner performance at full input and at minimum input.

11.2 INSPECT & RECHARGE CONDENSATE COLLECTION & NEUTRALIZING RESERVOIR

1. Inspect the connections to the neutralizer/ condensate box.
2. Remove screws holding lid on to condensate collection box. Remove lid from the condensate collection box.
3. Fill with fresh water until the water begins to flow out of drain. Recharge with neutralizer medium as required.
4. Re-install the lid and hold-down screw on the neutralizer condensate collection box.
5. Inspect the condensate neutralizer supplied on site and confirm that it contains sufficient calcium carbonate to operate effectively to neutralize condensate to required level.
6. Check pH level of condensate.

WARNING

The neutralizer condensate collection box must be filled with water to prevent flue gas emissions from escaping during boiler operation.

CAUTION

A leak in a boiler heating "System" will cause the fill system to introduce fresh water constantly, which may cause the tubes to accumulate a lime/scale build up. Lime/scale buildup leading to heat exchanger failure is **NOT** covered by warranty.

11.3 HEATING BOILER INSTALLATIONS

It is recommended that this appliance be installed in a primary/secondary reverse return piping system for proper operation. Before beginning the installation, consult local codes for specific plumbing requirements. The installation should provide unions and valves at the inlet and outlet of the appliance so it can be isolated for service. An air separation device must be supplied in the installation piping to eliminate trapped air in the system. Locate a system air vent at the highest point in the system. The system must also have a properly sized expansion tank installed. Typically, an air charged diaphragm-type expansion tank is used. The expansion tank must be installed close to the boiler and on the suction side of the system pump (appliance Inlet) to ensure proper operation. **Caution: This appliance should not be operated at less than 12 PSIG.** Water piping must be supported by suitable hangers or floor stands, **NOT** by the appliance. Pipe systems will be subject to considerable expansion and contraction. Pipe supports could allow the pipe to slide resulting in noise transmitted into the system. Padding is recommended. The boiler pressure relief valve must be piped to a suitable floor drain. See Part 4.

CAUTION

- 1) A leak in a boiler "System" will cause the "System" to intake fresh water constantly, which may cause the heat exchanger/tubes to accumulate a lime/scale build up. This will be a **NON-WARRANTABLE FAILURE**.
- 2) If boiler pumps are not operated when treated water is introduced a corrosion cell may be created in the boilers leading to a failure which is not covered by warranty.
- 3) Target water quality of treated water to be stable and neutral with regards to corrosive/scaling properties. Damage to or failure of the heat exchanger as a result of scaling or corrosive water quality is not covered by warranty.

11.4 WATER CONNECTIONS

All models have groove locked inlet and outlet stainless steel connections. Pipe size must be in accordance with Table 3 and, between supply and return lines, must not exceed 80 feet of equivalent length. Any reduction in recommended pipe size may decrease flow resulting in high water temperatures, boiler noise, flashing to steam and non-warrantable heat exchanger damage.

11.5 PIPING LENGTHS

The appliance circulator provides the water flow from the system piping, through the boiler and back to the system. Pipe diameter and length are critical to ensure proper flow through the boiler.

The secondary loop piping to and from the appliance must have a fully ported ball valve installed in both the inlet and outlet side piping and will be used for isolation only. **The ball valves must be the same diameter as the installed piping.** If flow control is required, other means of flow control such as globe valve or flow setter should be used.

11.6 INTERMITTENT PUMP OPERATION

An intermittent pump operation signal is standard and can be used to operate a separate pump contactor. A 1/6 hp pump delay relay is standard, and a 1 hp pump delay relay is available. When utilizing this feature, the boiler's integral circulating pump will cycle on each call for heat, before the burner fires. The pump will continue to operate while the burner is firing. The pump will run for a post-pump period after the temperature set point is satisfied. This will remove any residual heat from the combustion chamber before turning the pump off. See wiring diagram shipped with the unit.

11.7 SUMMARY

a) Typical Boiler Installations

General Plumbing Rules

1. Check all local codes.
2. For serviceability of boiler, always install unions.
3. Always pipe pressure relief valve to an open drain.
4. Locate system air vents at highest point of system.
5. Expansion tank must be installed near the boiler and on the suction side of the system pump.
6. Support all water piping.

b) Placing the Boiler in Operation

Pre-Start Check List

1. Review the location of the boiler, clearances from combustibles and available service clearances.
2. Review Part 2 Venting and Air Supply. Ensure that all vent components are fabricated from the correct category of materials with adequate clearance from combustibles.
3. Ensure that the boiler condensate drain, and all vent system condensate drains are properly routed to an acceptable floor drain or neutralization system.
4. Review the vent termination point for proper location and clearances.
5. Ensure that proper volumes of combustion and ventilation air are provided to the mechanical room. If a separate combustion air pipe is used, ensure that it is properly sized, sealed and terminated.
6. Review the water piping from the boiler to the system. The boiler must be installed in a primary/ secondary piping system. Review the diameter and equivalent length of the installed piping to and from the boiler for proper flow.
7. Ensure that a properly sized primary system pump is installed with an expansion tank.
8. Check system pressure. Ensure a minimum of 12 PSIG with the system hot and not more than 90% of the rated pressure of the relief valve.
9. Review the installed gas piping from the meter to the boiler. Ensure that the gas pipe, meter and any regulators are adequately sized.
10. Review the field wiring and electrical service for both the boiler controls and pump. Ensure that the electrical service(s) is adequately sized.

Boiler Set-Up

1. Ensure that the boiler and piping system are full of water. Bleed all air from the pump housing and secondary loop.
2. Check system for any water leaks.
3. Check system for installation of glycol or water treatment where required. Where glycol has been used to maintain the temperature rise across the appliance confirm that the recommended flow for pure water has been increased by 15% and the head loss by 20%.
4. Turn on power to the primary system pump and the appliance secondary pump and verify operation.

Boiler Operational Checks

1. Turn the boiler main power switch to the "ON" position.
2. Program the adjustable points.
3. Turn the switch to the "ON" position to start boiler operation.
4. Turn the resets for low water level, high water temperature and alarm.
5. Install a manometer on the gas supply to the boiler and verify minimum gas supply pressure as the burner fires at 100% of rated input.
6. Verify operation of safeties as necessary (low water cut-off, high limit, gas pressure, blocked flue switch, etc.).
7. With the firing valve closed allow the boiler to proceed through 3 ignition attempts. After the third failed ignition attempt the boiler will proceed to an Ignition Error fault. After this has been verified, recycle power on the boiler and open the firing valve.
8. Once the boiler is running and the flame has stabilized, open the *UV Scanner* wires at an interconnection point in the harness. Main flame must extinguish within 4 sec. If flame does not extinguish replace the ignition control.

Boiler Operation

1. Appliance should begin the start-up process for the sequence of operation.
2. The boiler will fire down to approximately 20% on initial start-up and adjust input as required to meet system demand.
3. Based on system demand, the appliance will modulate accordingly.
4. As system demand is satisfied, the burner will cycle off and the combustion air fan will decelerate at a pre-programmed rate before the appliance shuts down.
5. Models AR1000 – AR2500 utilize direct ignition and models AR3000 - AR4000 utilize proven pilot.

Direct Ignition: AR1000 – AR2500

FOR YOUR SAFETY READ BEFORE OPERATING

WARNING: If you do not follow these instructions exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

A. This appliance does not have a pilot. It is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.

B. BEFORE OPERATING smell all around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle on the floor.

WHAT TO DO IF YOU SMELL GAS

- DO NOT TRY TO LIGHT ANY APPLIANCE.
- DO NOT TOUCH ANY ELECTRIC SWITCH.
- DO NOT USE ANY PHONE IN YOUR BUILDING.
- IMMEDIATELY CALL YOUR GAS SUPPLIER FROM A NEIGHBOUR'S PHONE. FOLLOW THE GAS SUPPLIER'S INSTRUCTIONS.
- IF YOU CANNOT REACH YOUR GAS SUPPLIER, CALL THE FIRE DEPARTMENT.

C. Use only your hand to turn the Manual Gas Cock control handle. Never use tools. If the handle will not turn by hand, don't try to repair it, call a qualified service technician. Force or attempted repair may result in a fire or explosion.

D. Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the appliance and to replace any part of the control system and any gas control which has been under water.

E. Do not operate appliance unless unit is filled with water and inlet valves are fully open.

MANUAL GAS COCK

"OFF" POSITION




FIGURE "A"

"ON" POSITION

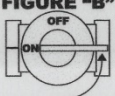





FIGURE "B"

OPERATING INSTRUCTIONS

1. **STOP!** Read the safety information above on this label.
2. Turn off all electric power to the appliance.
3. Set the thermostat to lowest setting.
4. This appliance is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.
5. Turn the Manual Gas Cock clockwise  to "OFF" (Fig. "A")
6. Wait five (5) minutes to clear out any gas. Then smell for gas, including near the floor. If you smell gas, **STOP!** Follow "B" in the safety information above on this label. If you don't smell gas, go to the next step.

7. Turn Manual Gas Cock counterclockwise  to "ON". (Fig. "B")
8. Set thermostat to desired setting.
9. Turn on all electric power to the appliance. The main burner will be light directly.
10. If the main burner fails to ignite, follow the instructions "To Turn Off Gas to Appliance" and Call your service technician or gas supplier.

TO TURN OFF GAS TO APPLIANCE

1. **STOP! READ THE SAFETY INFORMATION ABOVE ON THIS LABEL.**
2. Turn off all electric power to the appliance if service is to be performed.
3. Set the thermostat to lowest setting.
4. Turn the Manual Gas Cock clockwise  to "OFF" position. Do not force. See step 5 above and diagrams.

STKR-234

Proven Pilot: AR3000 – AR4000

FOR YOUR SAFETY READ BEFORE OPERATING

WARNING: If you do not follow these instructions exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

- A.** This appliance is equipped with an ignition device which automatically lights the pilot. Do **not** try to light the pilot by hand.
- B. BEFORE OPERATING** smell all around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle on the floor.
- WHAT TO DO IF YOU SMELL GAS**
- DO NOT TRY TO LIGHT ANY APPLIANCE.
 - DO NOT TOUCH ANY ELECTRIC SWITCH.
 - DO NOT USE ANY PHONE IN YOUR BUILDING.
 - IMMEDIATELY CALL YOUR GAS SUPPLIER FROM A NEIGHBOUR'S PHONE. FOLLOW THE GAS SUPPLIER'S INSTRUCTIONS.
 - IF YOU CANNOT REACH YOUR GAS SUPPLIER, CALL THE FIRE DEPARTMENT.
- C.** Use only your hand to turn the Manual Gas Cock control handle. Never use tools. If the handle will not turn by hand, don't try to repair it, call a qualified service technician. Force or attempted repair may result in a fire or explosion.
- D.** Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the appliance and to replace any part of the control system and any gas control which has been under water.
- E.** Do not operate appliance unless unit is filled with water and inlet valves are fully open.

