INSTALLATION OPERATION AND SERVICE MANUAL

ADVANTUS™ SERIES

GAS FIRED FIRE TUBE COMMERCIAL CONDENSING STAINLESS STEEL BOILERS

HYDRONIC HEATING

Models; AVH 500, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000, 2500, 3000, 3500, 4000

HOT WATER HEATER

Models; AVW 500, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000, 2500, 3000, 3500, 4000

H HLW

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

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

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 neighbor's phone. Follow the gas supplier's instructions,
- If you cannot reach your gas supplier, call the fire department.

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

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.

6226 Netherhart Road
Mississauga, Ontario
L5T 1B7
Canada

CAMUS® Hydronics Ltd.

P: 905.696.7800
F: 905.696.8801

www.camus-hydronics.com

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PART 1 GENERAL INFORMATION

1.1 INTRODUCTION

The Advantus™ is a condensing, fan assisted, fire tube appliance 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 Advantus™ 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 down to 10% for models AV500 & AV600 and down to 4.5% for models AV800 to AV1800 and 4.0% for models AV2000 to AV4000. The Advantus™ models 500 & 600 use a single automatic gas valve and operate on the principle of negative pressure. As the fan varies in speed it generates a varying negative pressure at the fan suction which draws in a corresponding amount of gas.

The Advantus™ models 800-4000 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 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 the gas valve works on the principle of negative pressure.

Figure 1: Advantus™

1.2 SPECIAL INSTRUCTIONS TO OWNER

This 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 CO_2, 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 particular attention to parts accompanying the boiler, which may show signs of being hit or otherwise being mishandled. Verify total number of pieces shown on packing slip with those actually received. In case there is damage or a shortage, immediately notify carrier.

Figure 2: Checking the Advantus™

Do not attempt to pry any panel off. To begin disassembly, you must first remove the two top panels (which can be lifted off without the use of tools). Only then will you be able to remove the front and two side panels.

Once you have removed the two top panels, carefully check and confirm that all ¼" 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.

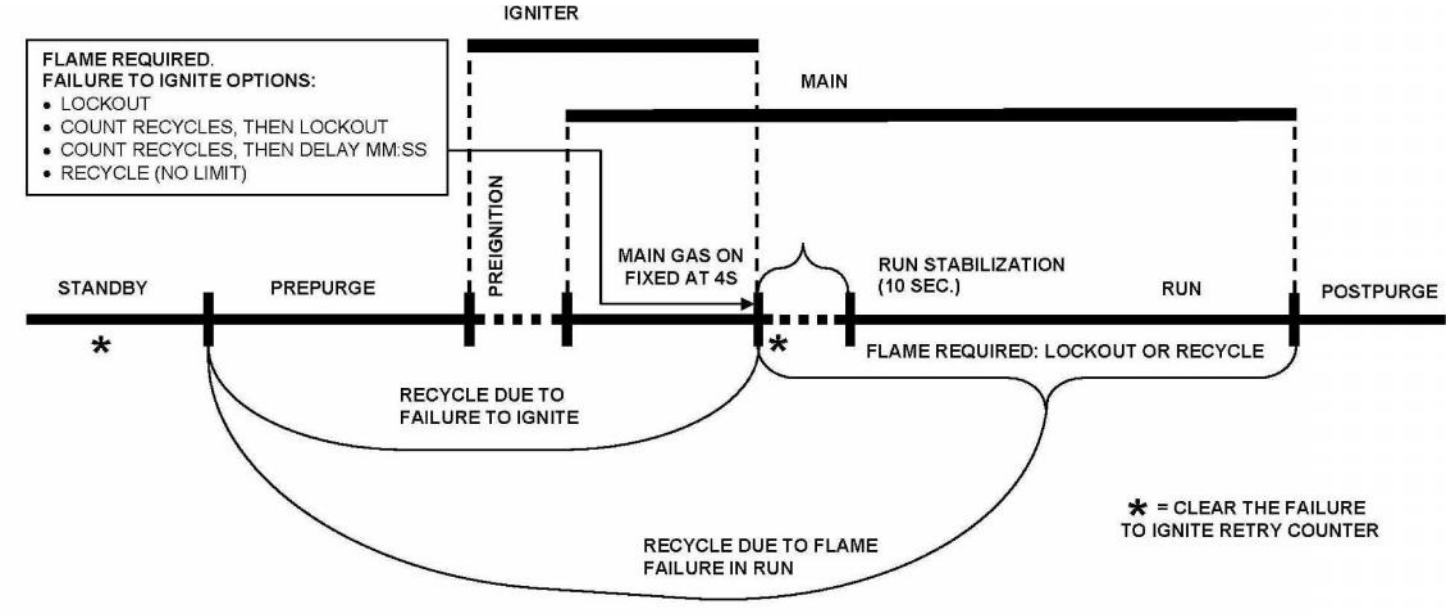
1.4 HOW IT OPERATES (SEQUENCE OF OPERATION)

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 for all models.
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 close at 30 PSI and is installed in the unit. The flow switch is mounted at the outlet of the appliance. If installing a flow switch, take care to properly trim the flow switch paddles so as 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 Advantus™ controller receives a call for heat via the remote operator contacts and the Demand parameter reads Central Heating, DHW, or Lead Lag Slave.
7. **a) AV500-AV600**: The Advantus™ controller energizes the pump contacts and starts to ramp up the voltage to the EC DC motor of the combustion fan after internal safety checks are satisfied.
   b) AV800-AV4000: The Advantus™ 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 VFD and allows 60 seconds for the variable frequency drive (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 Advantus™ controller will target the ignition fan speed.
9. **a) AV500-AV600 (Direct Ignition)**: The hot surface igniter will be energized for 22 seconds followed by opening of the gas valve. A signal of 0.8 Vdc minimum must be recognized by the controller at the UV scanner to keep the gas valve in an open position. The fan is kept at ignition speed as long as it receives a minimum modulation signal. As demand increases the modulation signal increases until full fire is reached. As target temperature is approached, the demand signal is reduced and the gas valve modulates downwards.
   b) AV800 – AV2500 (Direct Ignition): The Advantus™ controller will activate the hot surface igniter for 22 seconds followed by energizing the low end gas valve. A signal of 0.8Vdc 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 opens the fan inlet damper 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 high end gas valve shuts off and the boiler proceeds to post purge.
   c) AV3000 - AV4000 (Proven Pilot): The Advantus™ controller will activate the hot surface igniter for 22 seconds followed by energizing the pilot valve for 10 seconds, whereupon a signal of 0.8Vdc 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 (b) 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 4-20mA 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 igniter is energized with 115Vac when control is switching from the high end gas valve to the low end gas valve. To avoid shock do not contact bare igniter wires at this time

Figure 3: Advantus™ 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 ignition 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 temperate 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.

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.

DO NOT
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.

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 Camus Hydronics Limited qualified factory trained service technicians.

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.

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, 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).
- Using or storing **corrosive chemicals** in the vicinity of this appliance can rapidly attack 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 20 ft-lb (Models 500 & 600), 25 ft-lb (Models 800-4000).
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
Experience has shown that 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 Advantus™ boilers and water heaters are approved at 95% efficiency and 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

When placing the appliance, be aware that a minimum clearance of 24" (60cm) must be provided at the front to allow easy access to the heat exchanger.

When installed directly on carpeting, the appliance shall be installed on a metal or wood panel extending beyond the full width and depth of the appliance by at least 3 inches (76.2mm) in any direction, or if the appliance is installed in an alcove or closet, the entire floor shall be covered by the panel. The panel must be strong enough to carry the weight of the heater when full of water.

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

Service Clearances					
Model	Service Clearance, Inches (cm)				
	Top	Right Side	Left Side	Back	Front
500	24"	12"	12"	24"	24"
600	24"	12"	12"	24"	24"
800	24"	12"	12"	24"	24"
1000	24"	12"	12"	24"	24"
1200	24"	12"	12"	24"	24"
1400	24"	12"	12"	24"	24"
1600	24"	12"	12"	24"	24"
1800	24"	12"	12"	24"	24"
2000	24"	12"	12"	24"	24"
2500	24"	12"	12"	24"	24"
3000	24"	12"	12"	24"	24"
3500	24"	12"	12"	24"	24"
4000	24"	12"	12"	24"	24"

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 Advantus™ 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 and 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" (46cm) 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.
- The appliance designed for indoor installation (Indoor Models) must be installed indoors where it is protected from exposure to wind, rain and weather.
- The appliance designed for outdoor installation (Outdoor Models) must be installed outdoors. For outdoor installations, 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.

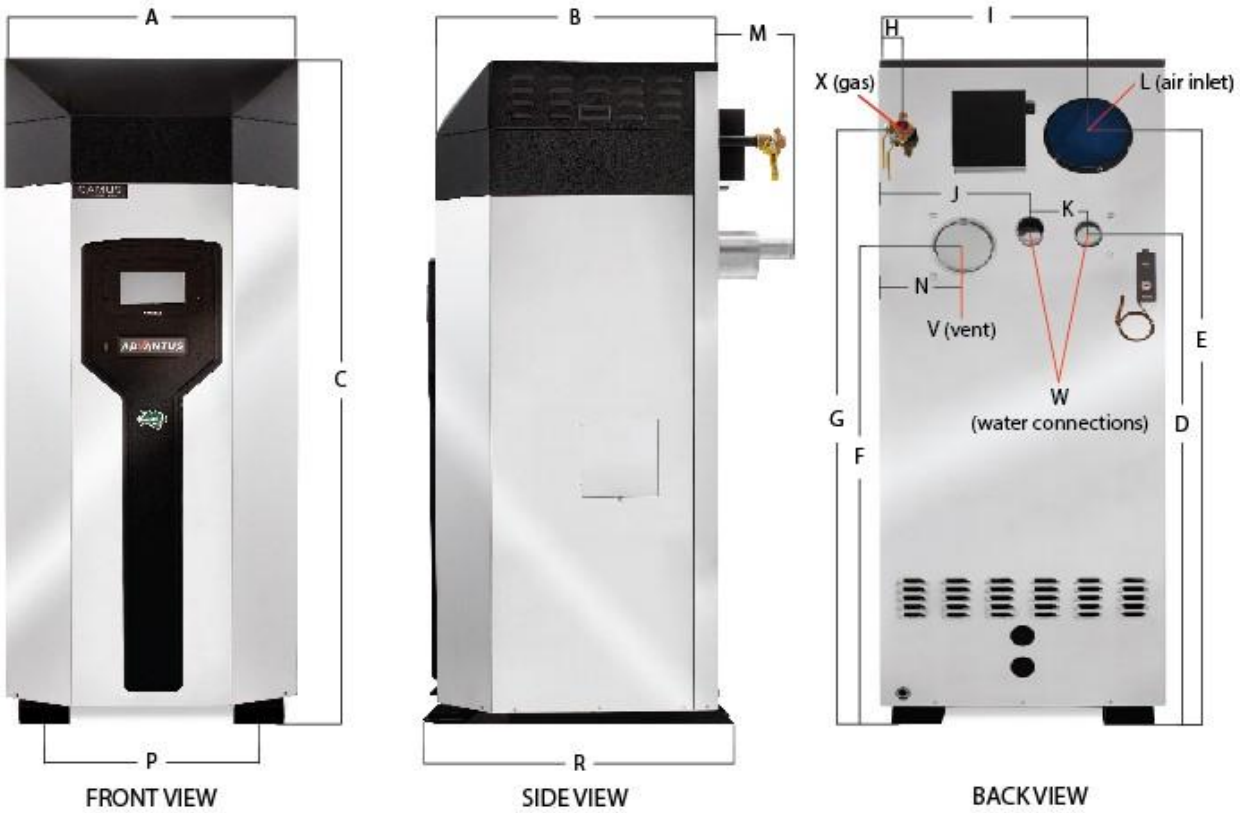


Table 3: Appliance Dimensions and Specifications

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.]	"M" [in.]	"N" [in.]	"P" [in.]	"R" [in.]	"W" [Øin.] Water	"X" [Ø in.] Gas	Weight [lbs.]
500	29½	34	60	39½	50	37	50	4	21½	15	6	6	19 1/8	9	22	37½	2	1	830
600	29½	34	60	39½	50	37	50	4	21½	15	6	8	19 1/8	9	22	37½	2	1	860*
800	30	34	83	61	74	59½	68½	4	21½	15½	6	8	19	9	22	37½	2	1	1000*
1000	30	34	83	61	74	59½	68½	4	21½	15½	6	8	19	9	22	37½	2	1	1100
1200	30	42	83	59	75	57	67	4	21½	15½	6	10	19	7½	22	37½	2½	1	1200*
1400	30	42	83	59	75	57	67	4	21½	15½	6	10	19	7½	22	37½	2½	1¼	1630
1600	30	42	83	54 ½	75	51	63	4	21½	16 ½	6	10	23	7½	22	37½	3	1¼	1840
1800	30	42	83	54 ½	75	51	63	4	21½	16 ½	6	10	23	7½	22	37½	3	1¼	1900*
2000	30	42	93	63 ½	80	60	72	4	22	16 ½	6	12	23	7½	22	37½	3	1¼	2160
2500	30	42	93	63 ½	80	60	72	4	22	16 ½	6	12	23	7½	22	37½	3	1½	2200*
3000	35	47	101	66	90	62	78	5 ½	26	17 ½	6	12	23	17½	27½	50	3	1½	2400*
3500	35	47	101	66	90	62	78	5 ½	26	17 ½	24	12	23	17½	27½	50	4	2	2700*
4000 (Natural Gas)	35	47	101	66	90	62	78	5 ½	26	17 ½	24	12	23	17½	27 ½	50	4	2½	3000
4000 (Propane)	35	47	101	66	90	62	78	5 ½	26	17 ½	24	12	23	17½	27 ½	50	4	2	3000

*Preliminary estimates

Model	Air Inlet up to 100 ft. Equiv. Length	Ø Dim. "V" (in.) Vent - As Shipped	CAT IV up to 100ft Equiv. Length	Ø Dim. "V" (in.) Vent CAT. II
500	5	5	5	6
600	5	5	5	6
800	6	6	6	6
1000	6	6	6	7
1200	6	7	7	8
1400	6	7	7	8
1600	8	8	7	9
1800	8	8	8	10
2000	8	8	8	10
2500	8	8	9	10
3000	10	10	10	10
3500	10	10	10	12
4000 (Natural Gas)	10	10	10	12
4000 (Propane)	10	10	10	14

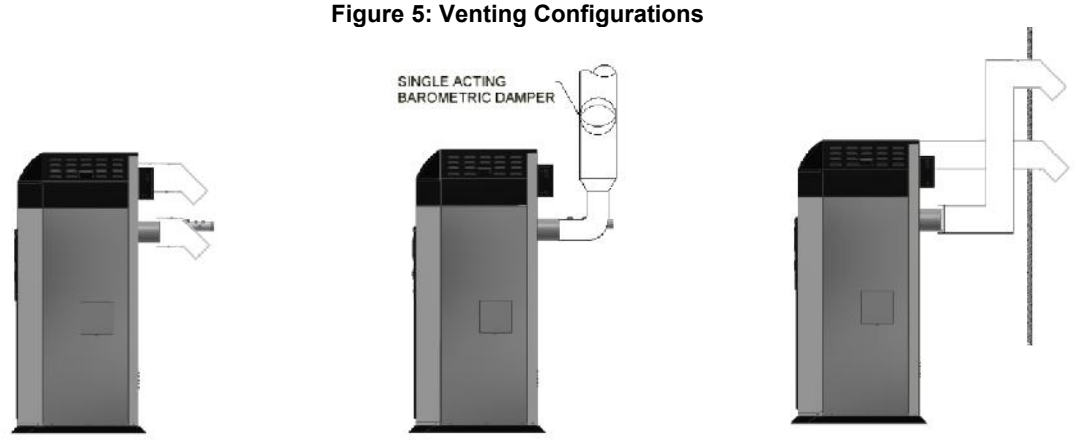
PART 2 VENTING & AIR SUPPLY

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



OUTDOOR VENTING **STANDARD VENTING** **SIDEWALL VENTING AND COMBUSTION AIR INLET**

The Advantus™ is a category II condensing appliance, up to 99% efficient unit.

- The Advantus™ 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 Advantus™ boiler must be vented and supplied with combustion and ventilation air as described in this section. Ensure that the venting and combustion air supply complies 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 though the chimney.

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 also 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 (30.5M) in length. Depending on diameter and centerline radius subtract from 7 to 19 feet per 90° elbow using published 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 30cm).

2.1.3 APPROVED VENTING MATERIALS

Exhaust Vent for Use for Advantus™ 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. CPVC Schedule 40 or 80 approved to ULC S636
5. CPVC Schedule 40 approved to comply with ANSI/ASTM F441. (US Jurisdictions ONLY when permitted)
6. 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)
CPVC	194
Polypropylene	230
AL29-4C	300+, limited only by rating of seals
316L Stainless Steel	300+, limited only by rating of seals

Stack temperature is generally 10-25°F above boiler inlet temperature when operating at steady state at full fire.

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.

Intake Air (Supply Air, or Fresh Air) Piping

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 (30cm) 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 (1m) 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 (1.25m) 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.

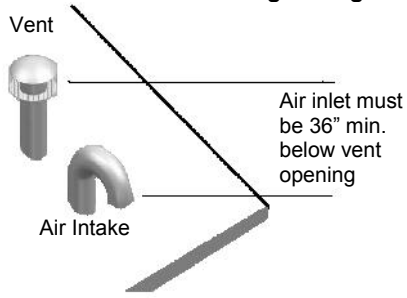
2.1.5 INLET CAP FOR ROOFTOP TERMINATION

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" (150mm) 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 (0.91m) below the point of flue gas termination (vent cap) if it is located within a 5 foot (1.5m) 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 (0.91m) 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 in to 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.

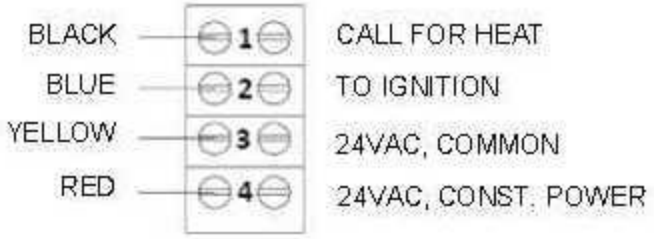
Figure 6: Vertical Direct Venting Configuration



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" (152mm) 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 MASONARY 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 (0.61m) above the highest point of the roof within a 10 foot (3.05m) radius of the termination.
- The vertical termination must be a minimum of 3 feet (0.91m) above the point of exit.
- A vertical termination less than 10 feet (3.05m) from a parapet wall must be a minimum of 2 feet (0.61m) 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.