MANUAL
GAS COCK

"OFF"
POSITION



FIGURE "A"

"ON"
POSITION

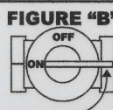


FIGURE "B"

OPERATING INSTRUCTIONS

1. **STOP!** Read the safety information above on this label.
2. Turn off all electric power to the appliance.
3. Set the thermostat to lowest setting.
4. This appliance is equipped with an ignition device which automatically lights the pilot. Do **not** try to light the pilot by hand.
5. Turn the Manual Gas Cock clockwise to "OFF" (Fig. "A")
6. Wait five (5) minutes to clear out any gas. Then smell for gas, including near the floor. If you smell gas, **STOP!** Follow "B" in the safety information above on this label. If you don't smell gas, go to the next step.
7. Turn Manual Gas Cock counterclockwise to "ON". (Fig. "B")
8. Set thermostat to desired setting.
9. Turn on all electric power to the appliance. Pilot burner will be ignited by electronic spark. After pilot ignites, the main burner will ignite.
10. If pilot fails to ignite, observe pilot using inspection mirror and check for an ignition spark. If the appliance will not operate, follow the instructions "To Turn Off Gas to Appliance" and call your service technician or gas supplier.

TO TURN OFF GAS TO APPLIANCE

1. **STOP! READ THE SAFETY INFORMATION ABOVE ON THIS LABEL.**
2. Turn off all electric power to the appliance if service is to be performed.
3. Set the thermostat to lowest setting.
4. Turn the Manual Gas Cock clockwise to "OFF" position. Do not force. See step 5 above and diagrams.

STKR-001

11.8 DOMESTIC HOT WATER HEATER

Hot water heaters are designed for installation with a storage tank. The operation of the properly sized circulating pump, the piping between the tank and heater and the control of water velocity, as explained below, are important for correct operation of your hot water heater.

11.9 WATER THERMOSTAT SETTING

1. This appliance is provided with an electronic temperature controller as detailed in Section 6.
2. The maximum setting for this water heater is 140°F.
3. There is a hot water scald potential if the temperature controller is set too high.

11.10 WATER FLOW CONTROL

To ensure proper water flow through the heat exchanger, it is necessary to select the proper pump. Temperature rise at full fire will be an indication of flow. This must be done on initial installation and periodically rechecked.

Excessive lime/scale build-up in the heat exchanger is a result of improper water treatment or improper pump operation. Care should be taken to maintain proper water treatment and proper pump operation.

11.11 TEMPERATURE RISE AT FULL FIRING RATE

1. The pump must run continuously when the burner is firing.
2. With the pump running and the burner in the appliance in the off cycle, the inlet temperature and outlet temperature readings on the display should read approximately the same temperatures.
3. Turn the hot water heater on and allow time for the temperature to stabilize. Check the temperature rise when the burner is firing at 100% of rated input.
4. Compare the temperature rise on the Avenger display with the expected temperature rise.

If the temperature rise is too high, adjust as follows:

1. Check for flow restrictions. Check for debris in strainers.
2. Check diameter and equivalent length of the piping between the storage tank and hot water heater.
3. Be sure all valves are open between the hot water heater and the storage tank. Ensure that all ball valves are fully ported.
4. Check the pump to be sure it is running properly and that the pump motor is running in the proper direction.
5. Be sure the pipes between the hot water heater and storage tank are not more than a total of 80 equivalent feet between inlet and outlet lines. If maximum equivalent length for the specified pipe diameter is exceeded, larger diameter pipe may have to be installed to achieve correct flow and temperature rise.
6. Common manifold piping for multiple unit installations will require larger minimum pipe sizes and tank circulating tapping to ensure proper flow.
7. Check PID settings and on/off hysteresis.

If the temperature rise is too low, adjust as follows:

1. Temperature rise can be increased by slowly closing the flow control valve (globe valve or flow setter) in the outlet piping from the hot water heater to the storage tank to achieve the proper temperature rise.

The required temperature rise, and the recommended pump size are based on the heating of potable water with normal hardness. Consult the factory when heating potable water exceeding these specifications. For DHW applications with other than normal hardness, choose a pump for the local water hardness conditions. Alternatively, soften the water to normal levels. Damage to the heat exchanger as a result of scaling or corrosive water conditions in non-warrantable.

CAUTION
Temperature rise cannot be adjusted when the burner is firing at less than 100% of input rate.

11.12 WATER HEATERS

The manufacturer recommends the use of a properly sized thermostatic mixing valve to supply domestic hot water at temperatures less than 140°F (60°C). Storing the water at a higher temperature and thermostatically mixing the water will decrease the size of the storage tank and increase the available quantity of mixed hot water.

- Piping components connected to the water heater for a space heating application shall be suitable for use with potable water.
- Toxic chemicals, used for boiler treatment, shall not be introduced into the potable water used for space heating.
- A water heater which will be used to supply potable water shall not be connected to any heating system or component(s) previously used with a non-potable water heating appliance.
- When a system requires water for space heating at temperatures higher than required for other uses, a means such as a mixing valve shall be installed to temper the water for those uses in order to reduce scald hazard potential.

CAUTION
Adequate care MUST be taken to prevent potential scald injury when storing water at 140°F (60°C) and hotter.

WARNING
Should overheating occur or the gas supply fail to shut off, do not turn off or disconnect the electrical supply to the pump, instead, shut off the gas supply at a location external to the appliance.

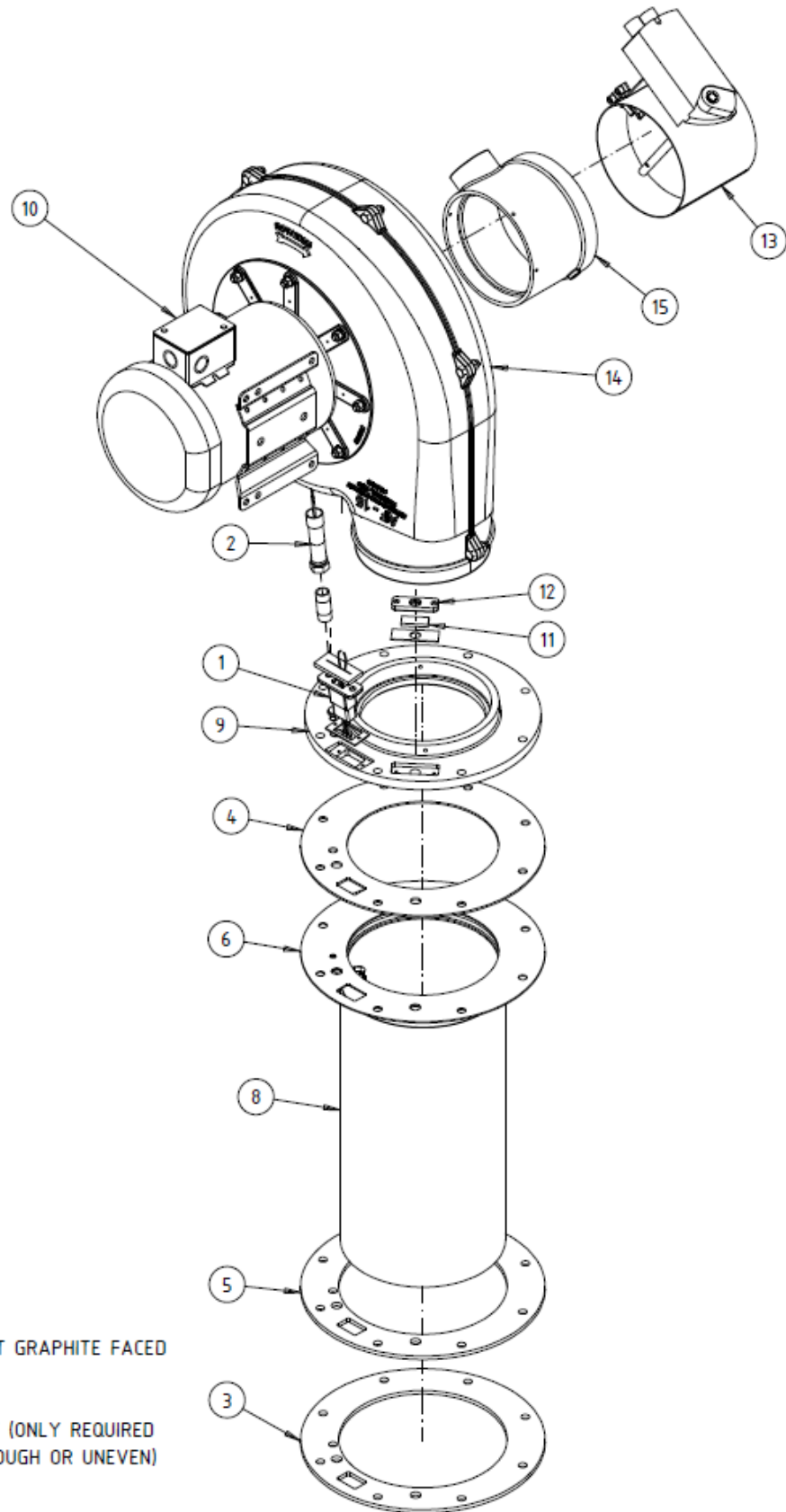
JACKET ASSMEBLY

ITEM #	FIGURE (S)	Part Description	Part Number	Avenger Models								
				All	1000	1500	2000	2500	3000	3500	4000	
1	A	Primary Heat Exchanger	651-00390-000		x							
			651-00100-000			x						
			651-00115-000				x	x				
			651-00394-000							x		
			651-00391-000								x	x
2	A	EMKA Latch With Insert RH	043-00061-000	x								
3	A	HX Base	003-00249-000		x							
			003-00251-000			x						
			003-00250-000				x	x	x	x	x	
4	A	Electrical Box Assembly	848-02021-000	x								
5	A	Jacket Frame	446-01750-000		x							
			446-01777-000			x						
			446-01783-000				x	x				
			446-01776-000						x	x	x	
6	A	Junction Box Assembly	125-00555-000	x								
7	A	Back Panel, Outer Jacket	136-00301-000		x							
			136-00302-000			x						
			136-04345-000				x	x				
			136-04355-000							x		
			136-04338-000								x	x
8	A	Panel Bracket, Top Side	527-00604-000		x							
			527-00608-000			x						
			527-00607-000				x	x	x	x	x	
9	A	EMKA Latch With Insert LH	043-00062-000	x								
10	A	Panel Bracket, Top Front	527-00605-000		x	x						
			527-00609-000				x	x				
			527-00606-000						x	x	x	
11	A	Front Bracket, Mid	083-00027-000		x	x						
			083-00028-000				x	x	x	x	x	
12	A	Front Panel , Outer Jacket (Bottom)	125-90026-000		x	x						
			125-90031-000				x	x				
			125-90029-000						x	x	x	
13	A	Control Panel, Outer Jacket	105-00118-000		x	x						
			105-00119-000				x	x	x	x	x	

14	A	Outer Jacket Left Panel (Top)	136-00106-000		x								
			136-00109-000			x							
			136-00111-000				x	x					
			136-00107-000						x	x	x		
15	A	Outer Jacket Side Panel (Bottom)	136-00105-000		x								
			136-00110-000			x							
			136-00112-000				x	x					
			136-00108-000						x	x	x		
16	A	Outer Jacket Right Panel (Top)	136-00106-000		x								
			136-00109-000			x							
			136-00111-000				x	x					
			136-00107-000						x	x	x		
17	A	Top Cover	019-00088-000		x								
			019-00091-000			x							
			019-00090-000				x	x	x	x	x		
18	A	Literature Pocket	125-00458-000	x									
19	A	Bezel (Bottom)	019-00200-000		x	x	x	x					
			019-00201-000						x	x	x		
20	A	Bezel (Top)	832-18241-000	x									
21	A	Top Cover Front	125-90027-000		x	x							
			125-90030-000				x	x					
			125-90028-000						x	x	x		
22	A	Condensate Box Assembly	125-00520-000	x									
23	A	Manual reset high limit	817-11064-000	x									
			858-11560-000 (DHW)	x									
24	A	Auto reset high limit	817-11063-000	x									
			836-09717-000 (DHW)	x									
25	A	Victaulic Coupling	221-00432-000		x								
			221-00433-000			x							
			221-00435-000				x	x	x				
			221-00436-000							x	x		
26	A	External Pipe Assembly - INLET	109898-13-EXT		x								
			109241-13-EXT			x							
			109956-13-01				x	x					
			109245-15-01						x				
			109246-15-1							x	x		
27	A	External Pipe Assembly - OUTLET	109898-15-EXT		x								
			109953-15-EXT			x							
			109956-15-01				x	x					
			109245-17-01						x				
			109246-17-1							x	x		
28	A	Lid Pull	037-00608-000	x									

29	A	Compression Latch >1"	043-00028-000	x								
29	A	Compression Latch <1"	043-00028-000	x								
30	A	Latch Frame Catch	043-00063-000	x								
31	A	Honeywell Touch Screen	833-25171-000	x								
32	A	12" Air Filter Assy.	125-00623-000	x								

Figure B
BLOWER & BURNER ASSEMBLY



WHITE CERAMIC GASKET GRAPHITE FACED

SOLID GRAPHITE GASKET
+ WHITE CERAMIC GASKET (ONLY REQUIRED
IF HEAT EXCHANGER IS ROUGH OR UNEVEN)

BLOWER & BURNER ASSEMBLY

ITEM #	FIGURE (S)	Part Description	Part Number	Avenger Models								
				All	1000	1500	2000	2500	3000	3500	4000	
1	B	Hot Surface Igniter	873-01045-000	x								
2	B	UV Scanner	817-00654-000	x								
3	B	Graphite Gasket	853-09540-000		x							
			853-09541-000			x	x	x				
			853-09554-000							x	x	x
4	B	Red Silicone Gasket	853-09544-000		x							
			853-09543-000			x	x	x				
			853-09552-000							x	x	x
5	B	White Ceramic Gasket with Graphite Facing	853-09545-000		x							
			853-09542-000			x	x	x				
			853-09553-000							x	x	x
6	B	Burner Flange	125-00518-000, (4")		x							
			125-00507-000, (8")			x	x	x				
			125-01464-000, (10")							x	x	x
7	B	Hot Surface Igniter Mounting Plate	285-03646-000	x								
8	B	Primary Burner (incl. Burner Flange)	829-20004-001 (4")		x							
			829-20005-001 (5-1/2")			x						
			829-20006-001 (8")				x					
			829-20007-001 (8")					x				
			829-20008-001 (10")							x		
			829-20009-001 (10")								x	x
9	B	Aluminum Fan Flange	285-03640-000		x							
			285-03642-000			x	x	x				
			285-03644-000							x	x	
			285-03643-000									x
10	B	Blower	813-02895-000 (1HP)		x							
			813-02896-000 (1.5HP)			x	x					
			813-02897-000 (3HP)					x				
			813-02898-000 (3HP)							x	x	
			813-02899-000 (5HP)									x
11	B	Sight Glass	851-06444-000	x								
12	B	Sight Glass Holder	285-03645-000	x								
13	B	Air Inlet Damper Assembly (Includes Siemens Electronic Damper Actuator)	427-25026-000		x	x	x					
			427-25028-000					x	x	x	x	

14	B	AF Fan Kit	813-02817-000		x								
			813-02818-000			x	x	x					
			813-02819-000						x	x			
			813-02820-000									x	
			833-25219-000		x								
			833-25208-000			x	x						
			833-25211-000					x	x	x			
			833-25215-000										x
15	B	Air/Gas Mixing Tube	090-05000-000		x	x	x						
			090-10301-000					x	x	x	x		

Figure C
TYPICAL GAS TRAIN AR1000-AR3000

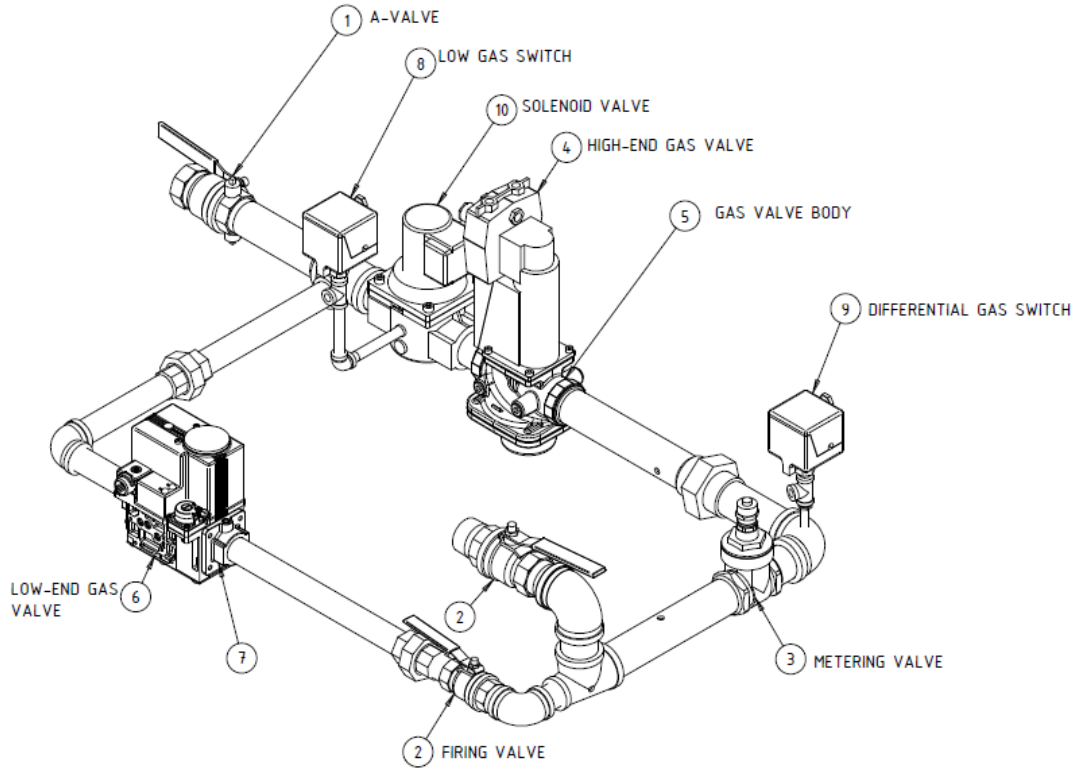
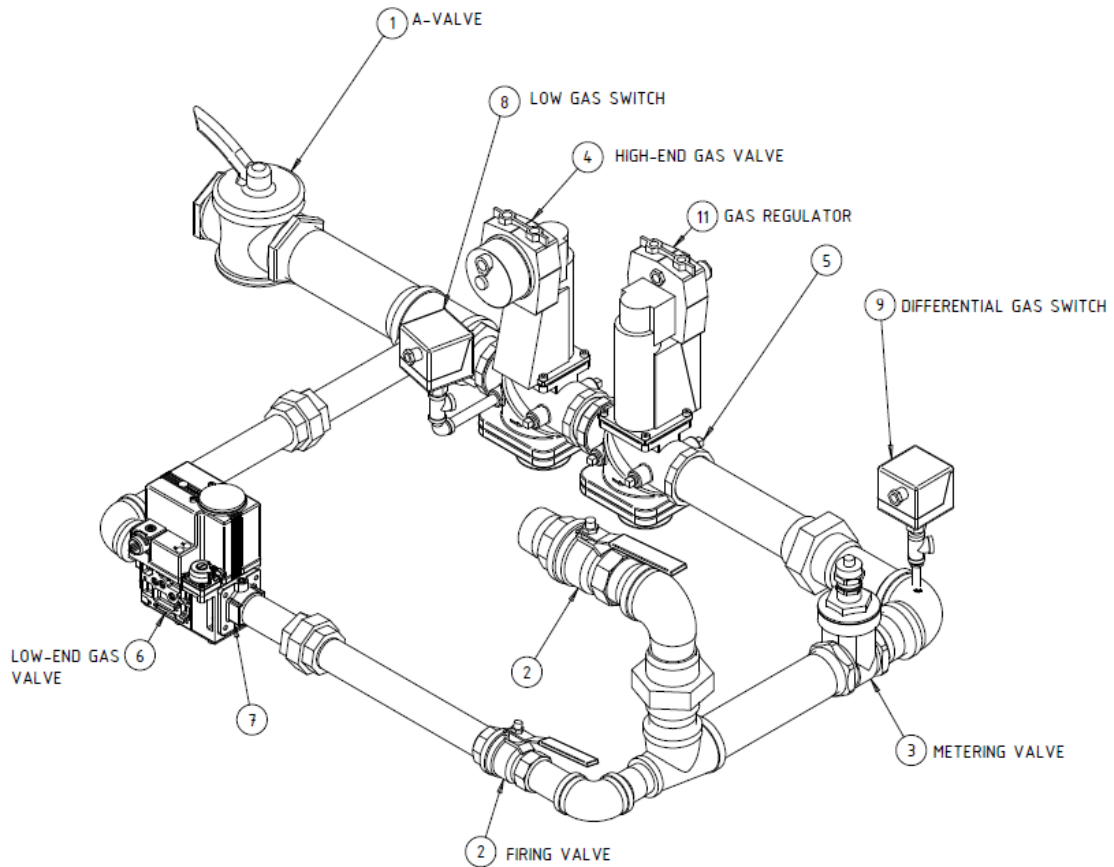