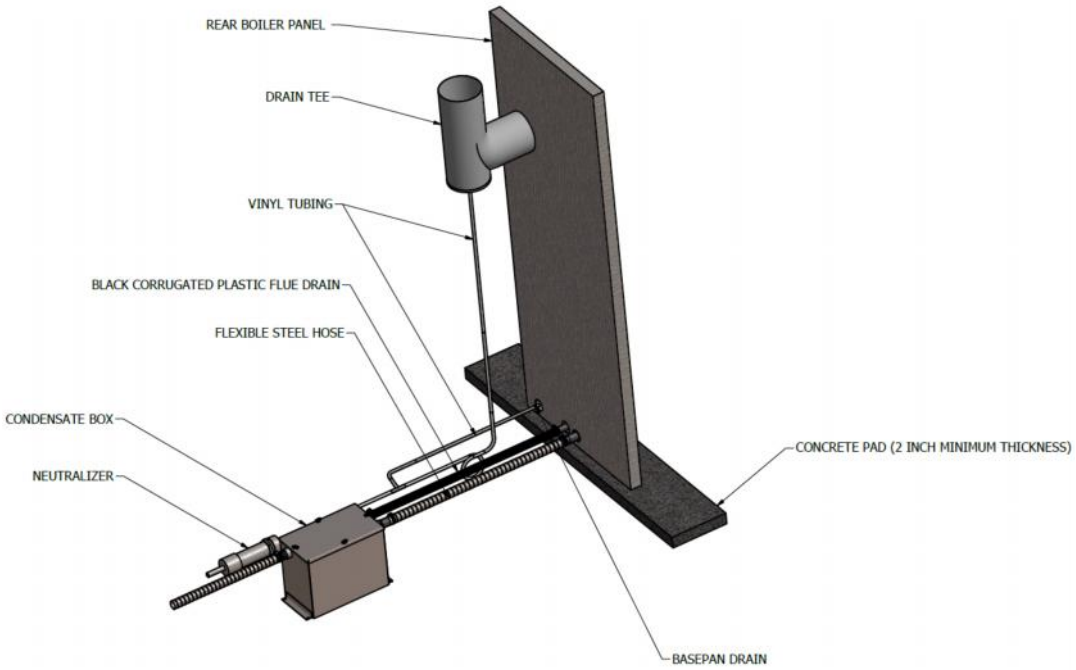
Equivalent pipe diameter = Sq Root $[(d_1)^2 + (d_2)^2 + (d_3)^2 + (d_4)^2 + ... + (d_n)^2]$, d, pipe diameter

- Example: What is equivalent pipe diameter of three air inlet pipes, 8" (20.3cm), 10" (25.4cm) and 12" (30.5cm)
    - Equivalent pipe diameter = Sq Root $[(8)^2 + (10)^2 + (12)^2]$ = Sq Root (308) = 17.5", Select 18" (82.8cm) 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 (30.5m). 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" (10cm) 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 Advantus™ is 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.), we recommend a single acting barometric damper.
- 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 rob 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 7000 Btuh input (5.5cm per kW) up to 1,000,000 Btuh and one square inch per 14,000 Btuh in excess of 1,000,000 Btuh. 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

The Advantus^{TM} 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 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.

2.4 SIDEWALL VENTING

When fitted with the factory supplied vent terminal, the Advantus^{TM} 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. Terminals differ with each application. Use approved single wall or double wall vent.

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.

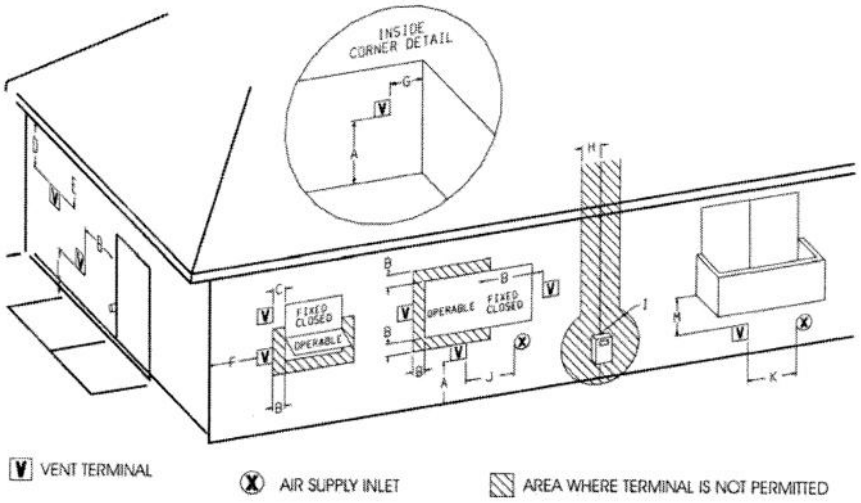
The Advantus^{TM} fan generates a positive pressure in the flue. Combustion air is drawn from the equipment room. Sidewall terminations are available from the factory. Refer to local codes for proper installation and location of vent terminals.

2.4.1 SIDEWALL VENT TERMINAL & SIDEWALL INTAKE AIR TERMINAL

- The sidewall vent terminal kit includes the wall penetration assembly and the discharge screen assembly.
- The opening through the wall for installation of the sidewall vent terminal must provide an air space clearance of 1 inch (2.5cm) 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 vent terminal provided by Camus Hydronics.
- 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 (1m) above any forced air inlet within 10 feet (3m) 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.
- Do not terminate the vent near soffit vents or crawl space vents or other areas where condensate or vapour could create a nuisance or hazard of cause property damage.
- Do not terminate the vent where condensate or vapour could cause damage or could be detrimental to the operation of regulators, relief valves or other equipment.
- The vent shall not terminate less than 7 feet above a public walkway due to the normal formation of water vapor in the combustion process.
- The vent system shall terminate at least 3 feet (1m) above normal snow levels and least 7 feet (2.15m) above grade when located adjacent to public walkways.
- The vent terminal shall not be installed closer than 3 feet (1m) from an inside corner of an L-shaped structure.
- The vent terminal should have a minimum clearance of 4 feet (1.25m) horizontally from and in no case above or below, unless a 4 foot (1.25m) 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.



Direct 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)	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 feet (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 nonmechanical air supply inlet to building or the combustion air inlet to any other appliance	36” (91cm)	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)[α]	*
M	Clearance under veranda, porch deck, or balcony	12” (30 cm)[β]	*

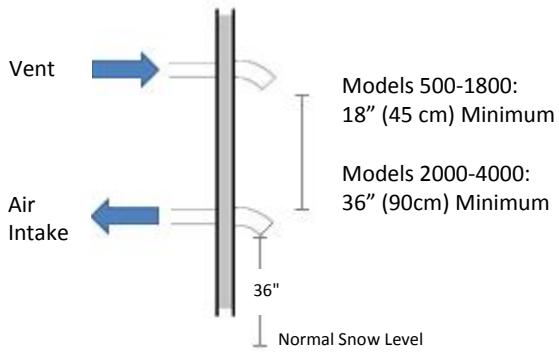
[1] In accordance with the current CSA B149.1 Natural Gas and Propane Installation Code
[2] In accordance with ANSI Z223.1/ NFPA 54 National Fuel Gas Code
[α] A vent shall not terminate directly above a sidewalk or paved driveway that is located between two single family dwellings and serves both dwellings
[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 nonmechanical air supply inlet to building or the combustion air inlet to any other appliance	36" (91cm)	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)[α]	*
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
[α] 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

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 500 – 1800:** The point of termination for the sidewall combustion air inlet terminal MUST be located a minimum 18 inches (0.45m) 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 3 feet (1m) 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 (30.5m) in length. Subtract 7 (2.13m) to 19 feet (5.8m) 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 – ¾" NPT	Pressure Relief Valve Size - 1" NPT
1	¾"	1"
2	1"	1 ¼"
3	1 ¼"	1 ½"
4	1 ¼"	2"
5	1 ½"	2"
6	1 ½"	2"
7	2"	2 ½"
8	2"	2 ½"

*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

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

Input	0-100 feet		101-200 feet		201-300 feet	
Btu/Hr x 1000	NAT.	L.P.	NAT.	L.P.	NAT.	L.P.
450	1 ½"	1 ¼"	2"	1 ½"	2"	1 ½"
600	1 ½"	1 ¼"	2"	1 ½"	2"	1 ½"
800	2 "	1 ½"	2"	1 ½"	2 ½"	2"
1000	2 "	1 ½"	2"	1 ½"	2 ½"	2"
1200	2"	1 ½"	2 ½"	2"	2 ½"	2"
1400	2 ½"	2"	2 ½"	2"	3"	2 ½"
1600	2 ½"	2"	3"	2 ½"	3"	2 ½"
1800	2 ½"	2"	3"	2 ½"	3"	2 ½"
2000	2 ½"	2"	3"	2 ½"	3"	2 ½"
2500	3"	2 ½"	3"	2 ½"	3 ½"	3"
3000	3"	2 ½"	3"	2 ½"	3 ½"	3"
3500	3"	2 ½"	3 ½"	3"	4"	3 ½"
4000	3 ½"	3"	4"	3 ½"	4"	3 ½"

3.2 GAS PIPING

All gas connections must be made with pipe joint compound resistant to the action 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 ½ PSI.

Table 7: Gas Pressures at Inlet to Appliance

	PROPANE	NATURAL GAS
Minimum (inches W.C.)	11	4
Maximum (inches W.C.)	11	14

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/ft^3. 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

Models 500 & 600 utilize a dual seat negative pressure air/gas ratio control valve. Operation of the gas valve in combination with the combustion air fan allows the burner input rate to vary from 10% to 100% based on temperature demand.

Models 800-4000 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 4.5% for AV800 to AV1800 and 4.0% for AV2000 and above of full input to achieve a 22:1 and 25:1 turndown, respectively. 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 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 and high end valves is preset at the factory and adjustment is not usually required if gas supply pressure is maintained within the specified range.

There are no serviceable parts on the dual seat negative pressure low end air/gas ratio control valve.

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: AV500 – 600 1:1 Negative Pressure Air Gas Ratio Control Valve

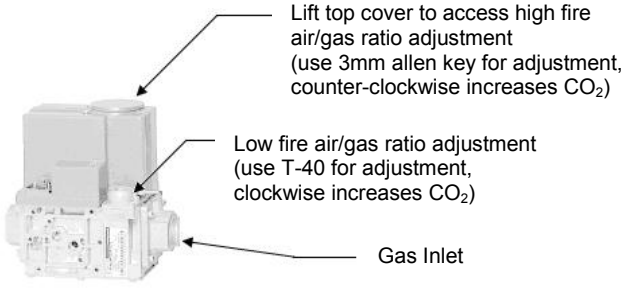
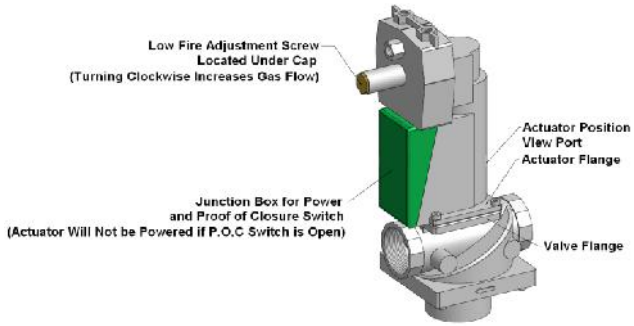


Figure 10: AV800 – 4000: 1:1 Air/Gas Ratio Control Valve



3.5 OPERATION OF NEGATIVE PRESSURE AND DIFFERENTIAL PRESSURE VALVES

- The Advantus™ Models 500 & 600 both operate on the principle of negative pressure. As the fan varies in speed it generates a varying negative pressure at the fan suction which draws in a corresponding amount of gas.
- The Advantus™ Models 800-4000 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 field conditions.
- **Always check settings posted on boiler test label.**

3.6 GAS MANIFOLD DIFFERENTIAL PRESSURE ADJUSTMENT (AV800-AV4000)

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 magnahelic gauge. Range of scale should be 0 to 14 inch 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 ADVANTUS™ BOILERS & WATER HEATERS

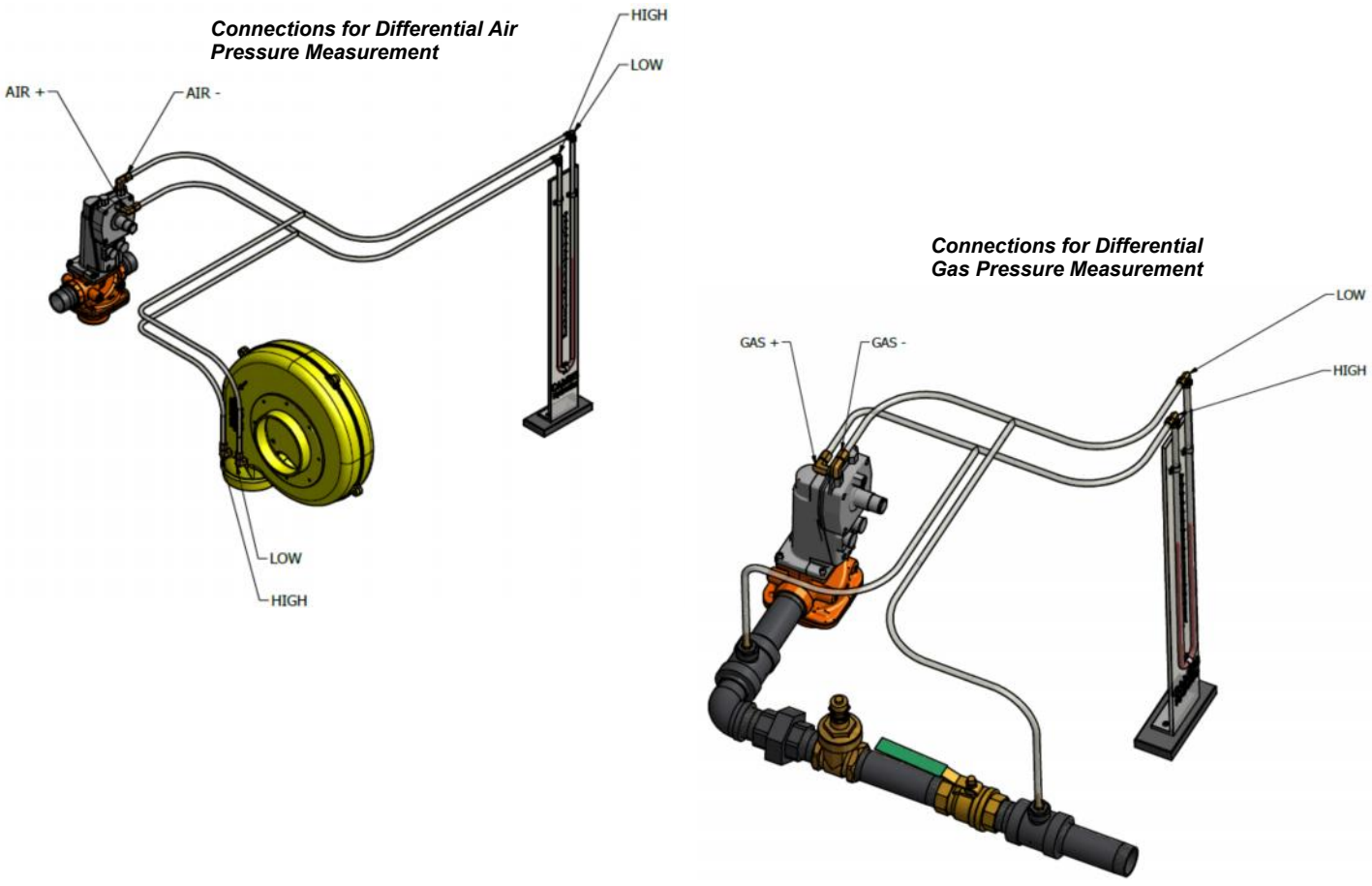
A stable gas supply pressure is important to avoid rough starts with machines like the Advantus™ which use a 1:1 ratio control valve for internal gas pressure regulation. Camus requires that all Advantus™ models be supplied with no more than 14" w.c.supply pressure. This means that lockup pressure must 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 Advantus™ 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 GAS PRESSURES (AV800-AV4000)

Figure 11: Checking Differential Air and Gas Pressures (AV800 – AV4000)



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 (93-0332). 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

Figure 12: Typical Gas Train (models AV500 & AV600)

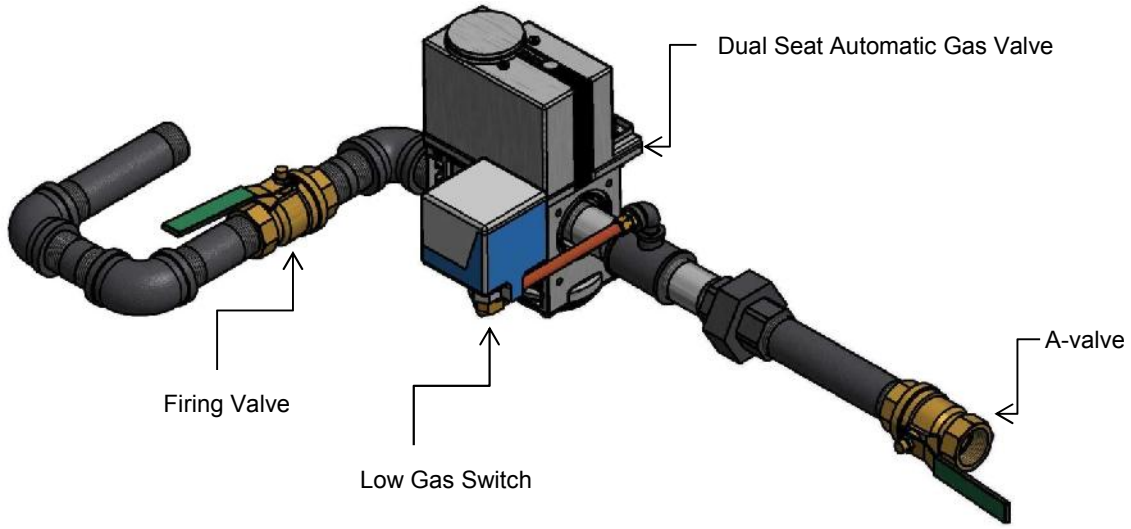


Figure 13: Typical Gas Train (Models AV800 -2000)

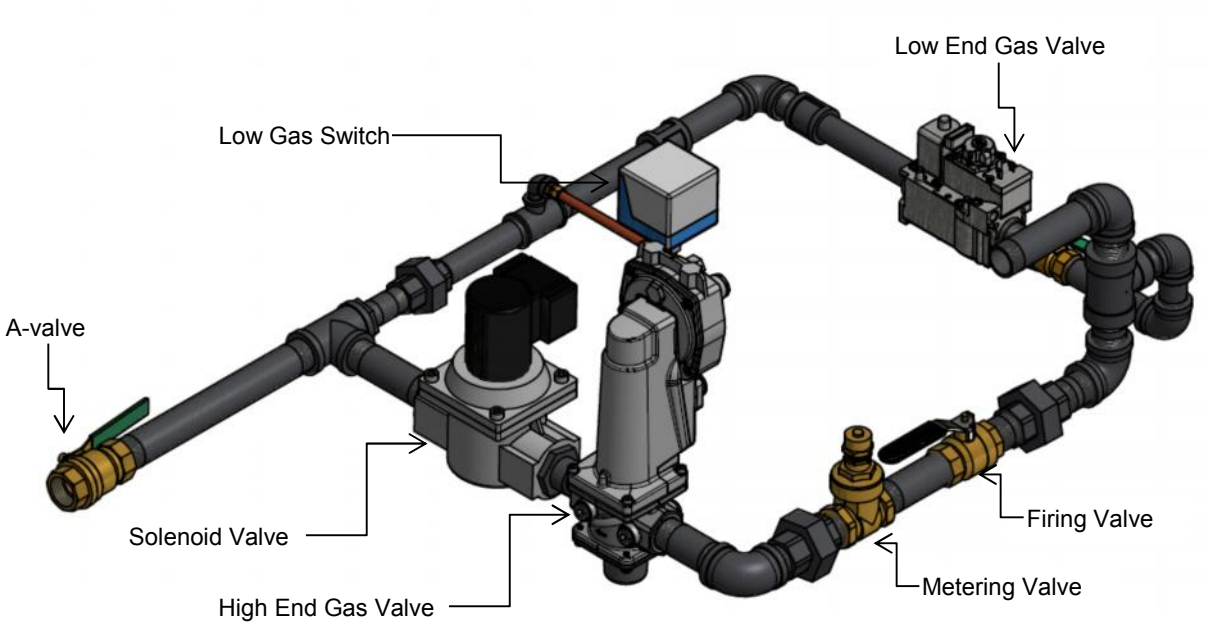


Figure 14: Typical Gas Train (Models AV2500-3000)