Figure D
TYPICAL GAS TRAIN AR3500-AR4000

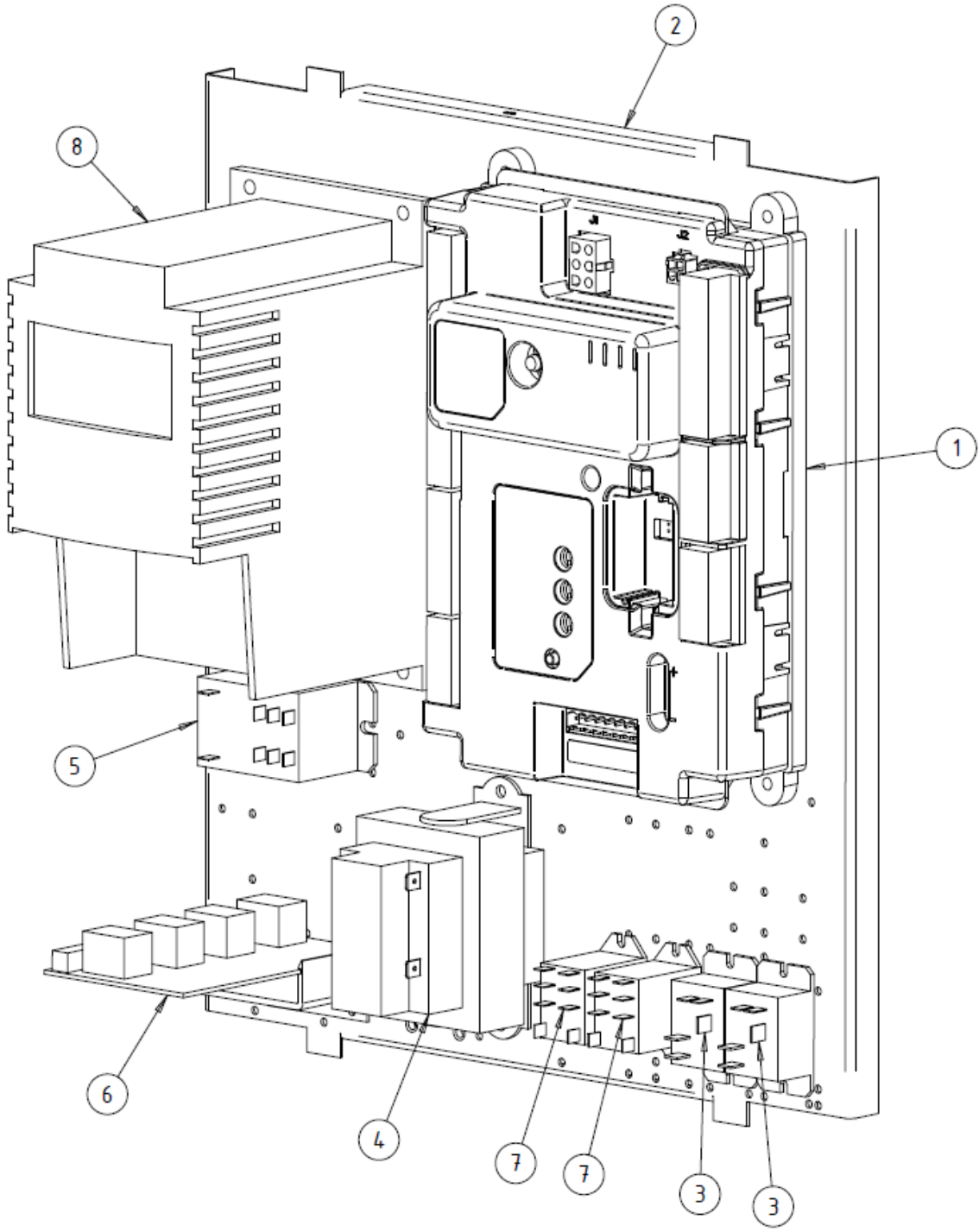


GAS TRAIN ASSEMBLY

ITEM #	FIGURE (S)	Part Description	Part Number	Avenger Models								
				All	1000	1500	2000	2500	3000	3500	4000	
1	C, D	A-Valve	223-01371-000		x							
			223-01373-000			x	x					
			223-01374-000					x	x			
			223-01375-000							x	x	
2	C, D	Firing Valve (Ball Valve)	223-01363-000		L							
			223-01367-000			L	L	L	L	L	L	L
			223-01368-000		H							
			223-01369-000			H	H	H	H			
			223-01370-000							H	H	
3	C, D	Metering Valve (Brass Gate Valve)	225-00883-000		x							
			225-00884-000			x	x	x	x			
			225-00885-000							x	LP	
			225-00925-000								Nat	
4	C, D	High End Gas Valve	996-30920-000	x								
5	C, D	High End Gas Valve Body	949-00461-000		x	x	x	x	x			
			949-00490-000							x	x	
6	C, D	Low End Gas Valve	833-25180-000		x							
			918-10251-000			x						
			918-10252-000				x	x	x			
			918-10253-000							x	x	
7	C, D	Low End Gas Valve Flange	918-10251-000			x	x	x	x	x		
			918-10245-000								x	
8	C, D	Low Gas Pressure Switch	817-02416-000	x								
9	C, D	Differential High Gas Pressure Switch	817-11049-000 or 817-02416-000	x								
10	C	Solenoid Valve	229-00287-000		x							
			229-00280-000			x	x	x	x			
11	D	Gas Regulator	269-00400-000							x	x	

* L = LOW END GAS TRAIN, H = HIGH END GAS TRAIN

Figure E
CONTROL BOARD ASSEMBLY

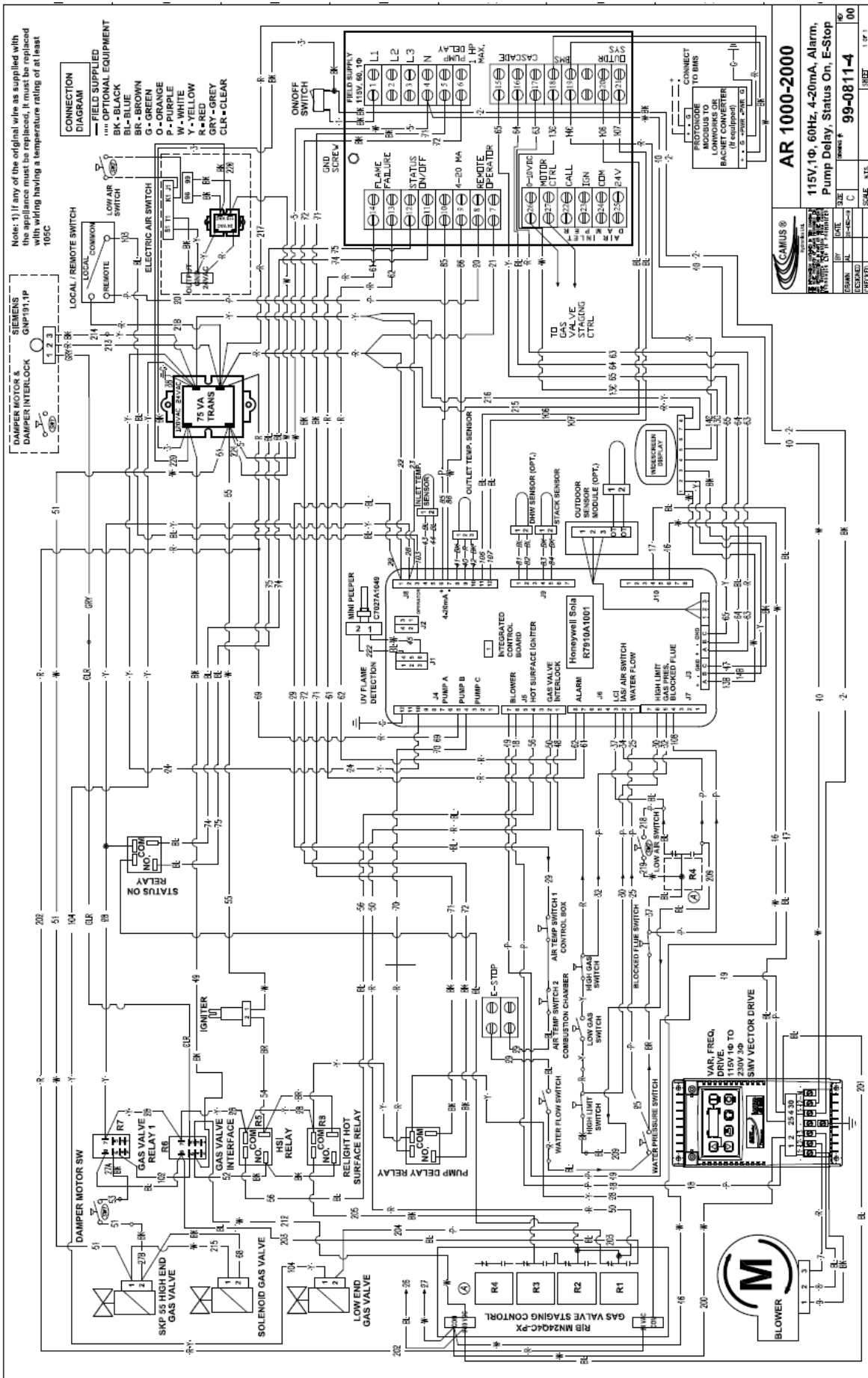


CONTROL BOARD

ITEM #	FIGURE (S)	Part Description	Part Number	Avenger Models								
				All	1000	1500	2000	2500	3000	3500	4000	
1	E	Sola Controller	833-25166-000	x								
2	E	Control Box Mounting Plate	125-00566-000	x								
3	E	Pump Delay Relay (up to 1hp)	959-05241-000	x								
4	E	Transformer (75VA)	834-03852-000	x								
5	E	Contactory Relay	175-00362-000	x								
6	E	Gas Valve Staging Control	832-18259-000	x								
7	E	Interface Relay	832-18299-000	x								
8	E	VFD (460 Vac)	833-25220-000		x	x						
			833-25209-000				x					
			833-25212-000					x	x	x		
			833-25216-000									x

ADDITIONAL PARTS

ITEM #	FIGURE (S)	Part Description	Part Number	Avenger Models								
				All	1000	1500	2000	2500	3000	3500	4000	
1	Not Shown	On/Off Switch (with rainproof cover)	817-11058-000	x								
2	Not Shown	Inlet Sensor	817-04468-000	x								
3	Not Shown	Outlet Dual Sensor	817-04403-000	x								
4	Not Shown	Blocked Flue Switch	817-11046-000	x								
5	Not Shown	Differential Pressure Switch	817-11073-000	x								
			880-04535-000	x								
6	Not Shown	Stack Sensor	817-11078-000	x								
7	Not Shown	Pilot Regulator (Combination Control)	833-25191-000						x	x	x	
8	Not Shown	2-10Vdc Converter	832-18249-000	x								
9	Not Shown	Snap-Action Thermostat	817-11054-000	x								
10	Not Shown	Wiring Harness	826-06097-000	x								
		Harness Kit	826-06102-000	x								
11	Not Shown	Mixing Tube Ring	090-10302-000						x			
12	Not Shown	Mixing Tube Ring- downstream	090-10303-000						x			
13	Not Shown	Air Vent (Inlet)	957-05174-000	x								
14	Not Shown	Manual Air Vent (Outlet)	957-05311-000	x								
15	Not Shown	Indoor Flow Switch	817-11069-000	x								
16	Not Shown	Water Pressure Switch	817-11011-000	x								

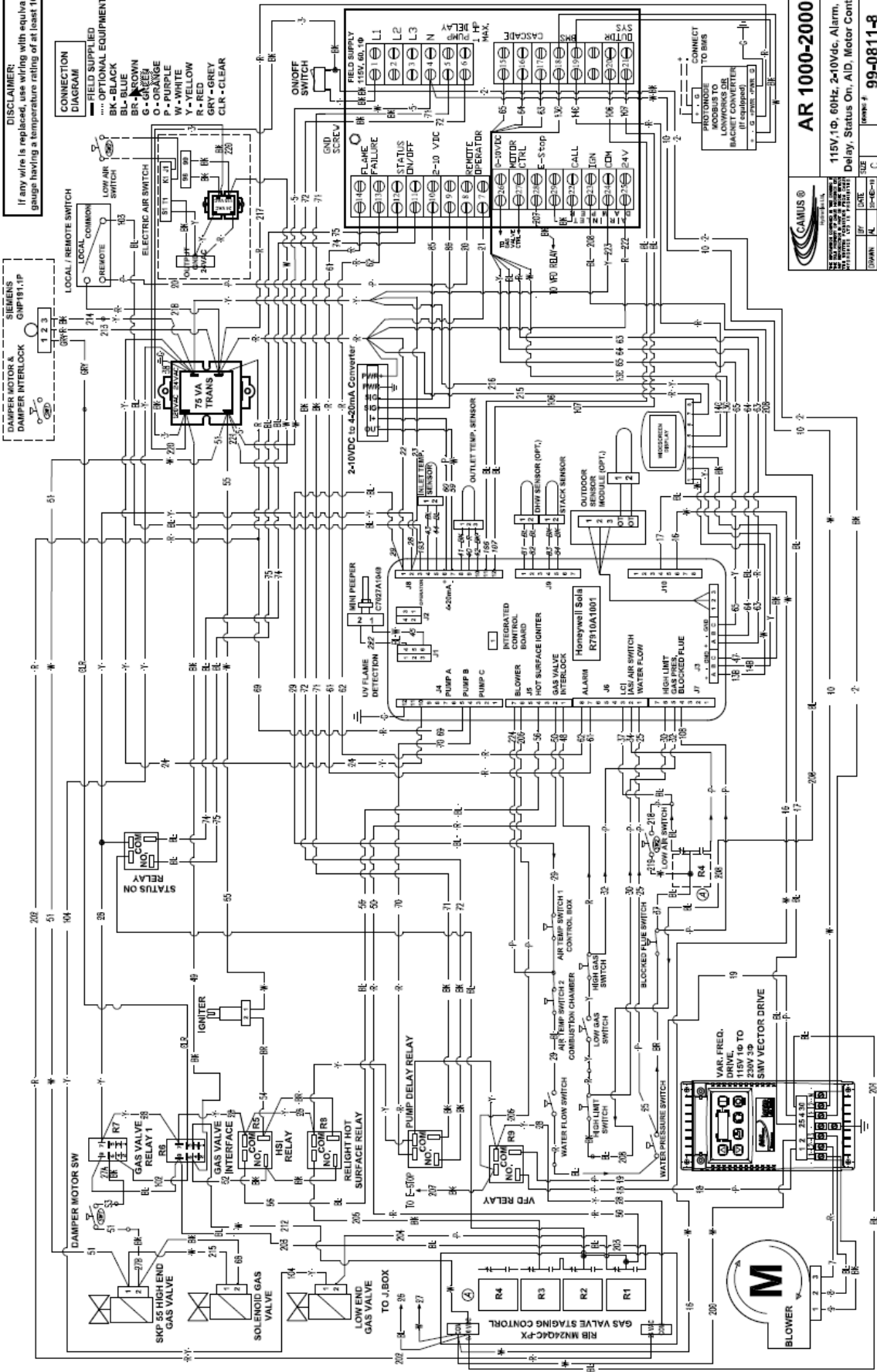


DISCLAIMER:
If any wire is replaced, use wiring with equivalent gauge having a temperature rating of at least 105°C.

CONNECTION DIAGRAM
FIELD SUPPLIED
BK - BLACK
BL - BLUE
BR - BROWN
G - GREEN
O - ORANGE
P - PURPLE
W - WHITE
R - RED
CLR - CLEAR

SIEMENS
DAMPNER MOTOR &
DAMPNER INTERLOCK
GNP181-1P

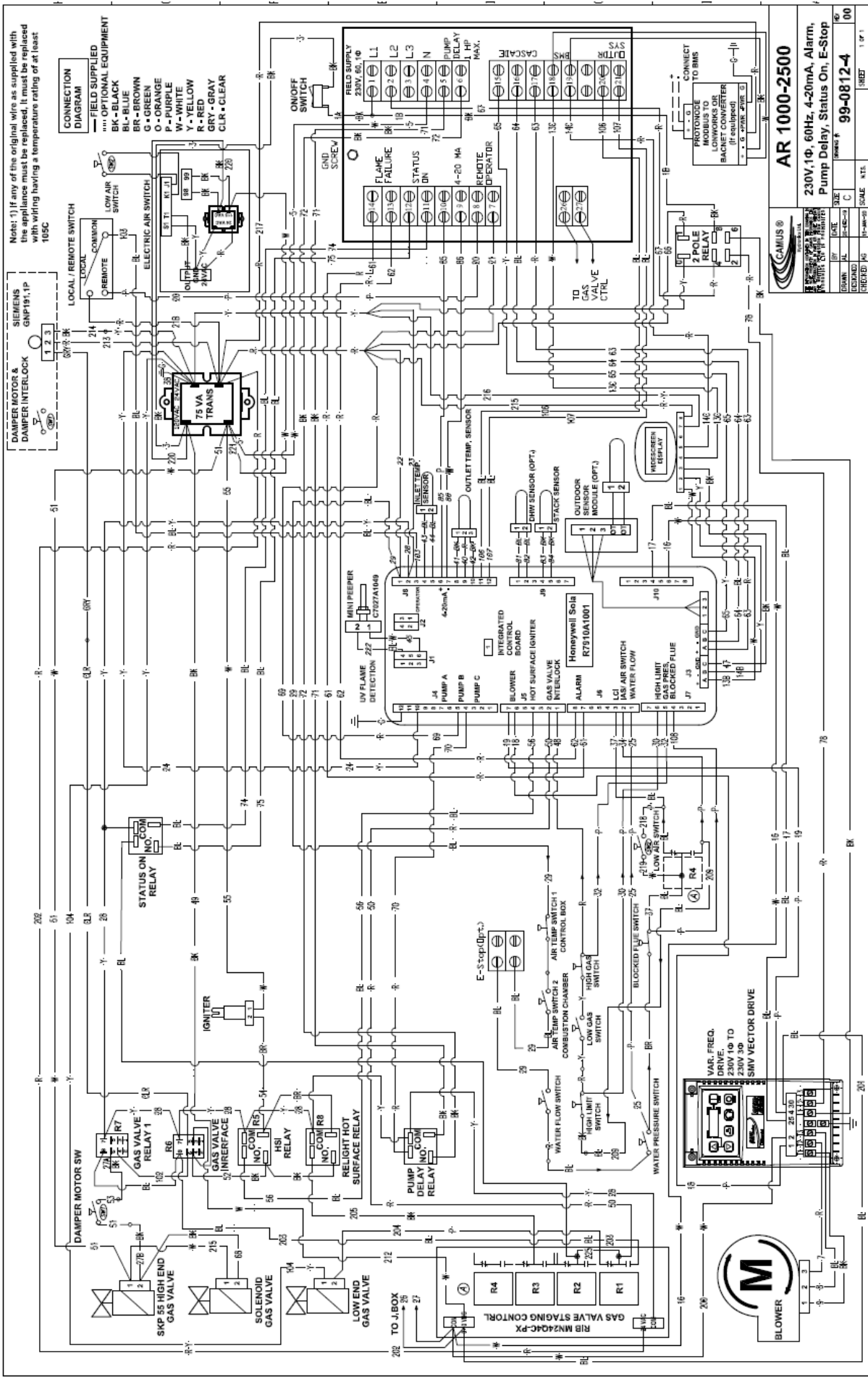
LOCAL REMOTE SWITCH
LOCAL COMMON
LOCAL REMOTE
ELECTRIC AIR SWITCH
LOW AIR SWITCH



AR 1000-2000

115V, 1Ø, 60Hz, 2-10Vdc, Alarm, Pump
Delay, Status On, AID, Motor Control (opt)