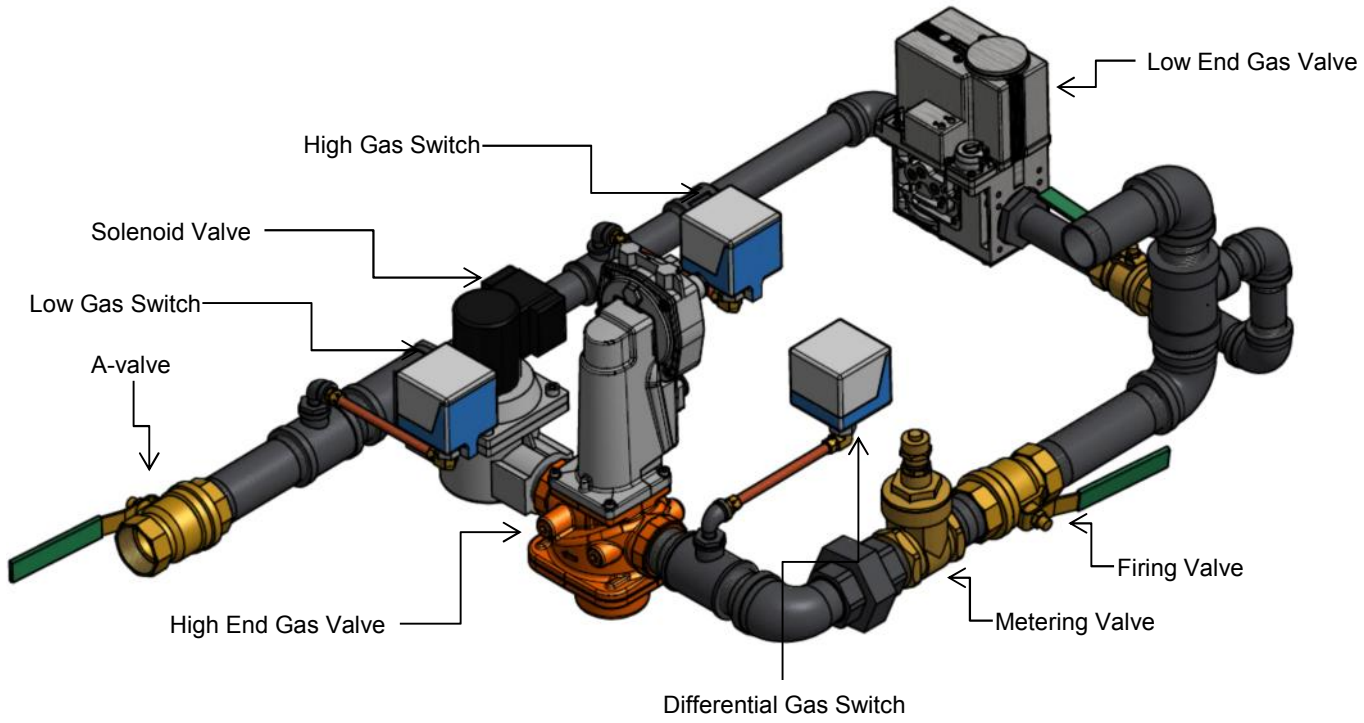
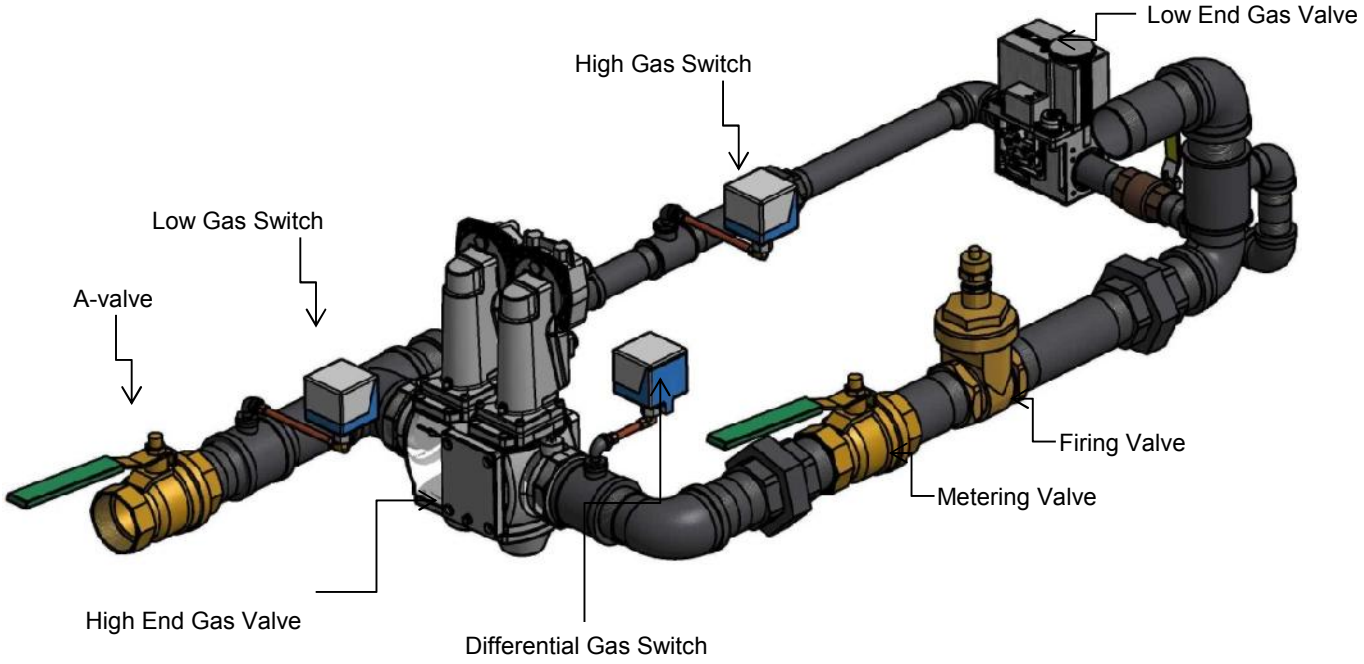


Figure 15: Typical Gas Train (Models AV3500-4000)

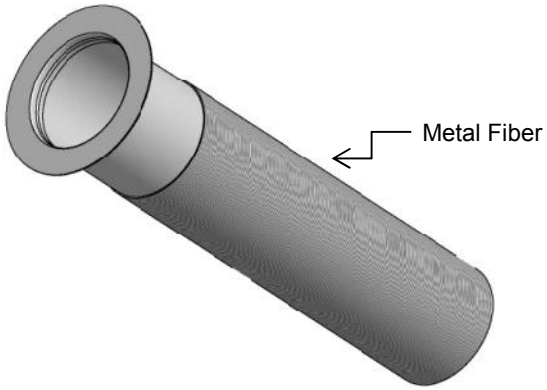


3.10 VENTING OF GAS VALVES AND PRESSURE SWITCHES

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 16: Burner



This appliance uses a single cylindrical burner installed vertically into the cavity 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 500-2500: Direct ignition is standard. 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: Proven pilot ignition is standard. 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.

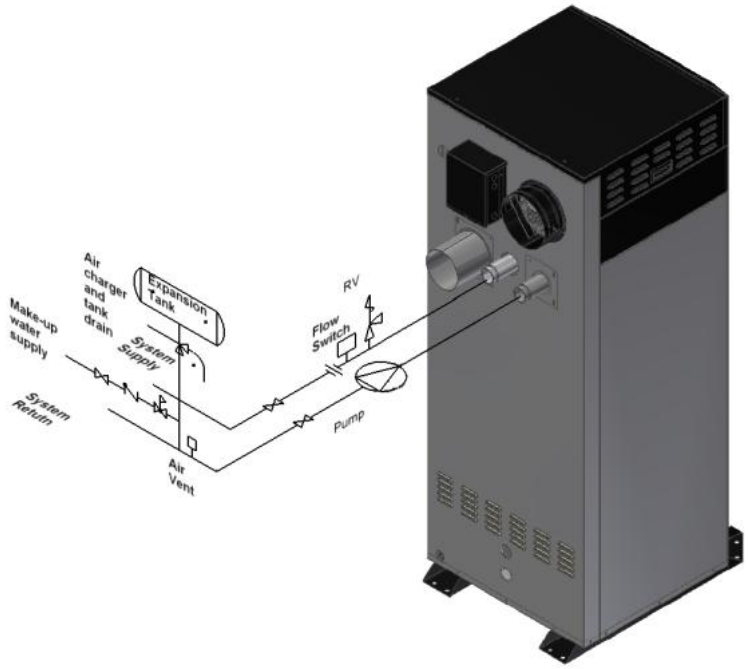
The hot surface igniter and UV Scanner are removable from the burner mounting flange without removing the burner assembly from the heat exchanger.

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

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 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 Advantus™. The relief valve must be mounted in a vertical position and piped to the floor in a manner acceptable to the enforcing authority.**
- **Minimum water operating system pressure should not drop below 30 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 Advantus™ 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 17: 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. Maintaining a mixture of 50% water and 50% propylene glycol is the preferred method of freeze protection in hydronic systems. This mixture will protect the appliance to approximately -35ºF (-37ºC). 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 to increase 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 13ft. = 15.6 ft.)
- A similar procedure must be followed to calculate the additional head loss in pipe and fittings in order to arrive at the proper pump selection.

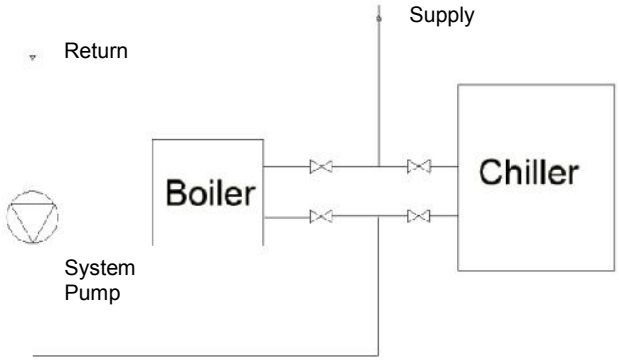
For outdoor installations in colder climates a snow screen should be installed to prevent snow and ice accumulation on and around the appliance. Regular inspections should be made to ensure that air intake and vent are free of snow and ice. Always consider the use of a shelter such as a garden shed in 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 18: 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 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 Advantus™. At incoming temperatures of 120°F or lower the Advantus™ 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 19)

Figure 19: Typical Instantaneous Water Heating System

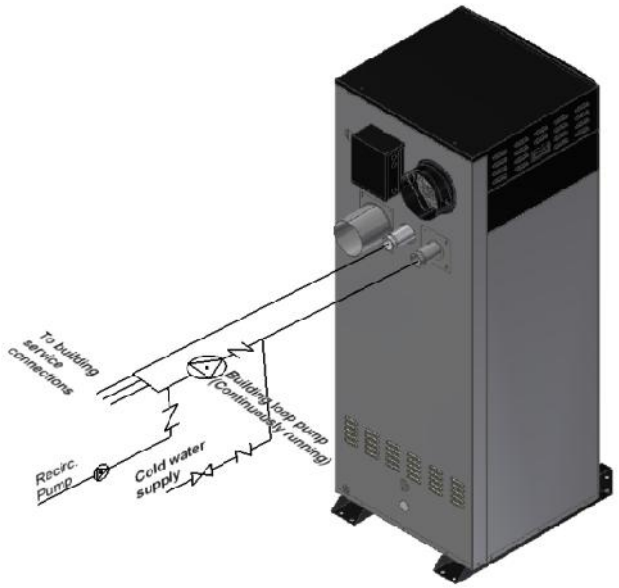


Table 8: Flow and Pressure Drop at a Given Temperature Rise (AV500-4000)

Model	Absolute Minimum Flow (10°F ΔT at 1/23rd input)	Pressure Drop ΔP	Flow at 20°F ΔT (Maximum Input)	Pressure Drop ΔP	Flow at 40°F ΔT (Maximum Input)	Pressure Drop ΔP	Flow at 60°F (Maximum Input)	Pressure Drop ΔP
500	n/a	n/a	47.2	1.8	23.6	0.5	15.7	0.2
600	n/a	n/a	56.6	2.6	28.3	0.6	18.9	0.3
800	6.6	0.03	74.8	4.5	37.4	1.1	24.9	0.5
1000	8.2	0.05	93.4	7.0	46.7	1.8	31.2	0.8
1200	9.9	0.02	112.2	2.0	56.1	0.5	37.4	0.2
1400	11.5	0.02	130.8	2.7	65.4	0.7	43.6	0.3
1600	13.2	0.03	149.6	3.9	74.8	0.8	49.9	0.4
1800	14.8	0.04	168.2	4.4	84.1	1.2	56.1	0.5
2000	16.5	0.05	189.8	5.6	94.9	1.4	63.2	0.6
2500	20.6	0.07	237.2	8.8	118.6	2.2	79.1	1.0
3000	24.7	0.01	284.6	1.6	142.3	0.4	95.0	0.2
3500	28.9	0.02	332.0	2.2	166.0	0.6	110.7	0.3
4000	33.0	0.02	379.4	2.9	189.7	0.7	126.5	0.3

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 (shipped loose)

A water flow switch 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 Equipped)

If this boiler is installed above radiation level, a low water cut-off 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 cutoff 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 20: Low Water Cut Off Electrical Connections (Watts)

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

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

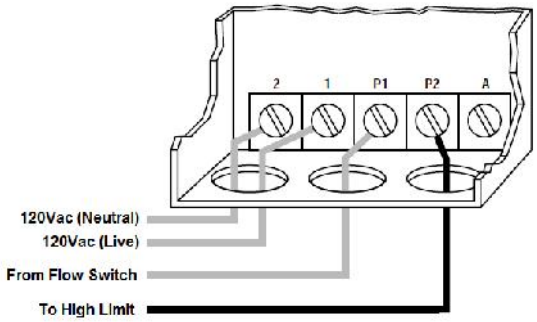
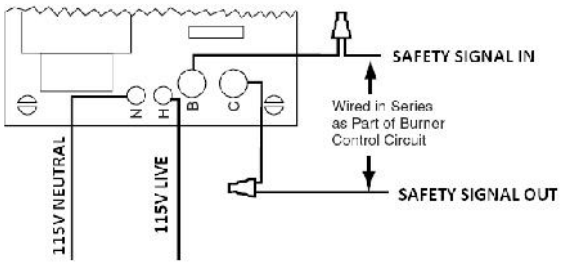


Figure 21: Low Water Cut Off Electrical Connections (ITT)



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 Advantus™ 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 20ºF to 40ºF (11.1ºC - 22.2ºC) 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 Advantus™ is constantly monitoring the inlet and outlet water temperatures when the ΔT approaches 60°F the burner will modulate down to prevent tripping of the high limit.

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]
500 – 1600	115VAC, 60Hz	15	8.0
800 – 1600 $^{\Delta}$	208/230VAC, 60Hz, 1 Phase*	10	4.0
1800 – 3500	208/230VAC, 60Hz, 1 Phase*	30	20
1800 - 3500 $^{\Delta}$	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
$^{\Delta}$ Optional power supply

Advantus^{TM} 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 • 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 MOCP information is below.

500VA transformer: DC0500UH

VFD:	**Model Range**:
n/a	AV500 – AV600
ESV371N04TXB	AV800 (0.5hp)
ESV751N04TXB	AV1000 – AV1600 (1hp)
ESV152N02YXB	AV1800 – AV2000 (2hp)
ESV222N02YXB	AV2500 – AV3500 (3hp)
ESV402N02TXB	AV4000 (5hp)

Advantus^{TM} Model	Voltage Requirement	Maximum Over Current Protection	Full Load Amps
		(Amperes)	(Amperes)
800 – 1000	460VAC, 60Hz, 3 Phase	10	n/a
1200 – 1800			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 AV800-4000. Three phase voltage is generated by the VFD and supplied directly to the fan motor on models 800-4000. 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 (AV800-4000)

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 LOW AIR DIFFERENTIAL PRESSURE SWITCH

Models 500 & 600 use a normally open differential air pressure switch to prove air flow. A pressure transducer coupled with an electronic controller is used to prove operation of the combustion air fan on the AV800-4000. The pressure switch sensing points are installed at the fan outlet housing for models 500 & 600 and they are installed at the fan intake for models 800 - 4000. 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 (ILK Open) when the differential pressure switch detects a sustained low air condition. This condition could be caused by a number of factors including:

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

Figure 22: Low Air Proving Switch (Models 500 & 600)

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 AV3000-4000 models and available as an option on AV500-2500 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.

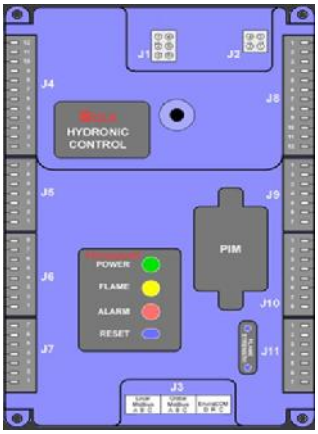
5.6 HIGH LIMIT

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 Advantus™ SOLA

AV500-AV2500 models utilize a hot surface ignition system. AV3000-AV4000 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 the “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 Advantus™ CONTROLLER

Table 10: Connector Description

Connector	Connector Description
J1	UV Scanner, Ground Rod
J2	Fan Modulation (AV500 & 600)
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

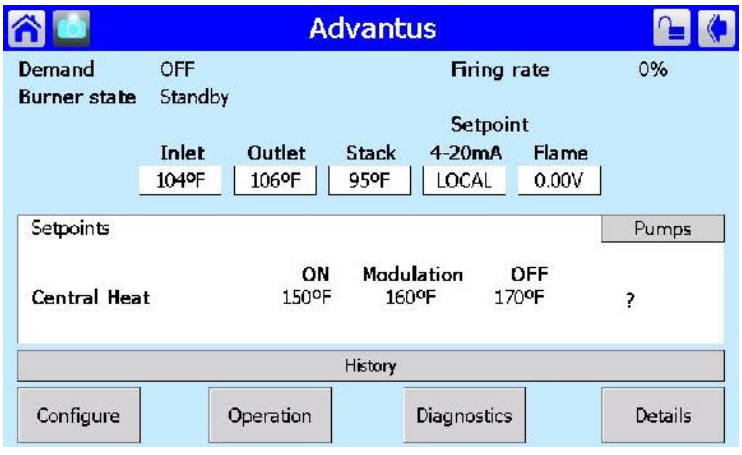
The following tables provide a description of all the possible errors with the Advantus™ appliance. Errors can be divided into two groups. Alert errors (will disappear when error is gone) and lockout errors (can only be reset by the RESET button).

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	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
81	Delta T Limit
82	Stack limit tripped (PVC: 149°F, CPVC: 194°F, 250°F)
91	Inlet sensor fault
92	Outlet sensor fault
93	DHW sensor fault
94	Header sensor fault
95	Stack sensor fault
96	Outdoor sensor fault
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
149	Flame detected

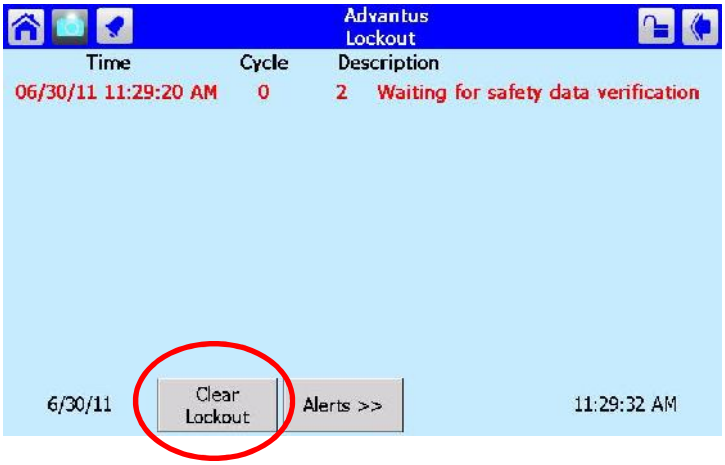
Figure 25: Lockout Condition



To eliminate the lockout error,

1. Press the red bar, as circled below
2. Press the [Lockouts] button

Figure 26: Lockout History



3. Press [Clear Lockout]

Table 12: Alert Codes

#	Description
29	Burner switch turned OFF
30	Burner switch turned ON
47	Invalid subsystem reset request occurred
50	Modulation Fault (DR300 – 1000 ONLY)
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
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

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

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.