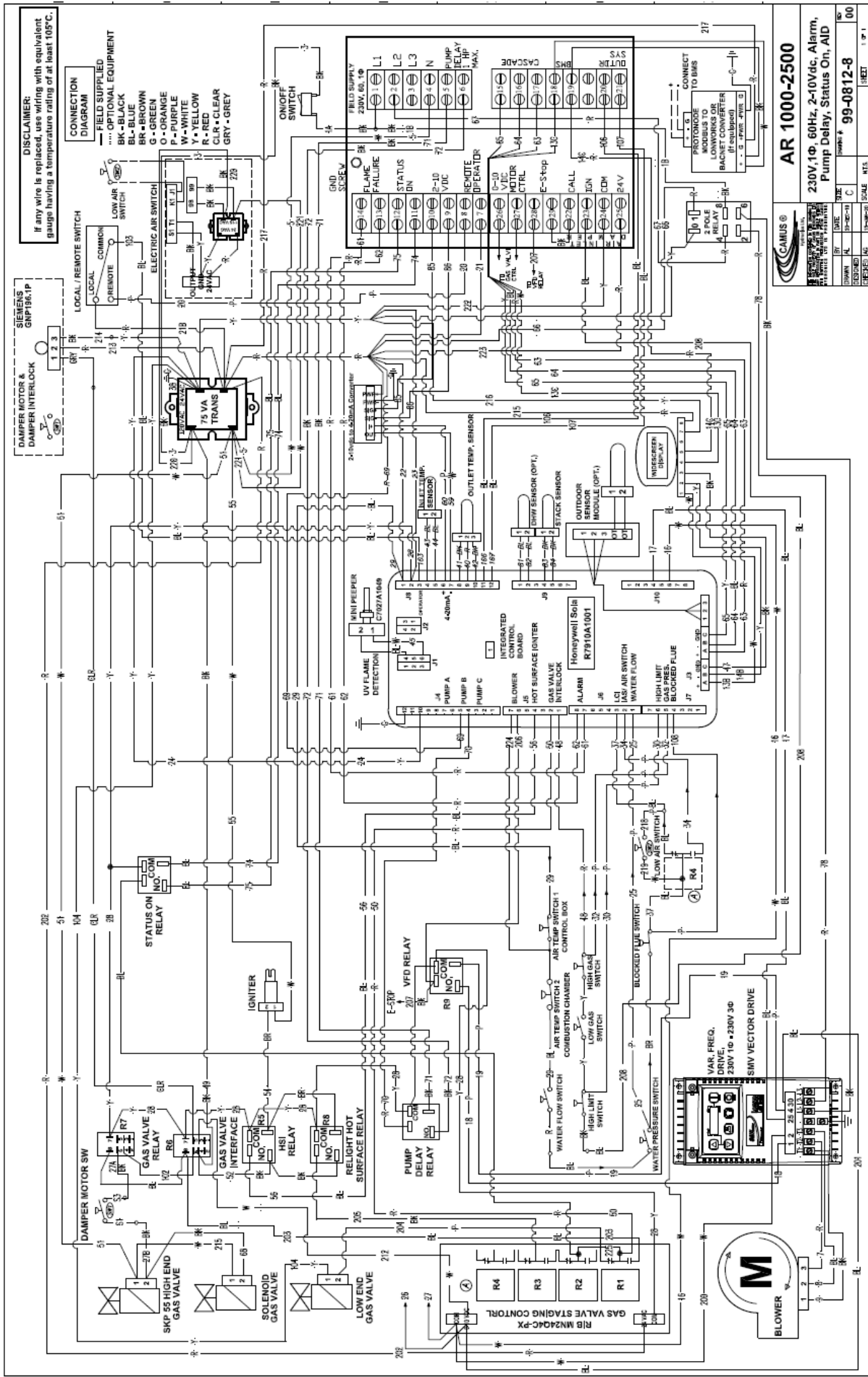
REV	DATE	BY	CHK	SCALE	SHEET
00				99-0811-8	1 OF 1



AR 1000-2500

230V, 1Ø, 60Hz, 4-20mA, Alarm, Pump Delay, Status On, E-Stop

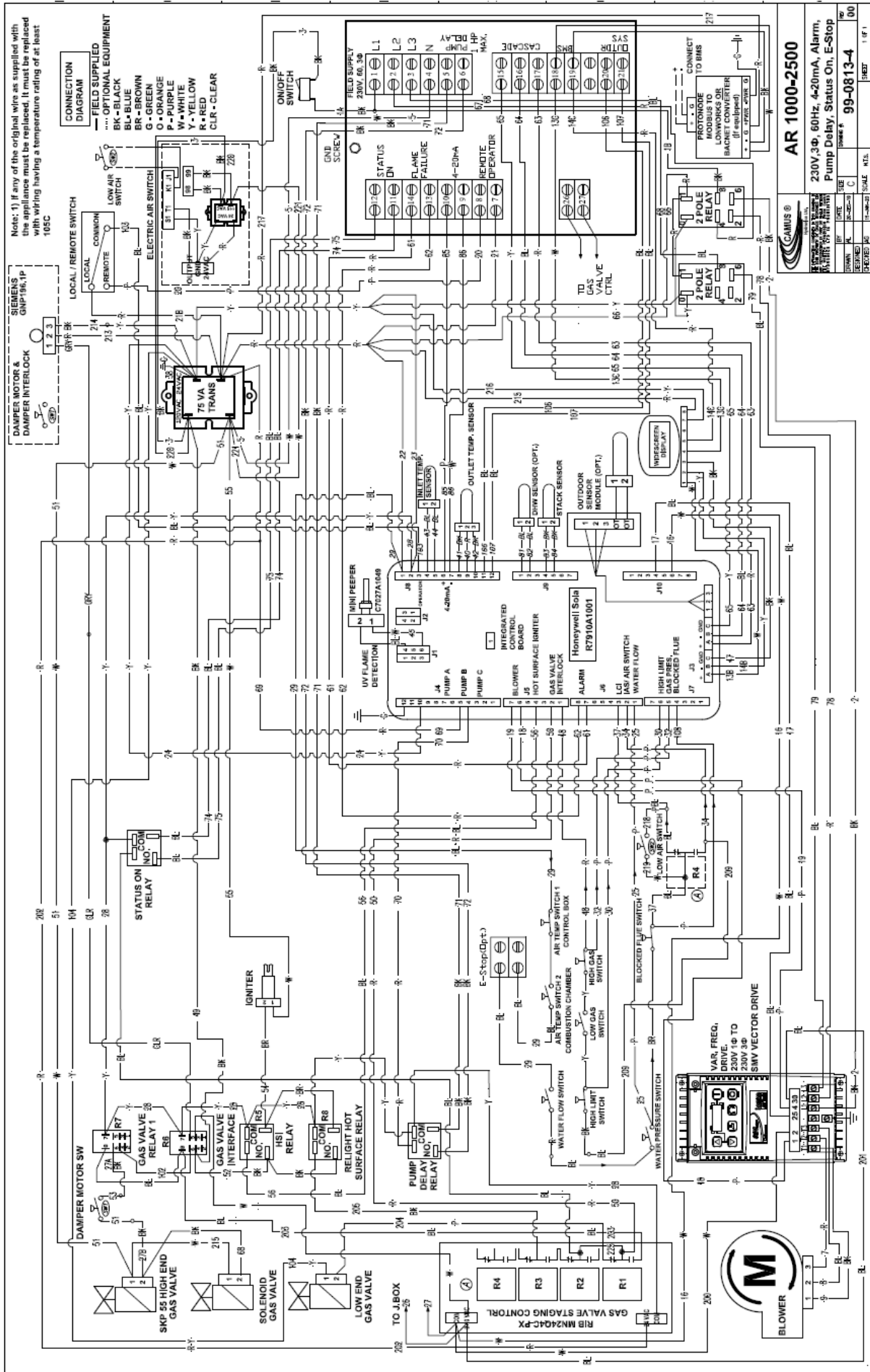
DATE: _____
 DRAWN BY: _____
 CHECKED BY: _____
 SCALE: N.T.S.
 SHEET: 1 OF 1

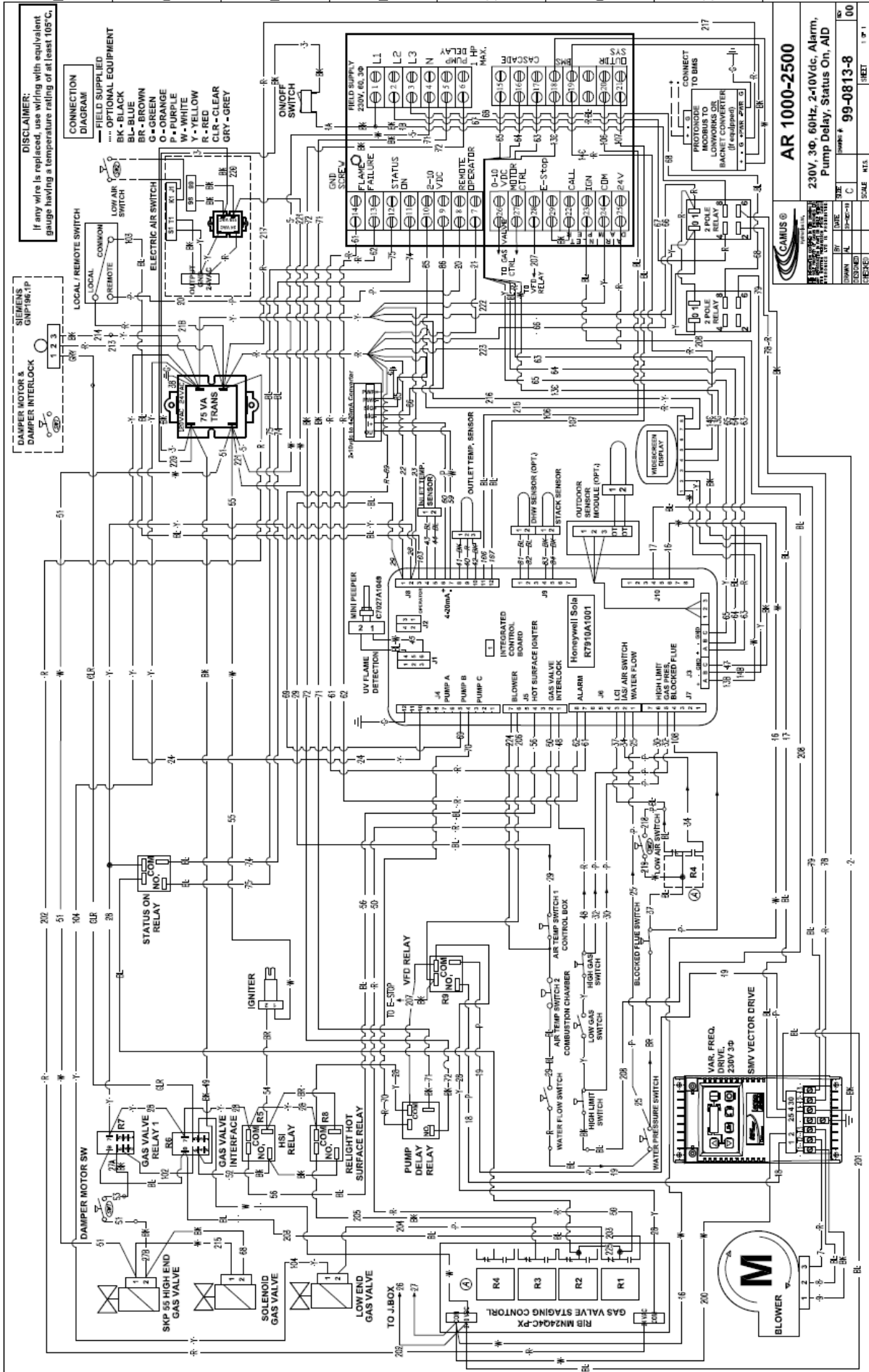


AR 1000-2500
 230V, 1Ø, 60Hz, 2-10Vdc, Alarm, Pump Delay, Status On, AID

DATE	BY	SIZE	NO.
10-10-18	C	C	00
REVISED	BY	DATE	NO.
SCALE	DATE	SCALE	DATE
1/8"=1'-0"	10-10-18	1/8"=1'-0"	10-10-18

99-0812-8

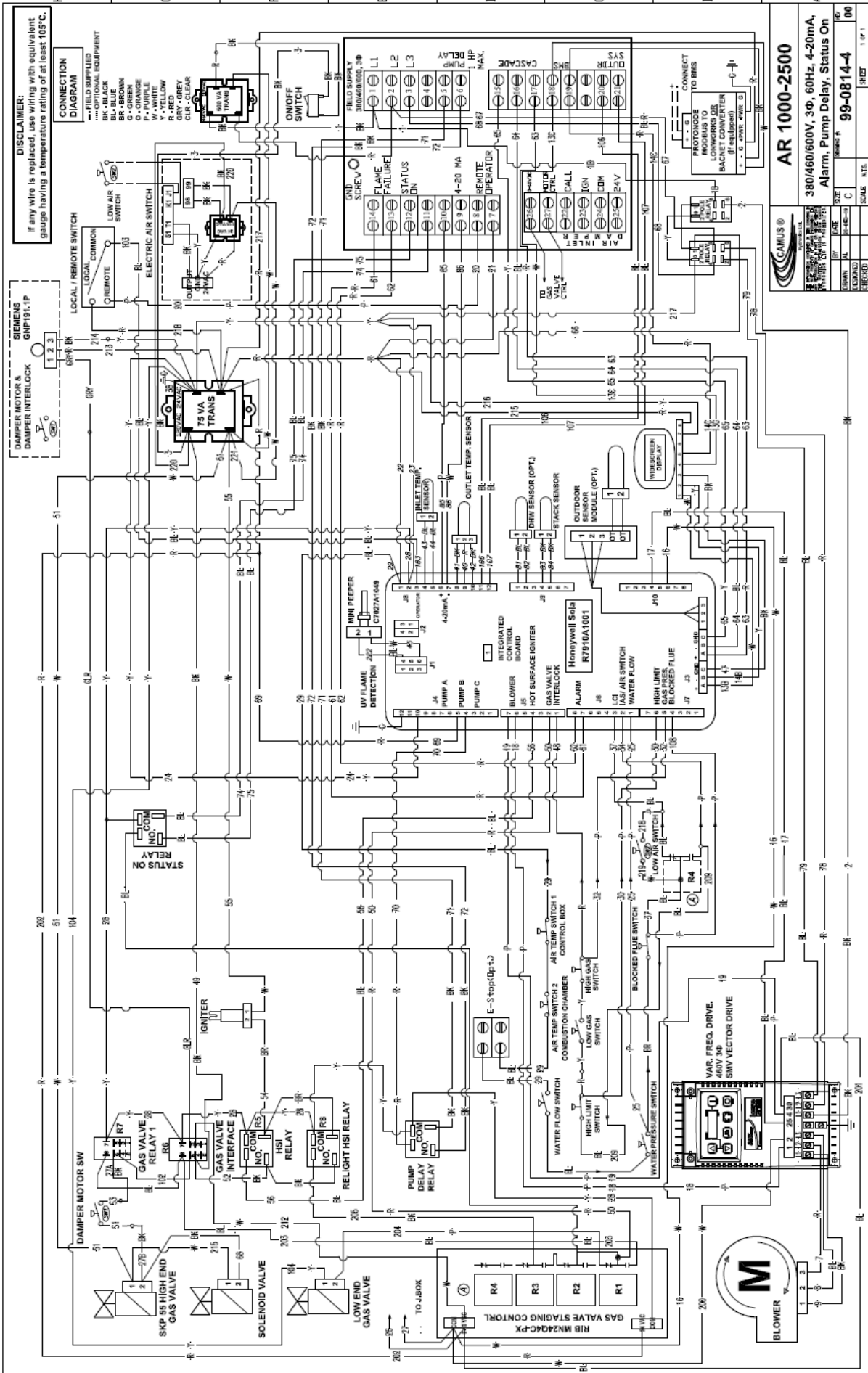


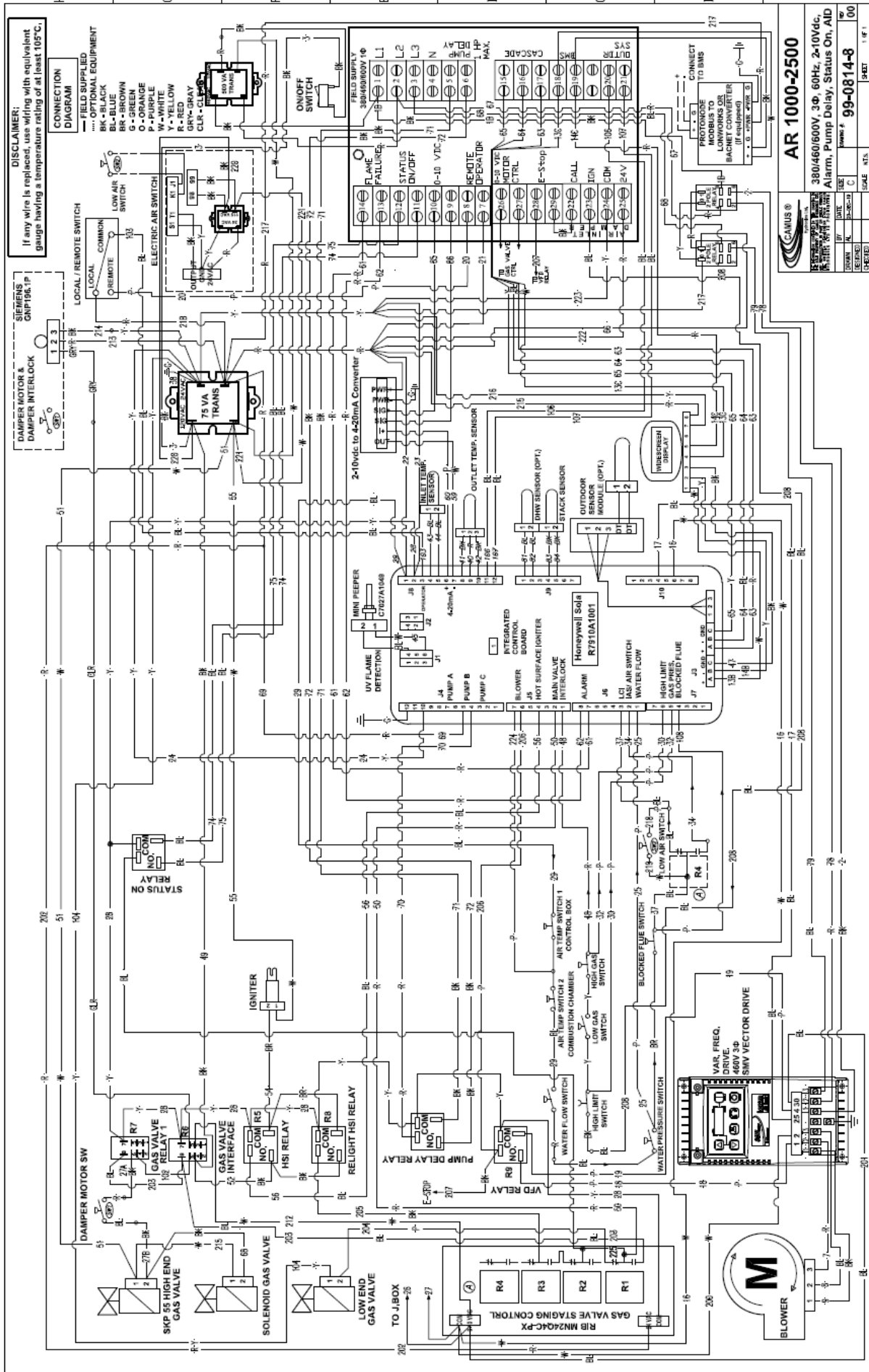


AR 1000-2500

230V, 3 ϕ , 60Hz, 2-10Vdc, Alarm, Pump Delay, Status On, AID

DATE: 10-10-11
 DRAWN: C
 CHECKED: C
 SCALE: NTS
 SHEET: 1 of 1



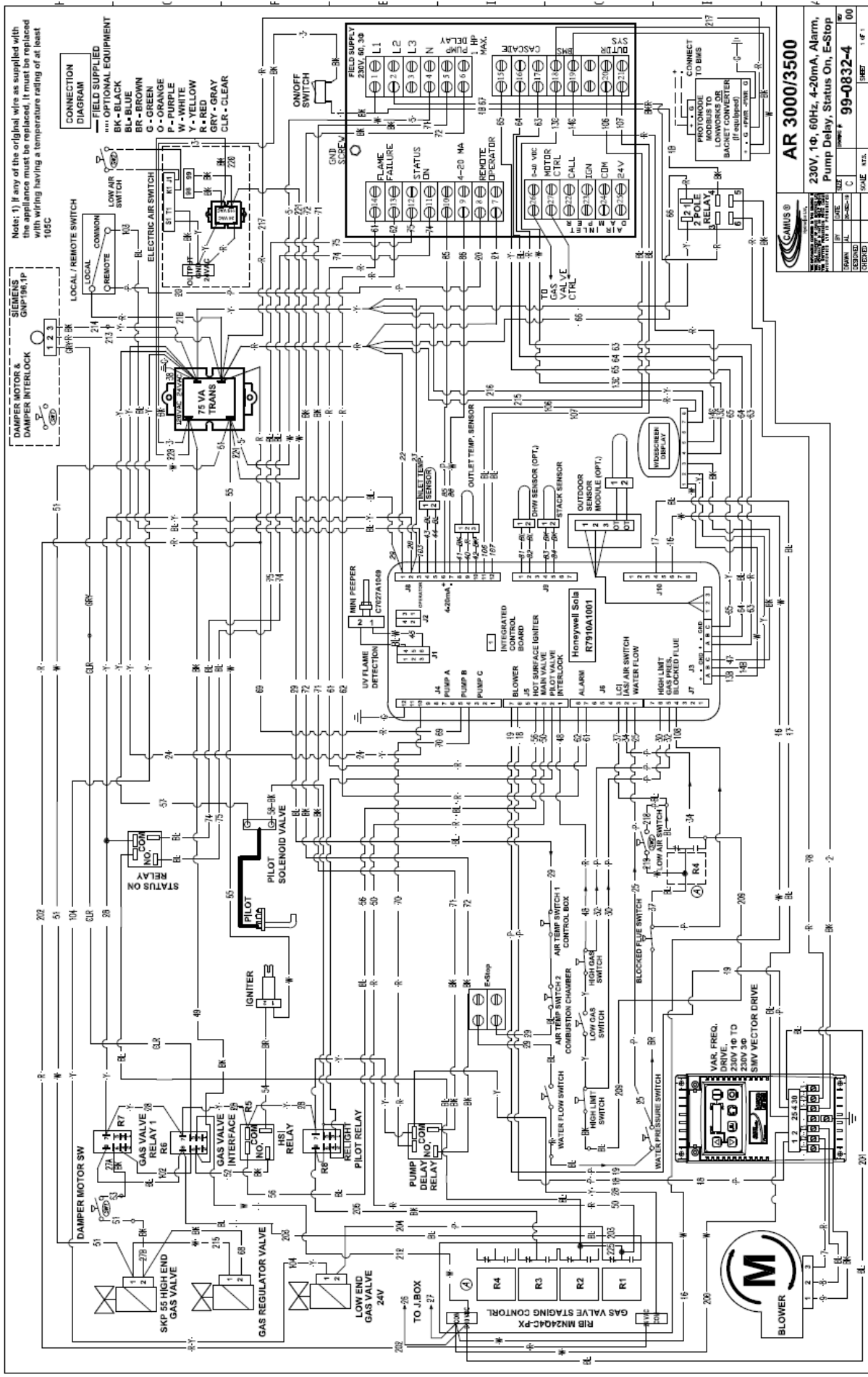


AR 1000-2500

380/460/600V, 3Ø, 60Hz, 2-10Vdc, Alarm, Pump Delay, Status On, AID

REVISED	DATE	BY	SIZE

SCALE: NTS. SHEET 1 OF 1



Notes: 1) If any of the original wire as supplied with the appliance must be replaced, it must be replaced with wiring having a temperature rating of at least 105C