Figure 27: 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 which 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.
- 60°F 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

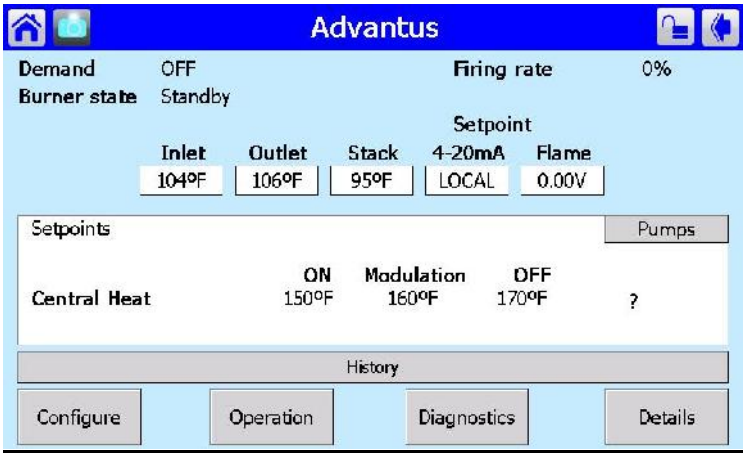
Two levels of access to simplify the use of the boiler.

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 the backend of a pen/pencil is recommended for accuracy

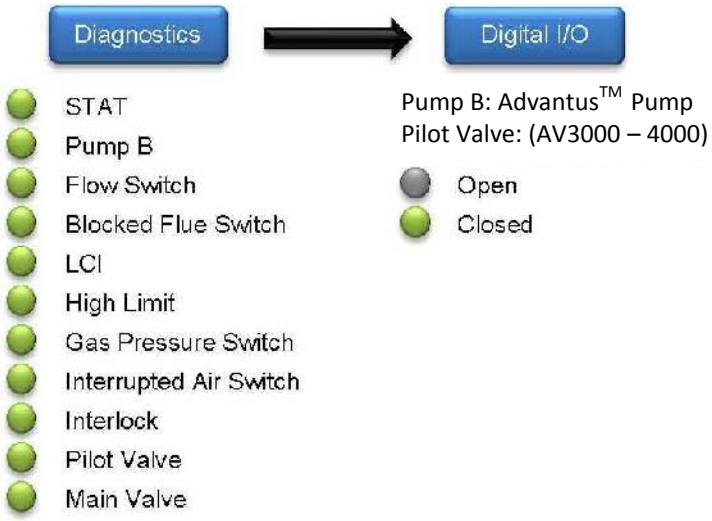
Figure 28: Home Screen



Parameter	Description
Demand	Central Heating (AVH)
	Domestic Hot Water (AVW)
	Lead Lag
Burner State	Current Status of Advantus™
Firing Rate	Target Firing Rate (AV800-4000)
Fan Speed	Actual Firing Rate (AV500-600)
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 Advantus™ 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



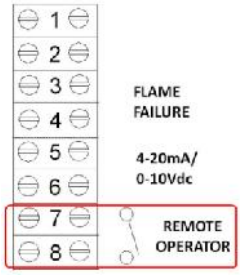
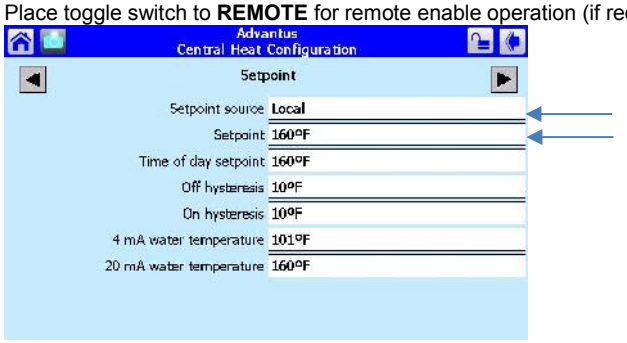
Flow Switch = Flow Switch, Water Pressure Switch (30 PSIG), Low Water Cut Off (if equipped)

Gas Pressure Switch = Low Gas Pressure Switch (4.5" w.c., N/O), High Gas Pressure Switch (14" w.c., N/C)

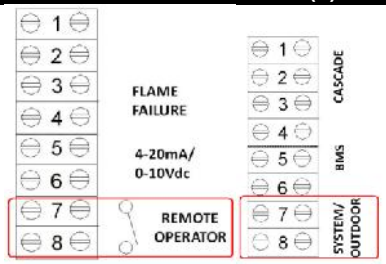
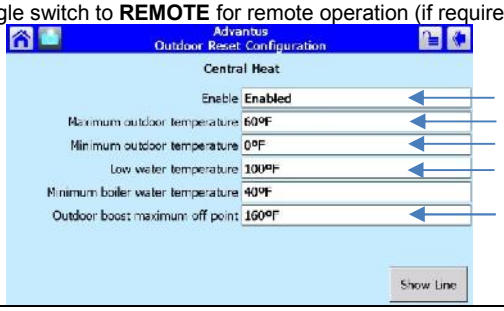
Interrupted Air Switch = Air Proving Switch (N/O)

Hydronic Heating

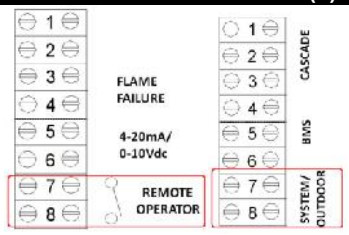
Modulation: Boiler Inlet, Boiler Fixed Setpoint Operation (Standalone)

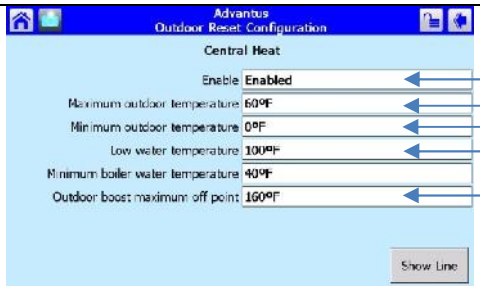
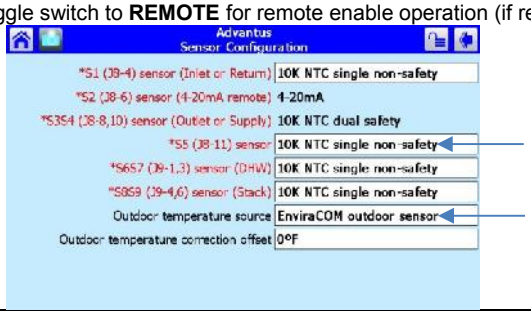
Description	Electrical Connection(s)	Programming Instructions
• Boiler operates at a fixed CH setpoint • Modulates on boiler inlet sensor (default) • Heat demand is generated when inlet temperature drops below setpoint minus on hysteresis • If set to local enable constant pumping is required • For remote enable intermittent pumping is allowed.		1) Place toggle switch to **LOCAL** 2) Press Configure and Login 3) Press **[CH – Central Heat Configuration]** 4) Press the ➤ to arrive at **Setpoint** 5) Select **Setpoint source: Local** 6) Enter desired **Setpoint** 7) Place toggle switch to **REMOTE** for remote enable operation (if required) 

Modulation: Boiler Inlet, Outdoor Reset Operation (Standalone)

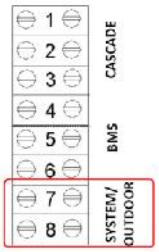
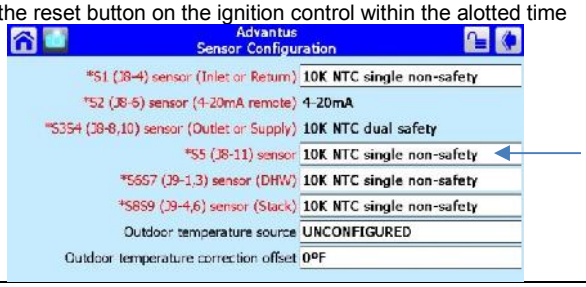
Description	Electrical Connection(s)	Programming Instructions
• Boiler operates with variable setpoint determined by outdoor reset curve • Modulates on inlet sensor (default) • Heat demand is generated when inlet temperature drops below setpoint minus on hysteresis		1) Connect outdoor sensor to System/Outdoor contacts 2) Place toggle switch to **LOCAL** 3) Press Configure and Login 4) Press **Outdoor Reset Configuration** 5) Press the ➤ to arrive at **Central Heat** 6) Select **Enable: Enable** 7) Select **Maximum outdoor temperature** (WWSD) 8) Select **Minimum outdoor temperature** (Outdoor Design) 9) Select **Low Water Temperature** (Min. Water Temp.) 10) Select **Outdoor boost maximum off point** (Design Max.) 11) Press **[CH – Central Heat Configuration]** 12) Select **Outdoor Reset = Enabled** 13) Set **CH Setpoint = Maximum off point** 14) Press **Sensor Configuration** 15) Select **Outdoor temperature source = S5 (J8-11) sensor** 16) Place toggle switch to **REMOTE** for remote operation (if required) 

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

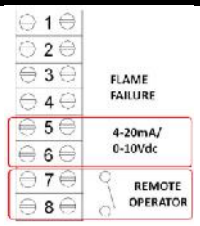
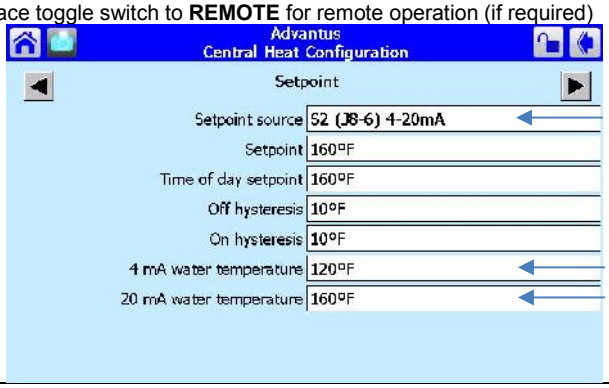
Description	Electrical Connection(s)	Programming Instructions
• Boiler operates with variable setpoint determined by outdoor reset curve • Modulates on system sensor • Heat demand is generated when system temperature drops below setpoint minus on hysteresis		1) Connect Remote Operator 2) Connect System 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) Press the ➤ to arrive at **Central Heat** 8) Select **Enable: Enable** 9) Select **Maximum outdoor temperature** (WWSD) 10) Select **Minimum outdoor temperature** (Outdoor Design) 11) Select **Low Water Temperature** (Min. Water Temp.) 12) Select **Outdoor boost maximum off point** (Design Max.)

		 13) Press **[Show Line]** to confirm reset curve 14) Press **Sensor Configuration** 15) Selet **S5 (J8-11) sensor: 10K NTC single non-safety** 16) Select **Outdoor temperature source = EnviraCOM outdoor sensor** 17) Place toggle switch to **REMOTE** for remote enable operation (if required) 

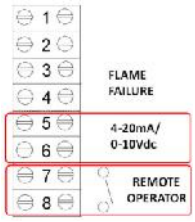
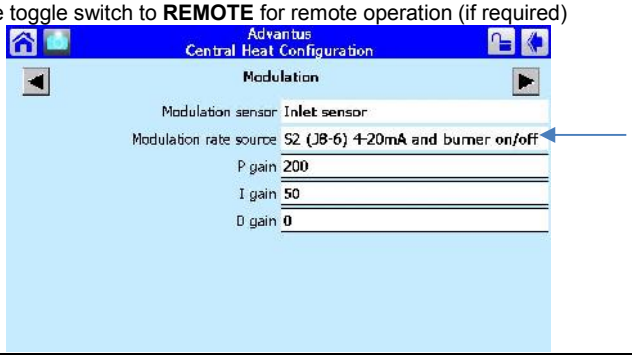
System Sensor Enable (Standalone)

Description	Electrical Connection(s)	Programming Instructions
• Method to enable system sensor for Standalone applications		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 alotted time 

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

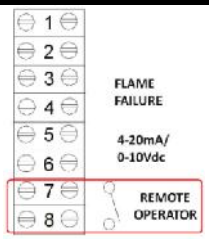
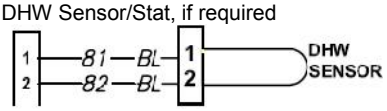
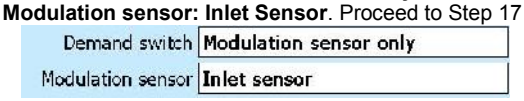
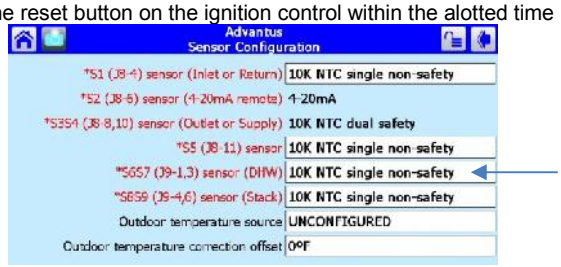
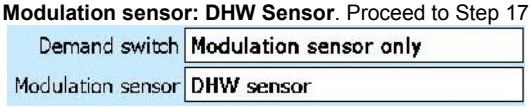
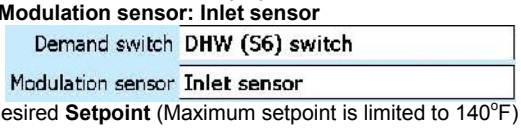
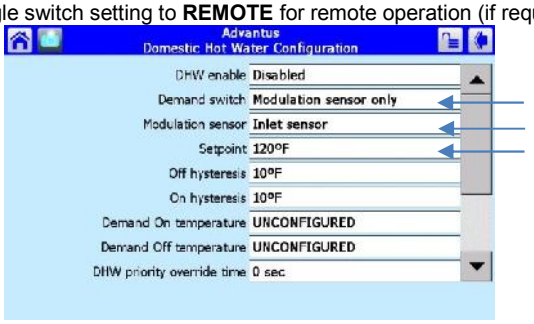
Description	Electrical Connection(s)	Programming Instructions
• Boiler operates with variable setpoint determined by 4-20mA incoming signal • Modulates on boiler inlet sensor (default) • Heat demand is generated when inlet temperature drops below setpoint minus on hysteresis and 4-20mA or 0-10Vdc signal is present. • If set to local enable constant pumping is required • For remote enable intermittent pumping is allowed.		1) Place both toggle switches in **LOCAL** 2) Press Configure and Login 3) Press **[CH – Central Heat Configuration]** 4) Press the ▶ to arrive at **Setpoint** 5) Select **Setpoint Source = S2 (J8-6) 4-20mA** 6) Select **4mA water temperature** 7) Select **20mA water temperature** 8) Place toggle switch to **REMOTE** for remote operation (if required) 

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

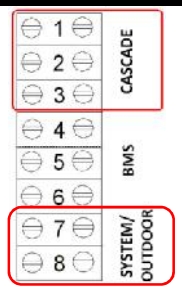
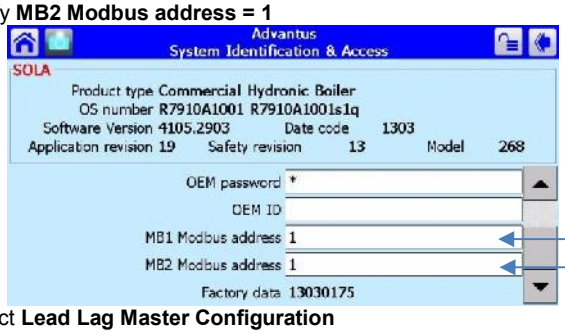
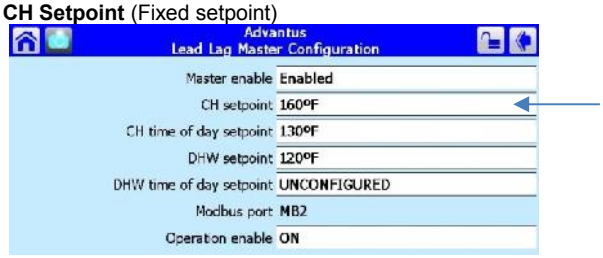
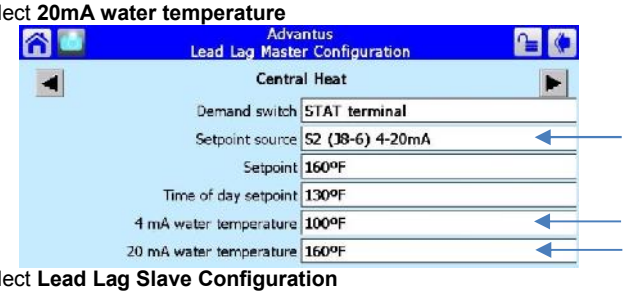
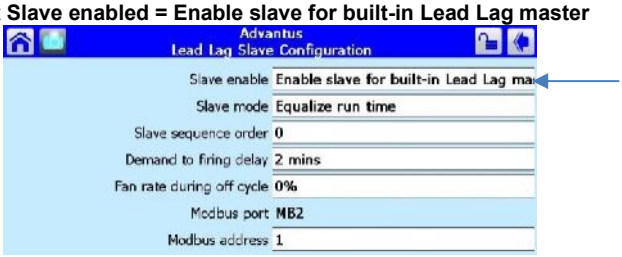
Description	Electrical Connection(s)	Programming Instructions
• Boiler operates with variable firing rate determined by 4-20mA incoming signal • Modulates on boiler inlet sensor (default) • Heat demand is generated when inlet temperature drops below setpoint minus on hysteresis and 4-20mA or 0-10Vdc signal is present. • If set to local enable constant pumping is required • For remote enable intermittent pumping is allowed.		1) Place both toggle switches in **LOCAL** 2) Press Configure and Login 3) Press **[Lead Lag Master Configuration]** 4) Press **[Advanced Settings >]** 5) Press the ▶ to arrive at **Central Heat** 6) Select **Modulation Rate Source = S2 (J8-6) 4-20mA and burner on/off** 7) Place toggle switch to **REMOTE** for remote operation (if required) 

DHW

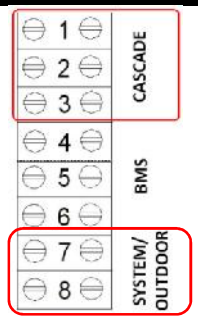
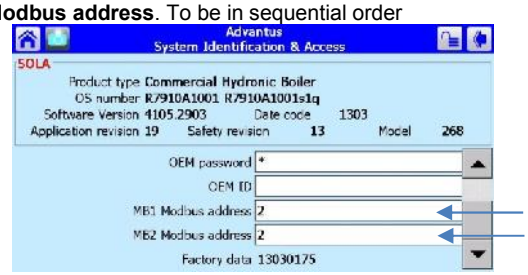
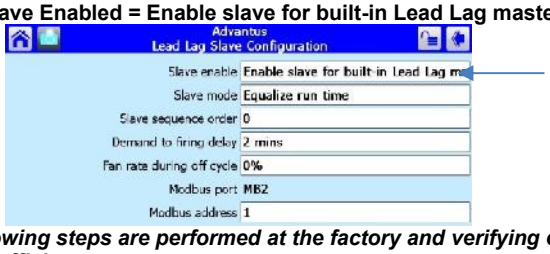
Modulation: Boiler Inlet, Fixed Setpoint Operation (Standalone)

Description	Electrical Connection(s)	Programming Instructions
• 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	 DHW Sensor/Stat, if required 	1) Place both toggle switches to **LOCAL** ***2)*** Press Configure and Login ***Inlet Sensor operation*** 3) Press **[DHW – Domestic Hot Water Configuration]** 4) Select **Demand Switch: Modulation sensor only** 5) Select **Modulation sensor: Inlet Sensor**. Proceed to Step 17  ***DHW Sensor/Stat operation*** 6) Press **[Sensor Configuration]** 7) Select **S6S7 (J9-1,3) Sensor (DHW)**: **10K NTC Single Non-Safety** 8) The control will proceed into a Lockout 2 condition 9) Press **[Verify]** > **[Begin]** > **[Yes]** 10) Press the reset button on the ignition control within the alotted time  ***DHW Sensor operation*** 11) Press **[DHW – Domestic Hot Water Configuration]** 12) Select **Demand Switch: Modulation sensor only** 13) Select **Modulation sensor: DHW Sensor**. Proceed to Step 17  ***DHW Stat operation*** 14) Press **[DHW – Domestic Hot Water Configuration]** 15) Select **Demand Switch: DHW (S6) switch** 16) Select **Modulation sensor: Inlet sensor**  17) Enter desired **Setpoint** (Maximum setpoint is limited to 140°F) 18) Place toggle switch setting to **REMOTE** for remote operation (if required) 

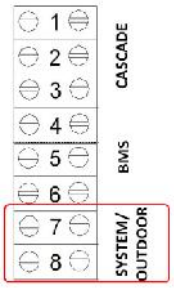
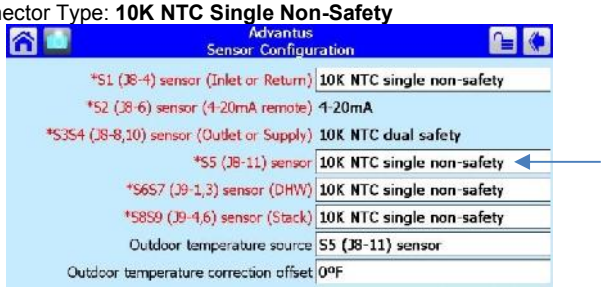
AV(H,W) Lead lag Operation
Master Boiler

Description	Electrical Connection(s)	Programming Instructions
• 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.		1) Place both toggle switches to **LOCAL** 2) Press Configure and Login 3) Select **System Identification & Access** 4) Verify **MB1 Modbus address = 1** 5) Verify **MB2 Modbus address = 1**  6) Select **Lead Lag Master Configuration** 7) Select **Master Enabled = Enabled** <u>Fixed Setpoint operation</u> 8) Enter **CH Setpoint** (Fixed setpoint)  <u>4-20mA/ 0-10Vdc setpoint operation</u> 9) Select **[Advanced Settings >]** 10) Press the ▶ to arrive at **Central Heat** 11) Select **Setpoint Source = S2 (J8-6) 4-20mA** 12) Select **4mA water temperature** 13) Select **20mA water temperature**  14) Select **Lead Lag Slave Configuration** 15) Select **Slave enabled = Enable slave for built-in Lead Lag master**  The following steps are performed at the factory and verifying on site will be sufficient: 16) Select **Pump Configuration** 17) Press **[Advanced Options >>]** 18) Press the ▶ to arrive at **Central Heat Pump** or **DHW Pump** 19) On Options: ☑ Local burner demand 20) On Options: Local Lead Lag ☑ Service Active 21) Force On: ☑ Outlet high limit

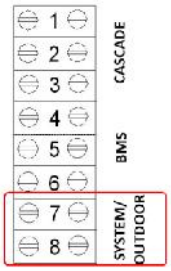
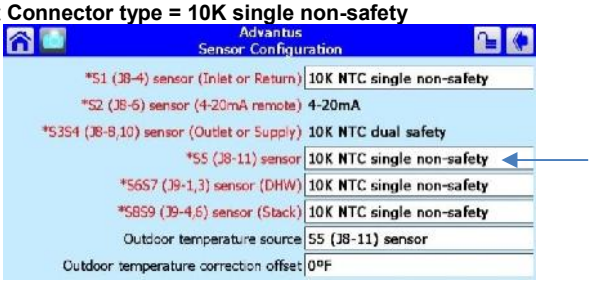
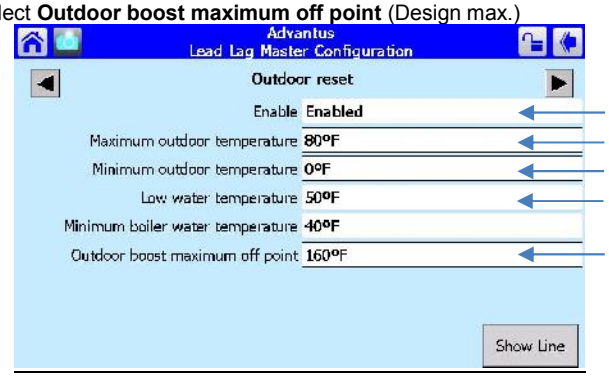
Slave Boiler

Description	Electrical Connection(s)	Programming Instructions
• Slave boiler lead lag setup • System temperature sensor must be connected to boiler #1. • Outdoor temperature sensor must be connected to boiler #2.		1) Place both toggle switches to **LOCALL** 2) Press Configure and Login 3) Select **System Identification & Access** 4) Verify **Modbus address**. To be in sequential order  5) Select **Lead Lag Slave Configuration** 6) Select **Slave Enabled = Enable slave for built-in Lead Lag master**  ***The following steps are performed at the factory and verifying on site will be sufficient:*** 7) Select **Pump Configuration** 8) Press **[Advanced Options >>]** 9) Press the ▼ to arrive at **Central Heat Pump** or **DHW Pump** 10) On Options: ☑ Local burner demand 11) On Options: Local Lead Lag ☑ Service Active 12) Force On: ☑ Outlet high limit

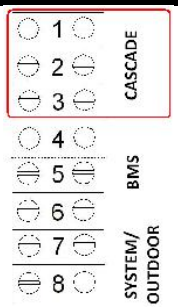
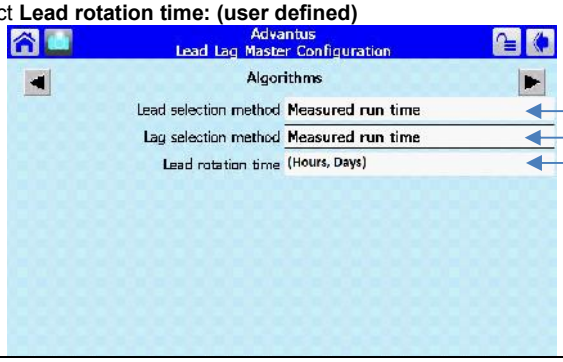
Master Boiler, System Sensor (Connected to Master Boiler #1)

Description	Electrical Connection(s)	Programming Instructions
• Master boiler system sensor configuration • System temperature sensor must be connected to boiler #1. • Outdoor temperature sensor must be connected to boiler #2.		1) Press Configure and Login 2) Press **[Sensor Configuration]** 3) Select **S5 (J8-11) Sensor** 4) Connector Type: **10K NTC Single Non-Safety**  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 alotted time

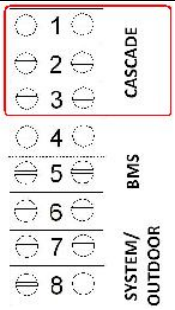
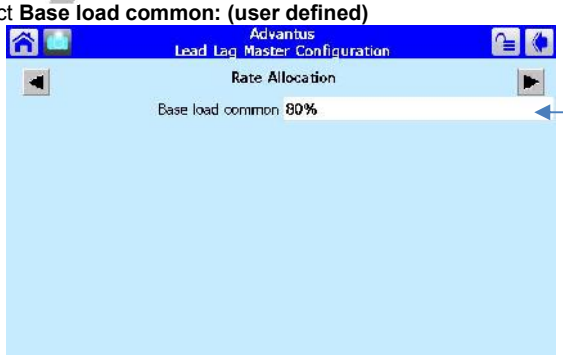
Outdoor Sensor connected to Slave boiler 2 (AVH ONLY)

Description	Electrical Connection(s)	Programming Instructions
• 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		***Slave Boiler*** 1) Press Configure and Login 2) Press **Sensor Configuration** 3) Select **S5 (J8-11) Sensor** 4) Select **Connector type = 10K single non-safety**  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 alotted time ***Master Boiler*** 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.)  17) Press **[Show Line]** to confirm reset curve 18) Press the ▶ to arrive at **Warm Weather Shutdown** 19) Select **Enable = Shutdown after demand ends** 

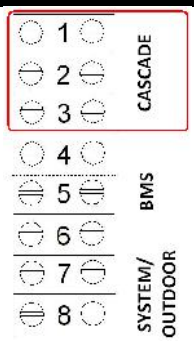
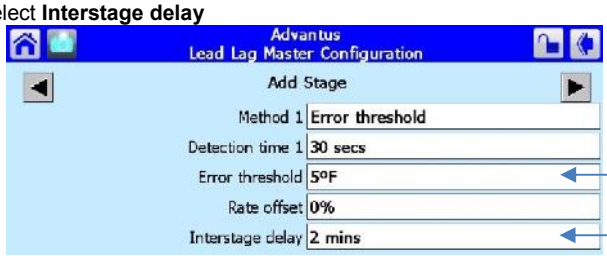
Rotation schedule adjustment

Description	Electrical Connection(s)	Programming Instructions
• 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)		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 **Lead selection method: Sequence order** 7) Select **Lead rotation time: (user defined)** 

Base load rate adjustment

Description	Electrical Connection(s)	Programming Instructions
• 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%).		1) Press Configure and Login 2) Press **[Lead Lag Master Configuration]** 3) Press **[Advanced Settings >]** 4) Press the ▶ to arrive at **Rate Allocation** 5) Select **Base load common: (user defined)** 

Adjust staging of boilers

Description	Electrical Connection(s)	Programming Instructions
• 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.		1) Press Configure and Login 2) Press **[Lead Lag Master Configuration]** 3) Press **[Advanced Settings >]** 4) Press the ▶ to arrive at **Add Stage** 5) Select **Error threshold** 6) Select **Interstage delay** 

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	Advantus™ Model Number
	Installation	Type of application

6.2.2 PUMP CONFIGURATION

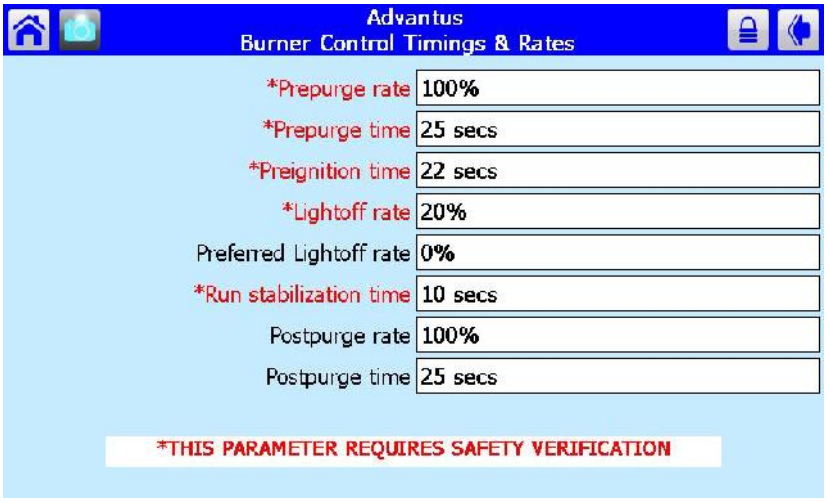
Menu Group Selection	Sub-Menu Group Selection	Parameter	Selection	Description
Pump Configuration	Central Heat Pump	Pump Control	Auto	Assigns the method for SOLA to control a Central Heating pump (Default: Auto, Pump is activated whenever a call for heat is present)
			ON	ON: Pump is constantly powered
		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)
	System Pump	Pump Control	Auto	Refer to above (Default)
			ON	ON: Pump is constantly powered
		Pump Output	None	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
		System pump cycles		Displays the number of cycles the system 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: AV500-600: 3000 RPM, AV800-4000: 100.0%)
		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: AV500-600: 3000 RPM, AV800-4000: 100.0%)
		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		Lightoff rate	AV500-600: 3000 RPM AV800-4000: Consult 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 (AVW 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 adress 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 operaiton.
- 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 temperautre > 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

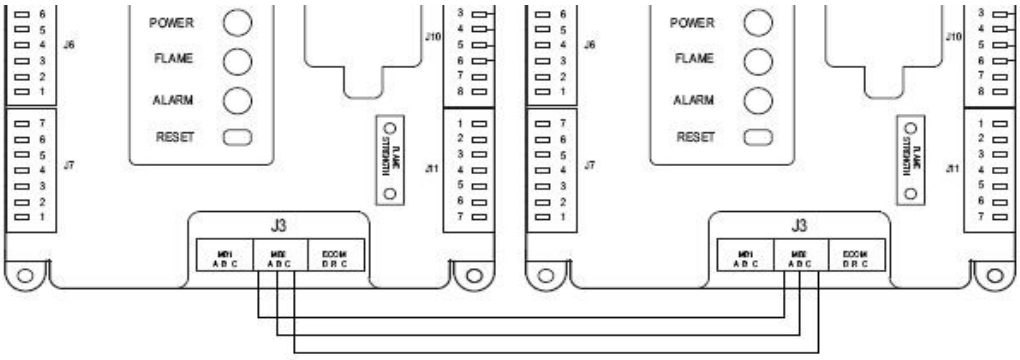
Slave Status Manager	
Unknown	Table entry is unused or empty
Available	Slave is operational and ready to use
Add Stage	Stage is getting ready to fire
Suspend Stage	Stage was getting ready but is not needed
Disabled	Slave is locked out or disabled
Recovering	Slave is in time delay to verify that it is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

Wiring the Lead Lag Setup

Use Cascade terminals in the juntion 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 in order for the system to operate correctly.

NOTE

The Local/Remote switch (explained below) 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 Advantus™, it is recommended to switch to *Local* mode.

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

For more instructions on interfacing with Modbus/Bacnet/LonWorks/MetasysN2 Network:

http://www.camus-hydronics.com/media/1296/93_0238_dynaflame_dynaforce_dynamaxhs_advantus_protocol_setup.pdf

6.6 VARIABLE FREQUENCY DRIVE (AV800-4000)

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 4-20mA as standard reference source	02
102	Min Freq.	Refer to factory test sticker
103	Max Freq.	Refer to factory test sticker
104	Acceleration time	220
105	Deceleration time	140
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
161	Speed at maximum signal	Refer to factory test sticker

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 Advantus™ 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 IGNITER (GLOW BAR)

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 Igniter

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 ½" 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 ½" 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

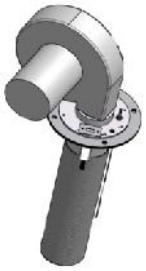
The ignition module relies on the UV Scanner to provide a flame rectification signal. Oxide deposits, improper placement or damaged ceramic insulator will result in insufficient signal leading to ignition module lock out. For proper operation minimum 0.8 Vdc must be fed back to the module. Oxide deposit 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 COMBUSTION AIR FAN

AV500-600

Uses a modulating 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 120 VAC, Single Phase EC/DC 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.

Figure 34: Fan, Burner, Hot Surface Igniter and UV Scanner Arrangement (AV800 – 4000)



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.

7.4 OUTER JACKET

The outer jacket assembly is constructed from mirror finish stainless steel. This ensures a long life for the jacket assembly, with full integrity.

7.5 VENTING TRANSITION

All appliances are shipped with a male vent outlet pipe. Depending on the appliance category, 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^{o}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 Advantus^{TM}. The condensate box provided with the Advantus^{TM} 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.

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. 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.
- Power to the boiler and pump must be from the same circuit to prevent the boiler firing in case the pump is inadvertently shut off.
- Vent all air from the heat exchanger prior to firing using the two air vents provided on the heat exchanger. Both air vents can be accessed by removing the top cover and they are located on top of the Advantus™ heat exchanger.
- Inlet gas pressure must be a minimum of 4.0" 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.
- **AV800-4000**: 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 sticker with actual reading is affixed to the unit.

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 Advantus™ 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 acceptable burner performance at full input and at minimum input.

8.3 GAS VALVE ADJUSTMENT PROCEDURE

Table 14: Combustion Values

Advantus™ Combustion Values				
	Natural Gas		Propane	
	CO_2	CO	CO_2	CO
Max Fire	9.0% - 9.5%	<100 PPM	10.5% - 11.5%	<100 PPM
Min Fire	8.0% - 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 10% input on models 500-600 and 4.0% input on models 800-4000. This set up must be achieved quickly to ensure low system temperatures are maintained throughout the setup of single or multiple boiler installations.

Models 500 – 600
Light off the boiler and make the initial adjustment to the low fire bias to obtain the specified CO_2, CO, at minimum gas input.

Allow the boiler to run for 5 minutes at 10% and then make the final low fire adjustment according to the combustion values above. Allow the boiler to run up to high fire and set the combustion according to the combustion values above.

Models 800 – 4000
Light off the boiler and adjust the low end valve as described above for models 500 – 600.

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 dead cold water, there should be a maximum amount of condensate in the lower heat exchanger. At this point adjust the combustion for CO_2.

The boiler must continue to run with stable combustion without making any howling 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.

In order to perform adjustments to the gas valve, the Advantus™ must be firing before proceeding.

Figure 35: AV800 – 1200 Low End Gas Valve

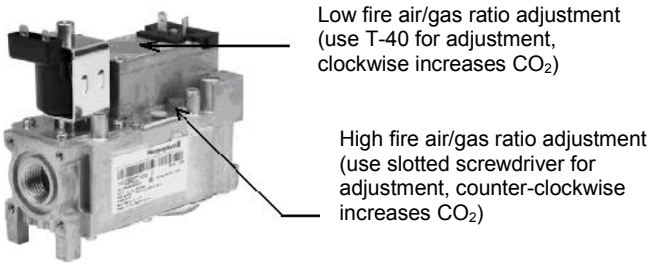
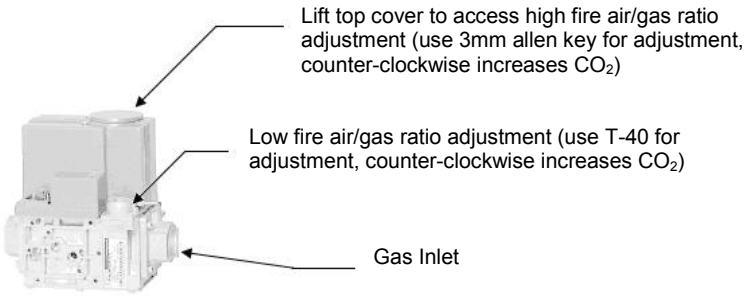


Figure 36: AV 500 – 600 Gas Valve, AV1400 – 4000 Low End Gas Valve



<u>To adjust the low fire setting (AV500-600)</u>

Use the Advantus™ Control Panel:

1. Press **[DIAGNOSTICS]** button
2. Press **[Diagnostic Tests]** button
3. Press **[Minimum Modulation]** button
4. Press **[start test]** to operate the boiler at minimum fire for 5 minutes

The Advantus™ should respond immediately and fire at 1075 RPM. When this is achieved, locate the low fire adjustment screw.

	Increase CO2	Decrease CO2
Low Fire Adjustment	↻	↺
	Clockwise	Counter-Clock Wise

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

- 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 PWM signal 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. Always make adjustments to meet the recommended CO_2 levels. Adjust low fire first followed by high fire adjustment.

<u>To adjust the high-fire setting (AV500-600)</u>

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 Advantus™ 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.

Locate the input adjustment screw on the top side of the gas valve.

	Increase CO2	Decrease CO2
High Fire Adjustment		
	Counter-Clock Wise	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.

To adjust the low fire setting of the low end valve (AV800 – 4000)

Use the Advantus™ Control Panel

1. Press **[DIAGNOSTICS]** button
2. Press **[Diagnostic Tests]** button
3. Press **[Minimum Modulation]** button
4. Press **[Start Test]** to operate the boiler at this firing rate for 5 minutes.

	Increase CO2	Decrease CO2
Low Fire Adjustment		
	Clockwise	Counter-Clock Wise

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

To adjust the high fire setting of the low end valve (AV800 – 4000)

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. It is advised to 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 Advantus™ Control Panel

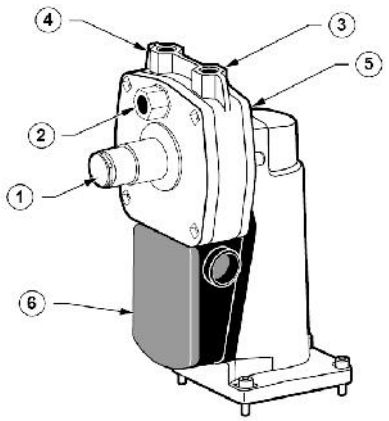
1. Press **[DIAGNOSTICS]** button
2. Press **[Diagnostic Tests]** button
3. Move the firing rate slider to a point where the VFD is 2 Hz before the transition point.
4. Press **[Start Test]** to operate the boiler at this firing rate for 5 minutes.

	Increase CO2	Decrease CO2
High Fire Adjustment		
	Counter- Clockwise	Clock Wise

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

To adjust the low-fire setting of the high end valve (AV800-4000)

Figure 37: 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 die casting

Use the Advantus™ Control Panel

1) Press **[DIAGNOSTICS]** button
2) Press **[Diagnostic Tests]** button
3) Move the firing rate slider to 30.0%
4) Press **[Start Test]** to operate the boiler at max fire for 5 minutes.

	Increase CO2	Decrease CO2
Low Fire Adjustment	↻	↺
	Clockwise	Counter-Clock Wise

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

To adjust the high-fire setting of the high end valve (AV800-4000)

Two manometers should be connected to the Advantus™ 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 Advantus™ 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.

Figure 38: Typical Gas Train (Models AV800 -2000)

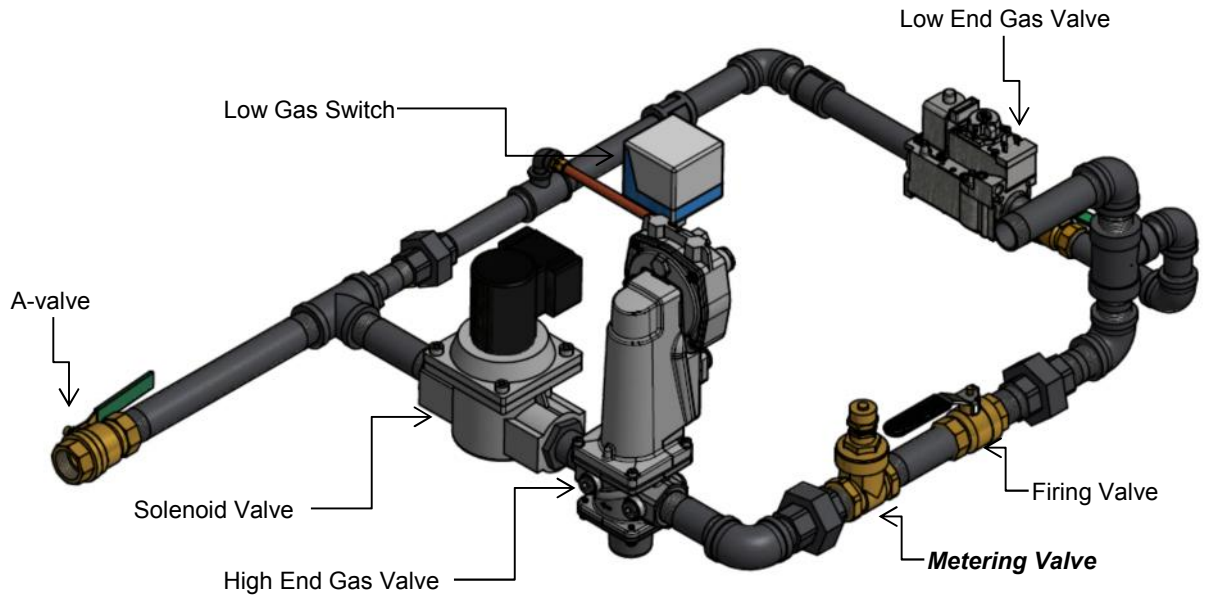


Figure 39: Typical Gas Train (Models AV2500-3000)

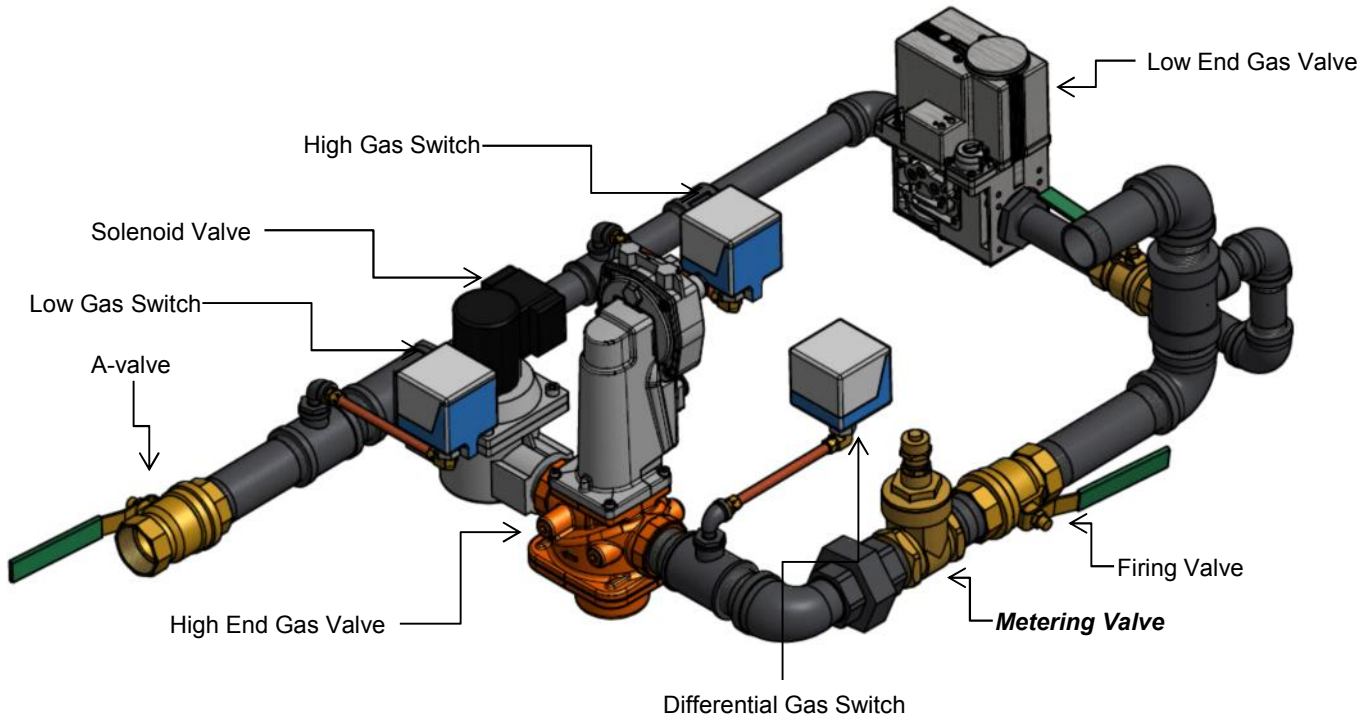
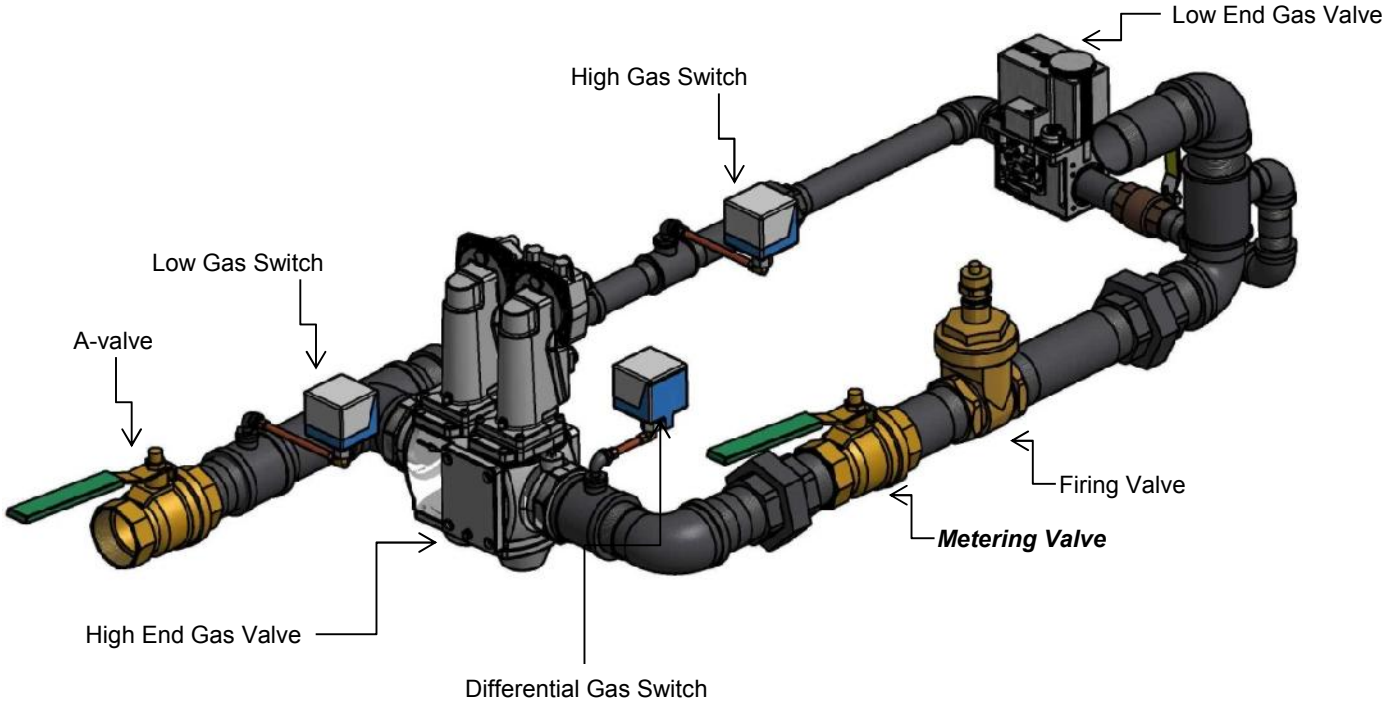


Figure 40: Typical Gas Train (Models AV3500-4000)



	Increase CO2	Decrease CO2
High Fire Adjustment	↺	↻
	Counter-Clock Wise	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.

To reset the metering valve to factory settings refer to the chart below and the step-by-step instructions that follow.

Table 15: Inline metering valve setting*

Model	LP Gas (Propane)	Natural Gas
	# of Turns Clockwise	# of Turns Clockwise
800	3	1 ½
1000	3	1 ½
1200	3	1 ½
1400	4	3
1600	4	3
1800	4	3
2000	3 ¾	2 ½
2500	3 5/8	2 7/8
3000	4	3
3500	5 ¾	4
4000	5 7/8	5

Step 1: Fully open inline metering valve (counter-clockwise)
Step 2: Close inline metering valve to preset level
Step 3: Above table shows initial settings only, fine-tuning will be required with the use of an analyzer.
***NOTE:** Metering valve is factory set and should not normally require adjustment

- 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 CO_2 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 Advantus™ 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 200ºF for domestic hot water and hydronic heating.
- At full fire, block 50% of the fan inlet opening. The display should show 'LCI not closed'. 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 or 10% for models 500 – 600 and 4% for models 800 – 4000.
- 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.

COMPONENT	FAILURE MODE	ANALYSIS
Incoming Power	• Two wires interchanged	• No effect on safety • Live and Neutral wires are interchanged.
Transformer Tripped	• The 24Volts and 120 Volts wired are interchanged • Alert: 49 • Lockout: 53	• Breaker on transformer trips
Relief Valve	• System pressure exceeds relief valve setting	• 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	• Flow Switch contacts are open • Alert: 63, 275-281, 460 • LCI OFF	• Verify that pump is operating • Verify for closed valves or obstructions in boiler piping • Verify that all air has been purged from the system • Verify that wiring is correct
Water Pressure Switch	• Pressure Switch contacts are open • Alert: 63, 275-281, 460 • LCI OFF	• Verify that minimum water pressure exceeds 30 PSI • Verify that pump is operating • Verify for closed valves or obstructions in boiler piping • Verify that all air has been purged from the system • Verify that wiring is correct
Flame Failure	• The boiler has failed to ignite the burner • Alert: 110, 291-294	• To reset the module refer to section 5.7.2 • Verify that all air has been purged from gas line • Inspect hot surface igniter and related wiring for damage and connection errors • AV500-2500: Verify igniter is glowing • AV3000-4000: 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 Advantus™ Controller during ignition. Check wiring from Advantus™ Controller and Gas Valve Relay. If a signal cannot be detected, the Advantus™ 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 Advantus™ Controller, if necessary
Flame Disappears During a Run Cycle	• The Advantus™ boiler was running and flame signal suddenly disappeared. • Lockout: 106, 107, 108, 109	• 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 air proving switch. Turn counter-clockwise to reduce sensitivity • 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 Advantus™ Controller if necessary

COMPONENT	FAILURE MODE	ANALYSIS
Noisy Operation	• Supply Gas Issue	• 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 should be at 11" w.c.
	• Air/Gas Mixture Issue	• Refer to Section 8.3 Gas Valve Adjustment Procedure for proper combustion setting.
	• Air Inlet and/or Vent configuration	• Refer to Part 2 Venting and Air Supply
	• Dirty/ Damaged Burner	• 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.
	• Air in the piping system	• Purge all air from the piping system
Auto Reset High Limit Trips	• The outlet temperature has exceeded the set point temperature specified. • Alert: 67, 79, 137, 303-310 • ILK OFF	• 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 120 VAC 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 120 VAC 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.

SYMPTOM	FAILURE MODE	ANALYSIS
Manual Reset High Limit Trips (if equipped)	• Manual Reset Safety High Limit tripped, outlet temperature in excess of 210°F • Alert: 63, 67, 79, 137, 276-281, 303-309 • LCI OFF	• 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 120 VAC 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 120 VAC is supplied. If so, pump impeller may be stuck. Use a flat head screwdriver on face of pump to turn impeller manually. • If 120 VAC is present during a call for heat, but the pump still does not circulate, replace pump.
Delta-T Limit Tripped	• Inlet and Outlet temperature has exceeded 60°F • Alert: 124	• 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 30 PSI
Temperature Overshoot	• Stack temperature has exceeded the limit temperature. • Alert: 125	• 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.
	• Outlet temperature has exceeded target temperature. • Alert: 63, 67, 79, 137, 276-281, 303-309 • LCI OFF	• 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=20, I = 10, 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	• Inlet sensor, Alert: 91 • Outlet sensor, Alert: 92 • DHW sensor, Alert: 93 • Flue sensor, Alert: 95 • Outdoor sensor, Alert: 96	• Verify sensors are connected • Verify wiring. • Measure resistance of sensors at room temperature, 10kΩ sensors. • Replace sensor if necessary
Fan Not Turning	• Fan refuses to rotate • Alert 122, 123, 128, 129, 130, 131, 132	• Check fan power wires • Fan signal wires are interchanged • Minimum fan speed must be greater than 800 RPM
Air Proving Switch	• Interrupted Air Switch error • Alert: 67, 137, 303-310 • ILK OFF	• Air Switch wire(s) is/are loose • Air Switch is set too tight • Models 500 – 600: Reduce sensitivity by turning screw ¼ turn counter-clockwise. • Models 800 – 1400: An electronic air switch is used.
Blocked Flue Switch opens at full speed	• LCI error • Alert: 63, 137, 276-281 • LCI OFF	• 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 light, reduce sensitivity by turning screw ¼ turn clockwise.
Flame Detection is out of Sync	• Flame detection is present when no visible signs of a flame exist • Lockout: 105, 158	• 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	• Blank display screen	• Check wire connections from Advantus™ Controller to touchscreen display
Internal Fault	• Lockout: 3-46, 58-60, 97-99, 143-148	• Reset SOLA, • If fault persists, replace SOLA

Table 16: Lockout Codes

#	Description
1	Unconfigured safety data
2	Waiting for safety data verification
3-46	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
81	Delta T Limit
82	Stack limit tripped (PVC: 149^{o}F, CPVC: 194^{o}F, 250^{o}F)
91	Inlet sensor fault
92	Outlet sensor fault
93	DHW sensor fault
94	Header sensor fault
95	Stack sensor fault
96	Outdoor sensor fault
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
149	Flame detected

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

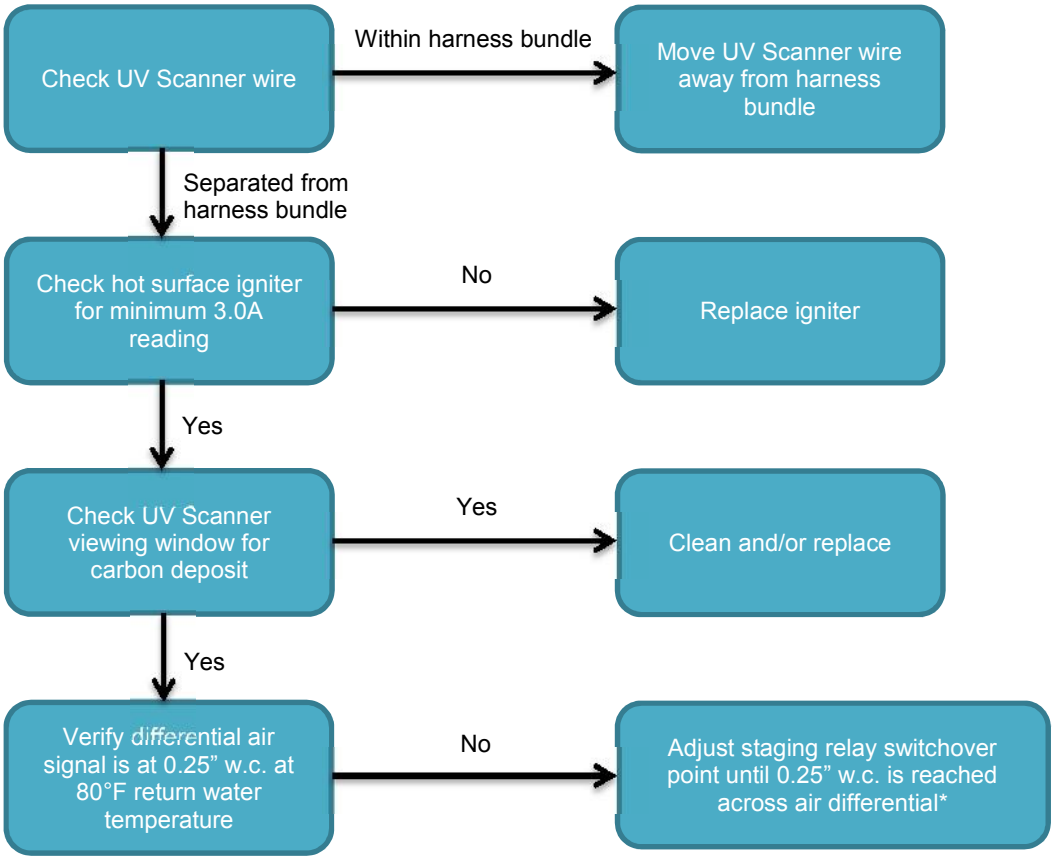
Table 17: Alert Codes

#	Description
29	Burner switch turned OFF
30	Burner switch turned ON
47	Invalid subsystem reset request occurred
50	Modulation Fault (DR300 – 1000 ONLY)
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
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

$^{+}$ 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 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

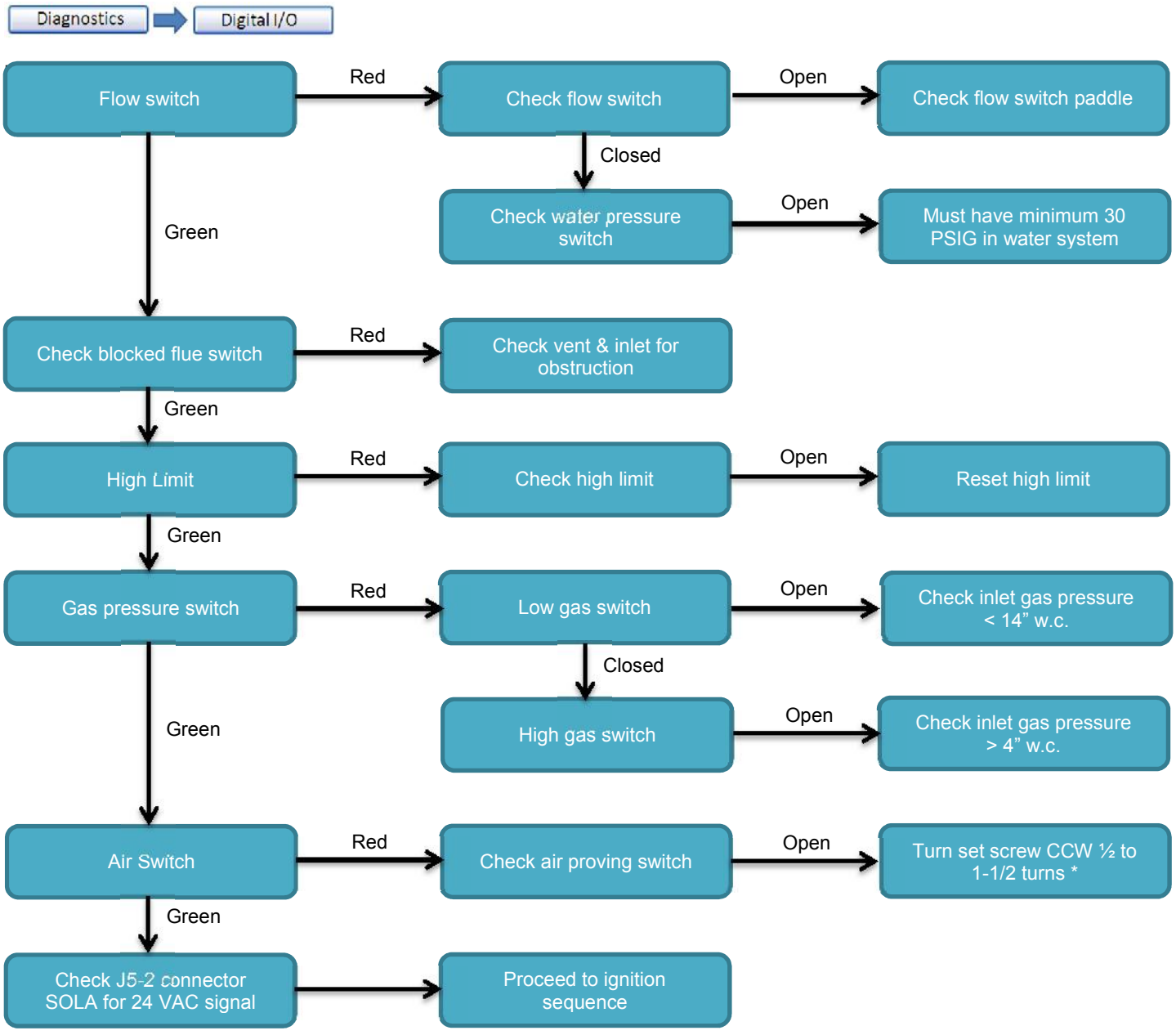
This error occurs when a flame signal is not detected by the UV Scanner. A minimum signal of 0.8Vdc must be detected by the UV Scanner to prove the flame.



* Models 800 – 4000: 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)
Hold 67: ILK OFF (High Limit, Gas Pressure Switch, and Interrupted Air Switch)
Alert 303-310: Abnormal Recycle: ILK off
Alert 460: LCI lost in run

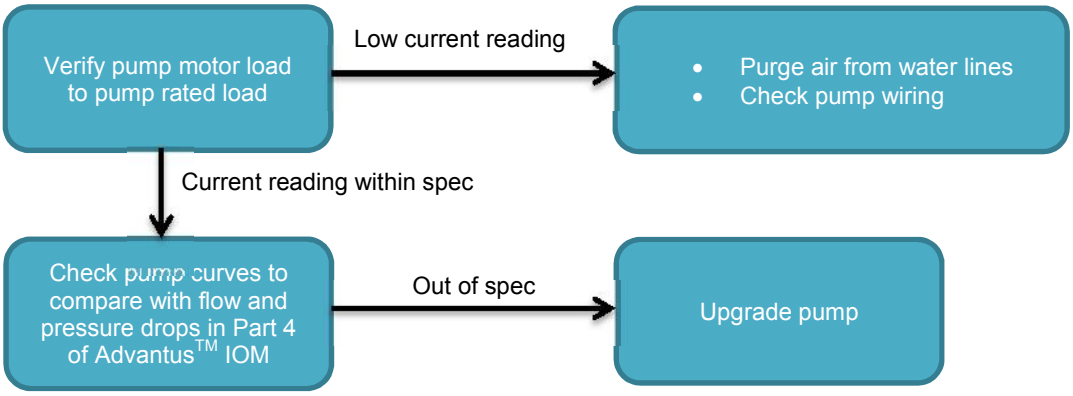
This error occurs when one of more of the boiler safety switches are in an open condition when it is to be in a closed condition before the ignition sequence is allowed to proceed.



* Models 500 and 600 only.
* Models 800 – 4000 are equipped with an electronic air switch

Alert 354: Abnormal Recycle Delta-T limit

This safety was breached as the inlet and outlet temperature difference exceeded 60°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 utilize a combustion analyzer to read CO_2, 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.

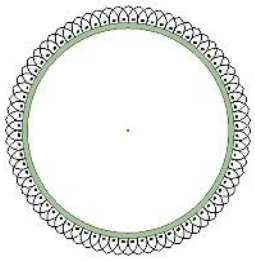
10.2 VISUALLY CHECK MAIN BURNER FLAMES

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 and direct contact could result in burns.

Figure 39: 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 following 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 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 ¼" per foot (21mm/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. 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 use. 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 Advantus™ 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 damage to 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 provided with the appliance and may be washed in the sink under the tap. 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

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 cover.
- 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 20 ft-lbs (models 500-600) and 30 ft-lbs (models 800-4000)

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 house. 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

- 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, do not hit or break the silicon carbide igniter. **DO NOT** pull out by leads.
- Ensure that the ceramic paper gaskets used to seal the base and top of the igniter are reinstalled on the new igniter.

10.6.1 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.
- 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 by hand only.
- Ensure that the igniter ceramic paper gaskets are properly installed and seal the point of contact between the igniter and fan mounting flange.
- 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 (Models 500 – 2500) or pilot (Models 3000 – 4000).

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.
- Remove fan assembly and burner as detailed in the Burner and Cleaning section.
- Check the heat exchanger tubes and combustion chamber. If soot is present, heat exchanger must be cleaned
- Remove the front outer jacket door.
- Use detergent water pressure wash to remove soot from heat exchanger tubes and combustion chamber.
- Disconnect condensate/ neutralizer box and allow dirty wash water 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
- Replace the top cover

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 50ºF (10ºC)
- **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 the manual for recommendations on setting combustion characteristics

11.2 CHECKING THE INSTALLTION

- 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.

11.3 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.

11.4 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 30 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.

11.5 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.

11.6 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.

11.7 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.

11.8 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 combustible surfaces 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 30 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. Push 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.

AV500 – AV2500

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”

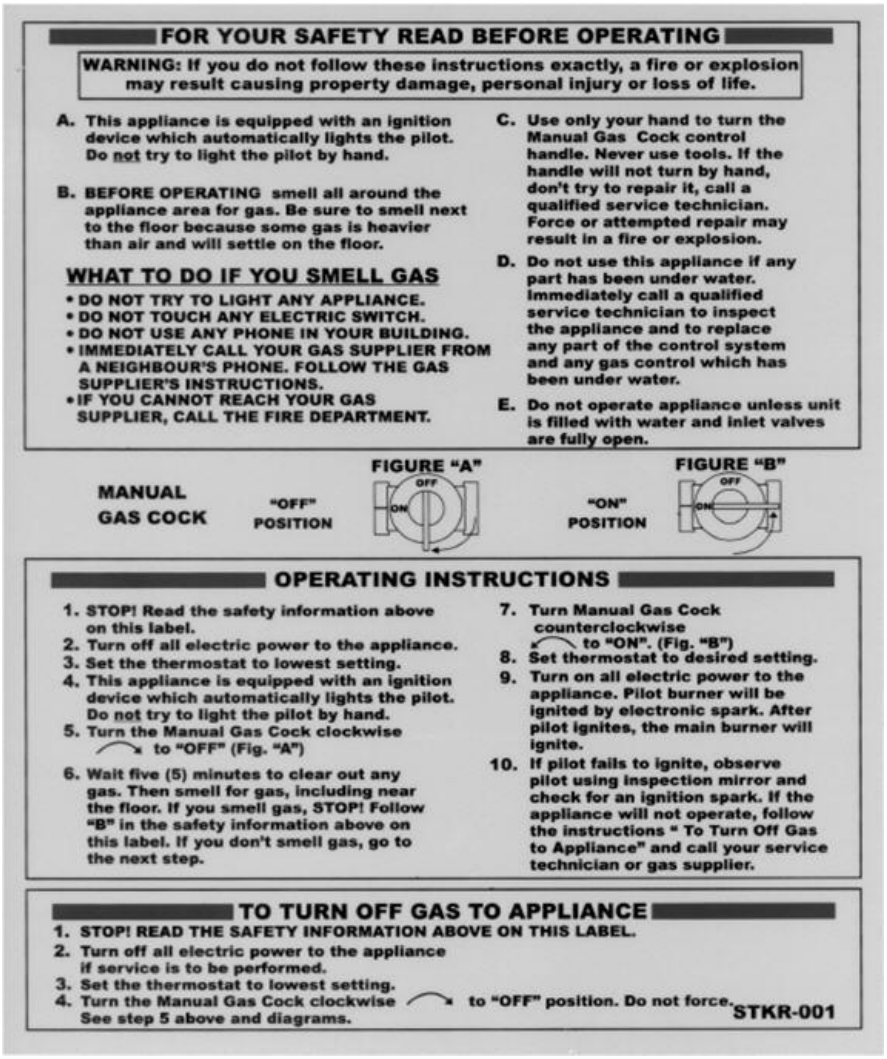
OPERATING INSTRUCTIONS

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-001-A



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

11.9 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.

11.10 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.

11.11 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:

11.12 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 Advantus™ 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.

11.13 WATER HEATERS

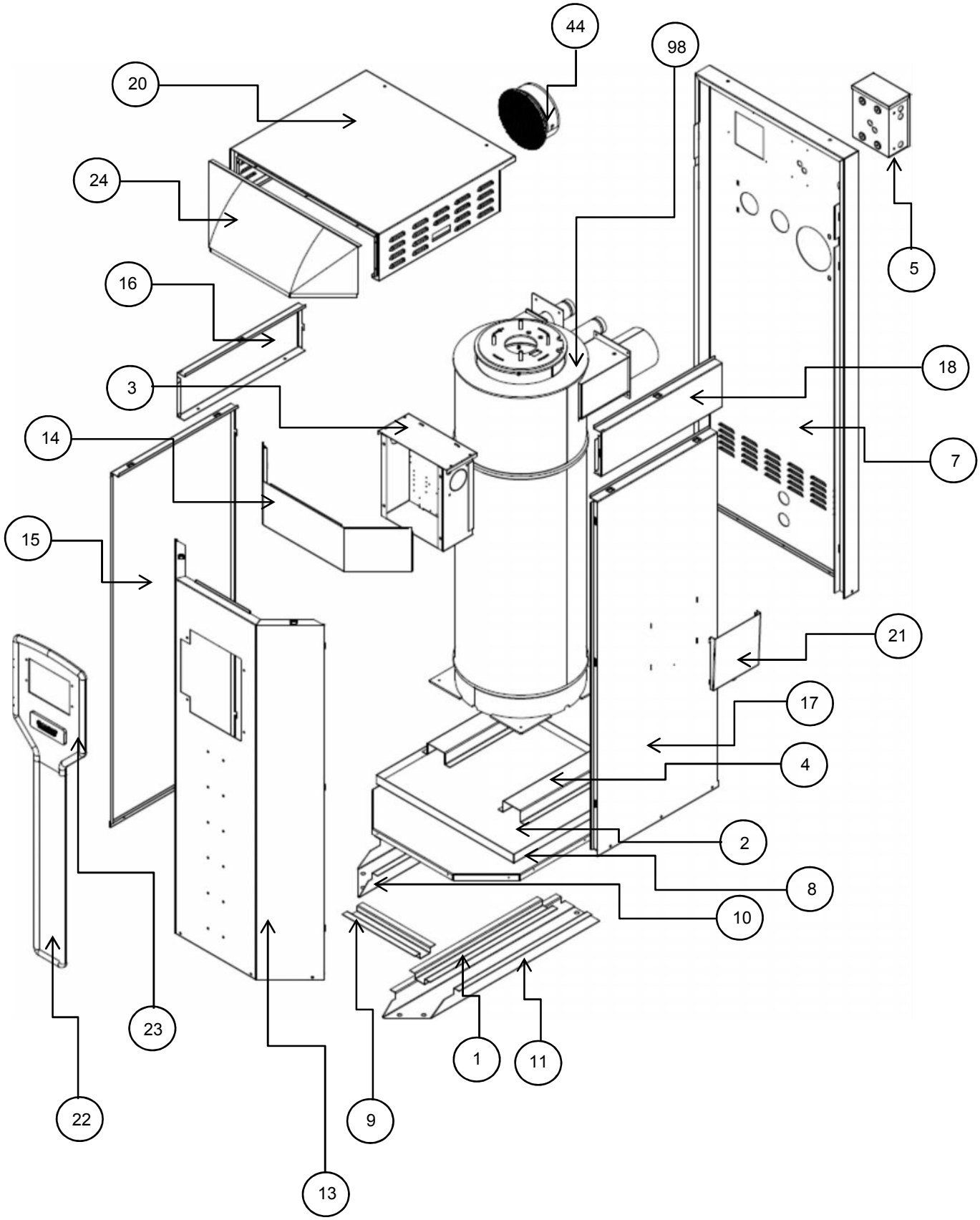
The manufacturer recommends the use of a properly sized thermostatic mixing valve to supply domestic hot water at temperatures less than 140°F (60°C). Storing the water at a higher temperature and thermostatically mixing the water will decrease the size of the storage tank and increase the available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

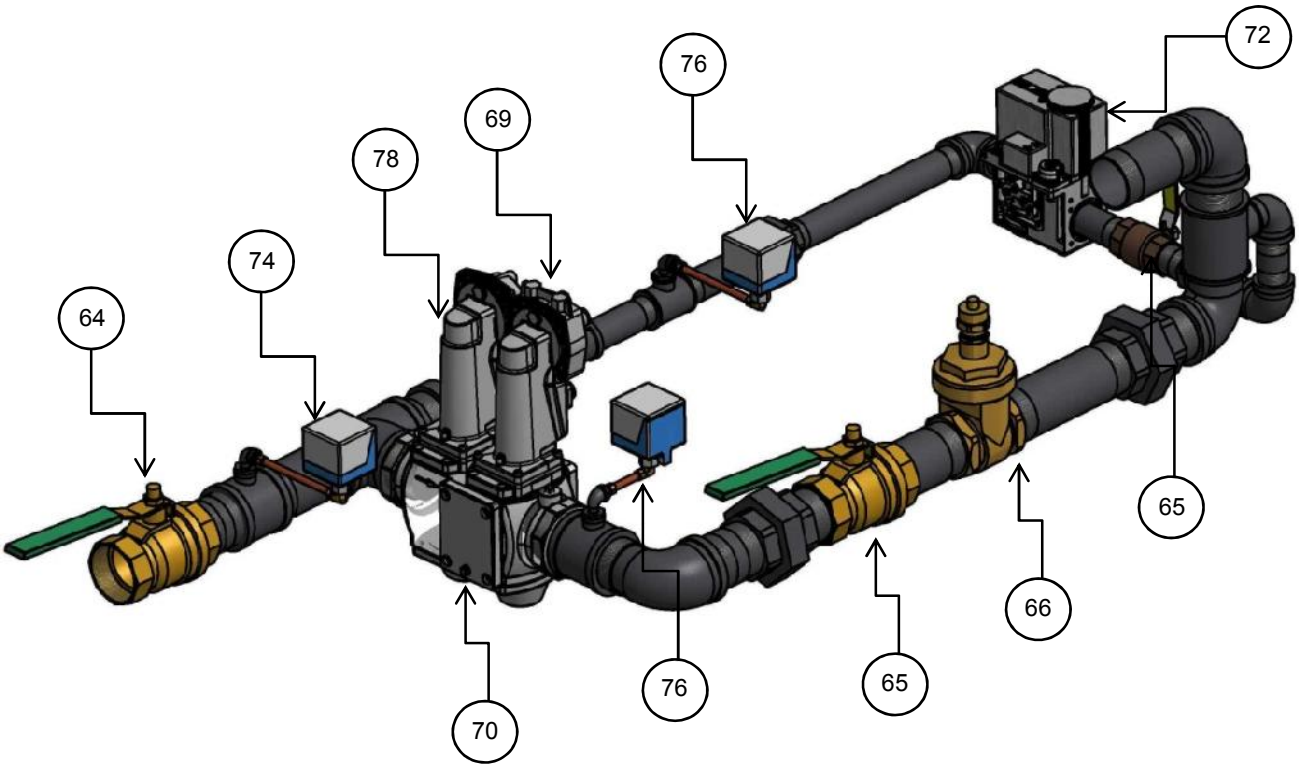
- Piping components connected to the water heater for a space heating application shall be suitable for use with potable water.
- Toxic chemicals, used for boiler treatment, shall not be introduced into the potable water used for space heating
- A water heater which will be used to supply potable water 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.

PART 12 EXPLODED VIEW

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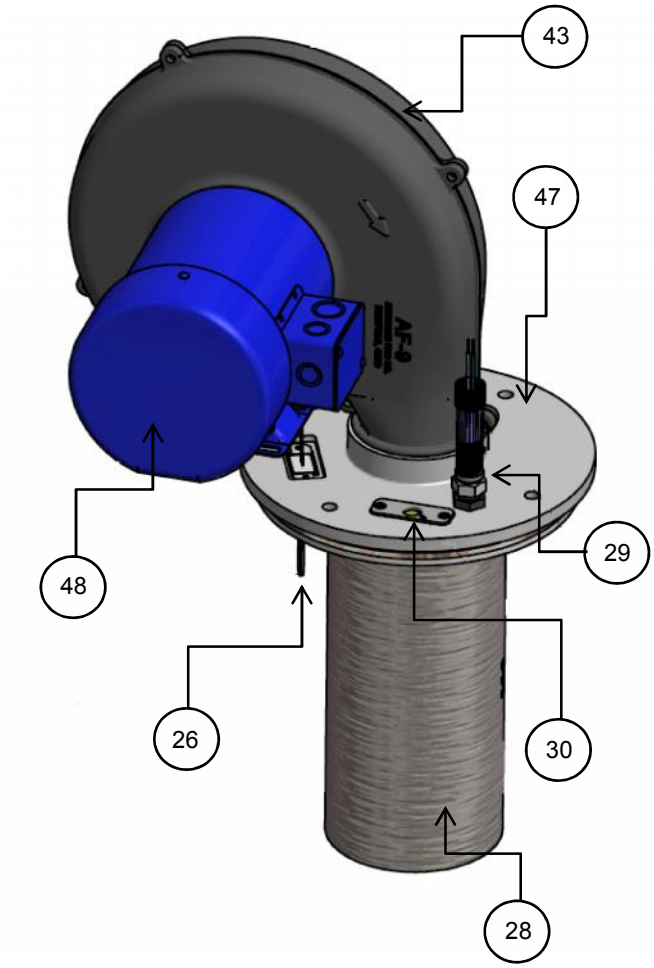
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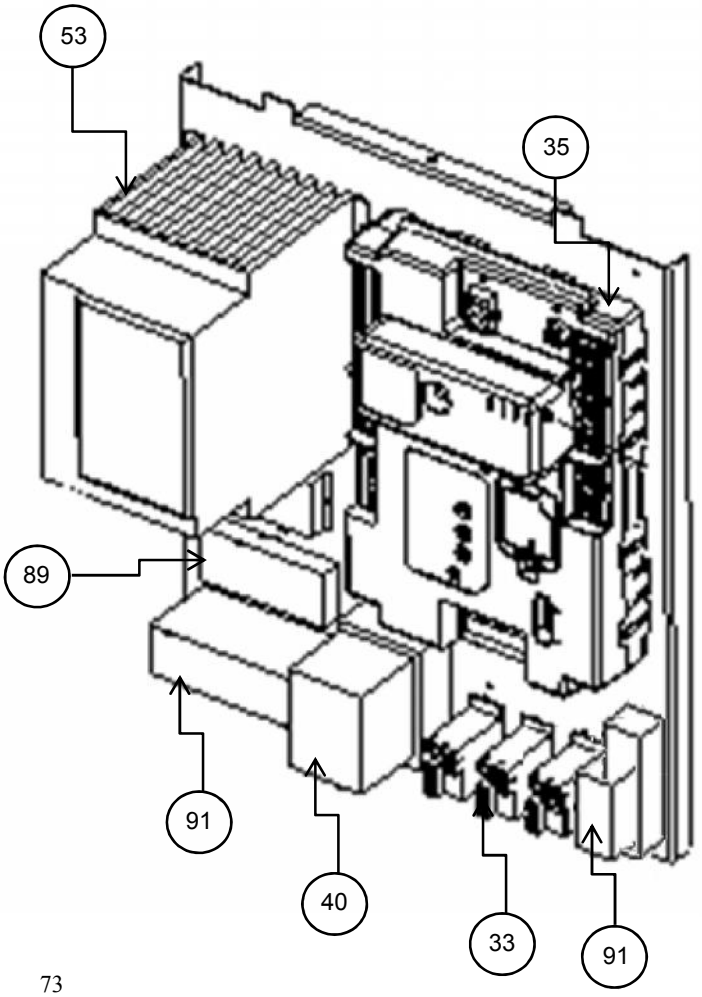
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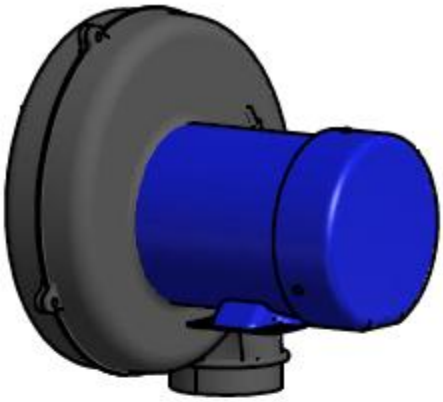
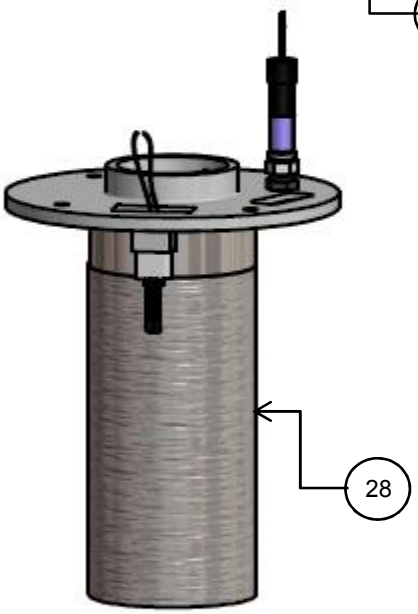
Blower



Red Silicone Gasket



Burner

White Ceramic Gasket

Graphite Gasket

White Ceramic Gasket (only required if heat exchanger surface is rough or uneven)

Ref#	Part Description	Part Number	Advantus™ Models													
			All	500	600	800	1000	1200	1400	1600	1800	2000	2500	3000	3500	4000
1	Base Stiffener	109105		x	x	x	x	x	x	x	x	x	x			
		109301												x	x	x
2	Condensate Tray Assembly	109099		x	x	x	x									
		109350						x	x	x	x	x	x			
		109295												x	x	x
3	Electrical Box Assembly	DR-14-1030		x	x	x	x	x	x	x						
		DR-14-1005									x	x	x	x	x	x
4	Heat Exchanger Riser	109114		x	x	x	x									
		109360						x	x	x	x	x	x			
		109306												x	x	x
5	Junction Box Assembly	DF-14-5240A	x													
6	Mixing Chamber Assembly (Transition Arm)	109266		x	x											
7	Outer Jacket Back Panel	109102		x	x											
		109339				x	x									
		109353						x	x							
		109368								x	x					
		109372										x	x			
		109298												x		
		109314													x	x
8	Outer Jacket Base	109104		x	x	x	x									
		109355						x	x	x	x	x	x			
		109300												x	x	x
9	Outer Jacket Base Stiffener (Long)	109324		x	x	x	x	x	x	x	x	x	x			
		109327												x	x	x
10	Outer Jacket Base Support (Left)	109106		x	x	x	x									
		109356						x	x	x	x	x	x			
		109302												x	x	x
11	Outer Jacket Base Support (Right)	109107		x	x	x	x									
		109357						x	x	x	x	x	x			
		109303												x	x	x
12	Outer Jacket Base Support (Center)	109657														x
13	Outer Jacket Front Panel (Bottom)	109100		x	x											
		109342				x	x	x	x			x	x			
		109595								x	x					
		109296												x		
		109312													x	x
14	Outer Jacket Front Panel (Top)	109697		x	x	x	x	x	x	x	x	x	X			
		109746												x	x	x
15	Outer Jacket Left Panel (Bottom)	109101		x	x											
		109345				x	x									
		109352						x	x			x	x			
		109367								x	x					
		109297												x		
		109313													x	x
16	Outer Jacket Left Panel (Top)	109695		x	x	x	x									
		109732						x	x	x	x					

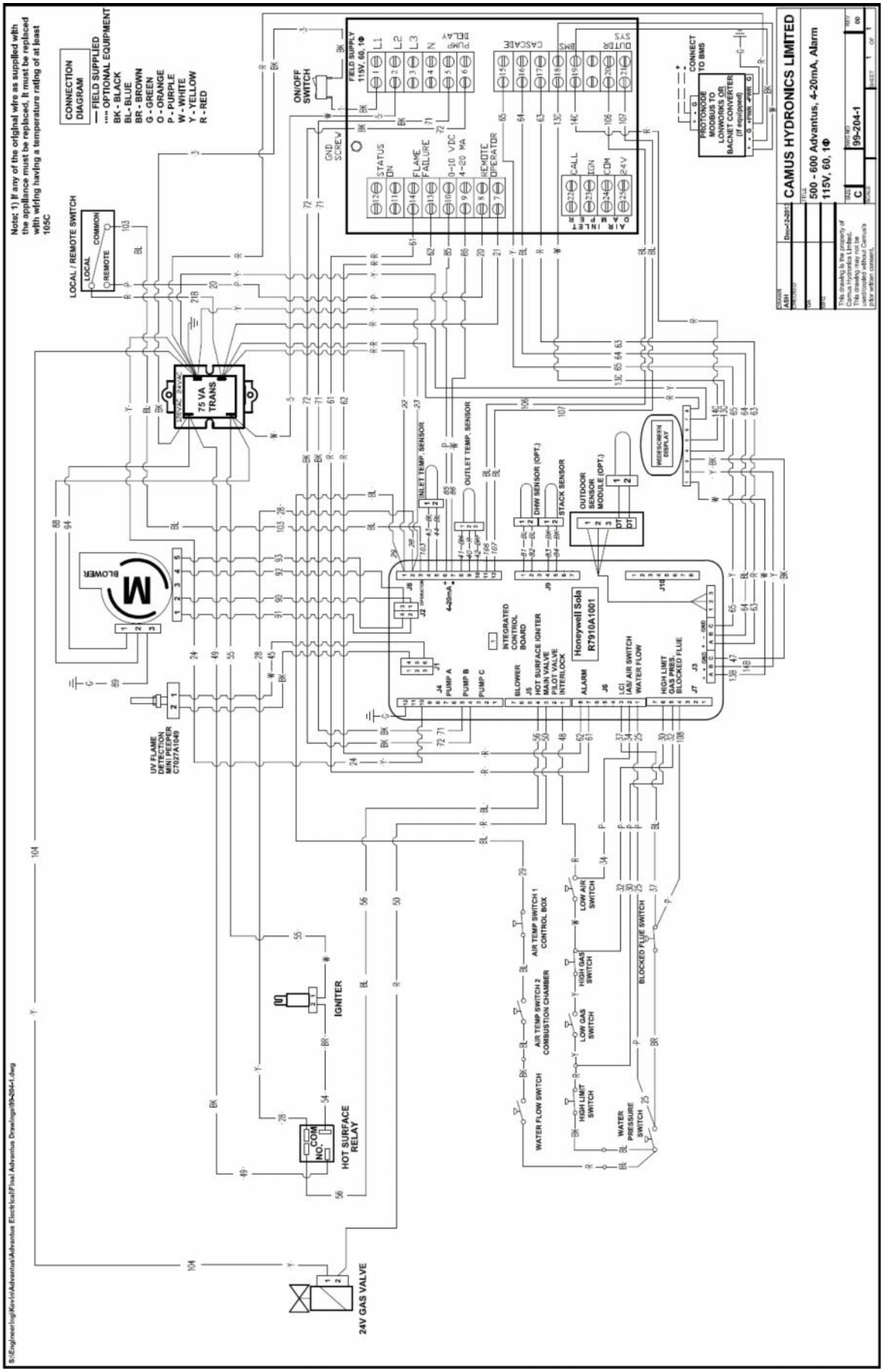
Ref#	Part Description	Part Number	Advantus™ Models													
			All	500	600	800	1000	1200	1400	1600	1800	2000	2500	3000	3500	4000
16	Outer Jacket Left Panel (Top)	109743										x	x			
		109745												x		
		109748													x	x
17	Outer Jacket Right Panel (Bottom)	109103		x	x											
		109344				x	x									
		109354						x	x			x	x			
		109369								x	x					
		109299												x		
		109315													x	x
18	Outer Jacket Right Panel (Top)	109696		x	x	x	x									
		109733						x	x	x	x					
		109744										x	x			
		109747												x		
		109749													x	x
19	Sight Glass Holder	13-5334	x													
20	Top Cover	109108		x	x	x	x									
		109358						x	x	x	x	x	x			
		109304												x	x	x
21	Literature Pocket	DR-14-0150	x													
22	Bezel (Bottom)	DR-90-10020		x	x											
		DR-90-10006				x	x	x	x	x	x					
		DR-90-10005										x	x	x		
		DR-90-10007													x	x
23	Bezel (Top)	DR-90-10004	x													
24	Top Cover Front (Plastic)	109279		x	x	x	x	x	x	x	x	x	x			
		109326												x	x	x
25	Burner Flange	109708, (4”)		x	x	x	x									
		109728, (6”)						x	x							
		109541, (8”)								x	x	x	x			
		109602, (10”)												x	x	x
26	Hot Surface Igniter	271R-225	x													
27	Hot Surface Igniter Mounting Flange	13-5335	x													
28	Primary Burner	109739		x	x											
		109740				x	x									
		109741						x	x							
		109742								x	x					
		109743										x	x			
		109744												x		
		109745													x	x
29	UV Scanner	C7027A1049/U	x													
30	View Port Glass	TG-94010-040	x													
31	2-10Vdc Converter	ETISO-V	x													
32	On/Off Switch (with rainproof cover)	C6000ALBB/G74/W46	x													
33	Pump Delay Relay (up to 1hp)	AMP1649341-8	x													
34	Snap-Action Thermostat	EKA-114-58	x													
35	Sola Controller	R7910A1001	x													

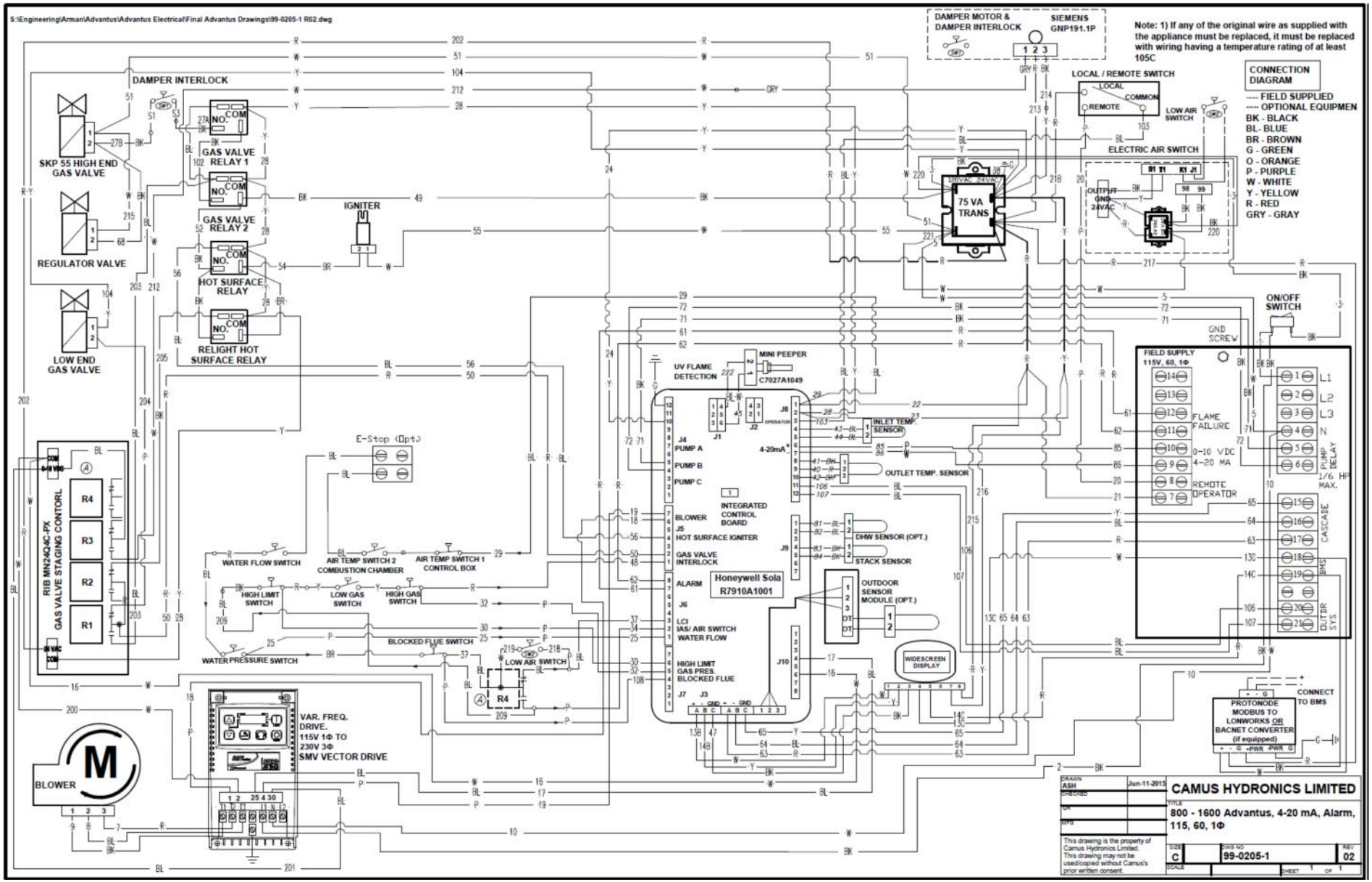
Ref#	Part Description	Part Number	Advantus™ Models													
			All	500	600	800	1000	1200	1400	1600	1800	2000	2500	3000	3500	4000
36	Sola Display	S7999D1006	x													
37	Terminal Block - 4 Pole	TB200-4	x													
38	Terminal Block - 6 Pole	TB200-6	x													
39	Terminal Block - 8 Pole	TB200-8	x													
40	Transformer (75VA)	HCT-01J2BB07	x													
41	Wiring Harness	77-0038	x													
	Advantus Kit Harness	77-0048				x	x	x	x	x	x	x	x	x	x	X
42	Air Inlet Damper Assembly (Includes Siemens Electronic Damper Actuator)	110008				x	x	x	x	x						
		110014									x	x	x	x	x	x
43	AF Fan Kit	AF09 FAN KIT				x	x	x	x	x						
		AF10 FAN KIT									x	x	x	x		
		AF12 FAN KIT													x	
		AF15 FAN KIT														x
44	Air Inlet Filter Assembly	DM-14-0117		x	x											
		DM-14-0118				x	x									
		DF-14-0119						x	x							
		DF-14-0120								x	x	x	x	x	x	x
45	Air Inlet to Fan Adapter (1)	DR-16-0015		x												
46	Air Inlet to Fan Adapter (2)	DR-16-0016		x												
47	Aluminum Fan Flange	109717				x	x									
		109736						x	x	x						
		109750 (AF10)									x	x	x	x		
		109751 (AF12)													x	
		109752 (AF15)														x
48	Blower	150930-03		x												
		150232			x											
		D391				x										
		D393					x	x	x	x						
		D394									x	x				
		D395											x			
		D396												x	x	
		C204B														x
49	Fan Gasket	33-0037		x												
50	Fan Flange Gasket	33-0058		x												
51	Gasket for Mixing Chamber End	33-0057		x	x											
53	VFD	ESV371N01SXB				x										
		ESV751N01SXB					x	x	x	x						
		ESV152N02XYB									x	x				
		ESV222N02YXB											x	x	x	
		ESV402N02TXB														x
54	Pilot Tubing	11-0115-10”												x	x	x
55	Plastic Coupling	1056-32		x												
		1056-44			x											

Ref#	Part Description	Part Number	Advantus™ Models													
			All	500	600	800	1000	1200	1400	1600	1800	2000	2500	3000	3500	4000
56	Relief Valve	10-614-09		x	x	x	x	x								
		10-615-15							x	x	x	x	x			
		10-616-15												x	x	x
57	Victaulic Coupling	VIC107-2		x	x	x	x									
		VIC107-3						x	x	x	x	x	x	x	x	x
58	Victaulic Stainless Steel Nipple (Inlet)	2" x ...		x	x	x	x									
		3" x ...						x	x	x	x	x	x	x	x	x
59	Victaulic Stainless Steel Nipple (Outlet)	2" x ...		x	x	x	x									
		3" x ...						x	x	x	x	x	x	x	x	x
60	Air/Gas Mixing Tube	13-0026/16-0033				x	x	x	x	x	x	x				
		13-0027/16-0036												x	x	x
		66-5005											x			
61	A-Valve	50-GB5-01A		x	x	x	x									
		50-GB6-01A						x	x	x	x	x				
		50-GB7-01A											x	x		
		50-GB8-01A													x	x
62	Ball Valve	USA0759101		x	x											
		USA1009101				x	x	x	x							
		USA1259101								x	x	x				
		USA1509101											x	x		
		USA2009101													x	x
63	Brass Gate Valve	14107				x	x	x	x	x	x	x				
		14108											x	x		
		14109													x	x
64	Dual Gas Valve	V8730C1007		x												
		V8730C1023			x											
65	High End Gas Valve	SKP55.011U1				x	x	x	x	x	x	x	x	x	x	x
66	High End Gas Valve Body	VGG10.254U				x	x	x								
		VGG10.404U							x	x	x	x	x	x		
		VGD40.065U													x	x
67	Low End Gas Valve	VR8615VB1044B				x	x	x	x							
		V8730C1007								x						
68	Low End Gas Valve	V8730C1015									x					
		V8730C1023										x	x	x		
		V8730C1031													x	x
69	Low End Gas Valve Flange	32006652-003									x	x	x	x	x	
		32006652-004														x
70	Low Gas Pressure Switch	C6097A1012	x													
71	Differential High Gas Pressure