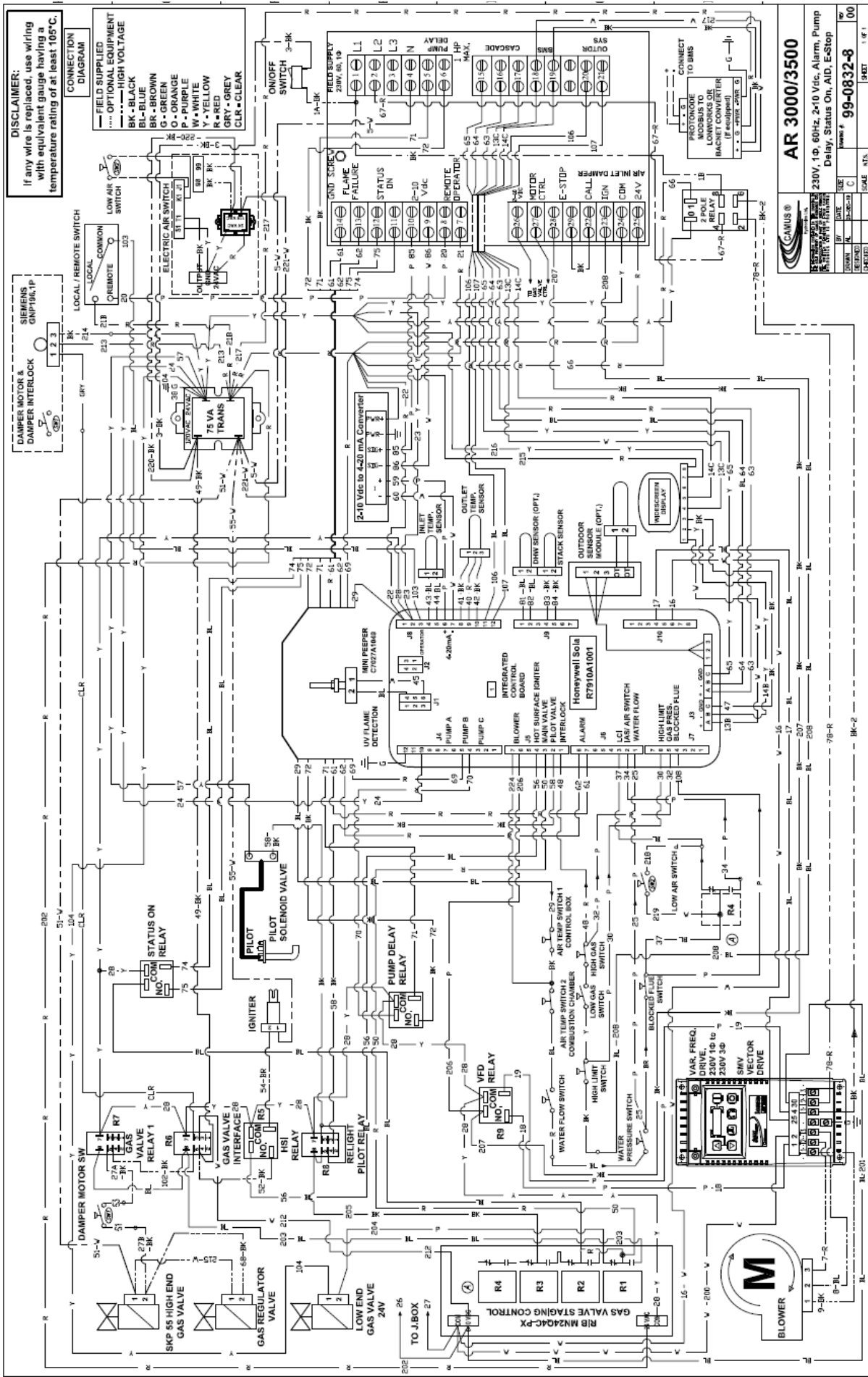
CONNECTION DIAGRAM
FIELD SUPPLIED
BK - BLACK
BL - BLUE
BR - BROWN
G - GREEN
O - ORANGE
W - WHITE
Y - YELLOW
R - RED
GR - GRAY
CLR - CLEAR

AR 3000/3500

230V, 1φ, 60Hz, 4-20mA, Alarm, Pump Delay, Status On, E-Stop

DATE	SIZE	REV
BY	BY	BY
CHECKED	CHECKED	CHECKED

99-0832-4



DISCLAIMER:
If any wire is replaced, use wiring with equivalent gauge having a temperature rating of at least 105°C.

- CONNECTION DIAGRAM**
- FIELD SUPPLIED
 - OPTIONAL EQUIPMENT
 - HIGH VOLTAGE
 - BK - BLACK
 - BL - BLUE
 - BR - BROWN
 - G - GREEN
 - O - ORANGE
 - P - PURPLE
 - W - WHITE
 - Y - YELLOW
 - R - RED
 - GR - GREY
 - CLR - CLEAR

AR 3000/3500

230V, 1Ø, 60Hz, 2-10 Vdc, Alarm, Pump Delay, Status On, AID, E-Stop

DATE	BY	CHKD	REV

Scale: 1/8" = 1'-0"

99-0832-8

CONDENSING BOILER LIMITED WARRANTY

GENERAL

Camus Hydronics Limited ("Camus") extends the following LIMITED WARRANTY to the owner of this appliance, provided that the product has been installed and operated in accordance with the Installation Manual provided with the equipment. Camus will furnish a replacement for, or at Camus option repair, any part that within the period specified below, shall fail in normal use and service at its original installation location due to any defect in workmanship, material or design. The repaired or replacement part will be warranted for only the unexpired portion of the original warranty. This *Limited* warranty does not cover failures or malfunctions resulting from: (1) Failure to properly install, operate or maintain the equipment in accordance with Camus' manual; (2) Abuse, alteration, accident, fire, flood, foundation problems and the like; (3) Sediment or lime build-up, freezing, or other conditions causing inadequate water circulation; (4) Pitting and erosion caused by high water velocity; (5) Failure of connected systems devices, such as pump or controller; (6) Use of non-factory authorized accessories or other components in conjunction with the system; (7) failing to eliminate air from, or replenish water in, the connected water system; (8) Chemical contamination of combustion air or use of chemical additives to water; (9) Production of noise, odors, discoloration or rusty water; (10) Damage to surroundings or property caused by leakage or malfunction; (11) All labor costs associated with the replacement and/or repair of the unit; (12) Any failed component of the hydronic system not manufactured as part of the boiler.

HEAT EXCHANGER

Within 10 years of the appliance having declared FOB from Camus®, a heat exchanger shall prove upon examination by Camus® to be defective in material or workmanship, Camus® will exchange or repair such part or portion if deemed warranty based on the number of years the appliance has been in service.

Years in Service	Avenger	Years in Service	Avenger
1	100%	6	100%
2	100%	7	100%
3	100%	8	100%
4	100%	9	100%
5	100%	10	100%

The exchanged or repaired heat exchanger will carry the balance of the remaining original warranty provided with the appliance based on the FOB date. In the event a replacement heat exchanger is delivered and if the defective heat exchanger is deemed to be repairable by Camus® the repaired heat exchanger will be returned to the customer and a credit will not be issued. Heat Exchanger shall be warranted for (20) years of the appliance having declared FOB from Camus® against "Thermal Shock" (excluded, however, if caused by appliance operation at large changes exceeding 150°F between the water temperature at inlet and appliance temperature or operating at temperatures exceeding 210°F (ARH & ARW).

BURNER

If within FIVE years of the appliance having declared FOB from Camus® to be defective in material or workmanship, Camus® will exchange or repair such part or portion.

ANY OTHER PART

If any other part fails within one (1) year after installation, or eighteen (18) months of the appliance having declared FOB from Camus® whichever comes first Camus® will furnish a replacement or repair that part. Replacement parts will be shipped FOB our factory.

DURATION OF LIMITED WARRANTY

Any *Limited* warranty, including the warranty of merchantability imposed on the sale of the boiler under the laws of the state or province of sale are *Limited* in duration to one year from date of original installation.

STATE LAW & LIMITED WARRANTY

Some states or provinces do not allow:

- a) Limitations on how long an implied warranty last.
- b) Limitations on incidental or consequential damages.

The listed limitations may or may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which may vary from state to state and province to province.

CONDITIONS

We will not:

- a) Repair or replace any boiler, or part, subject to conditions outlined in 'This *Limited* Warranty Does Not Cover'.
- b) Reimburse any costs associated with repair and/or replacement.
- c) Replace and/or repair any boiler without complete model number/serial number.
- d) Replace any boiler without prior receipt of actual rating plate from the appliance.

HOW TO MAKE A CLAIM

Any claim under this warranty shall be made directly to *Camus Hydronics Limited* Canadian Head Office

SERVICE LABOR RESPONSIBILITY

Camus shall not be responsible for any labor expenses to service, repair or replace the components supplied. Such costs are the responsibility of the owner.

DISCLAIMERS

Camus shall not be responsible for any water damage. Provisions should be made that in the event of a water/appliance or fitting leak, the resulting flow of water will not cause damage to its surroundings.

Name of Owner: _____

Name of Dealer: _____

Address: _____

Model Number: _____

Serial Number: _____

Date of Installation: _____

Date of Initial Operation: _____



CAMUS Hydronics is a manufacturer of replacement parts for most copper finned and stainless steel water heaters and heating boilers as well as a supplier of specialty HVAC products. Our service line is open 24 hours, 7 days a week! The CAMUS CERTIFIED! Seal assures you that Reliability, Efficiency & Serviceability are built into every single unit! For more information on our innovative products from CAMUS Hydronics Limited, call 905-696-7800 today!

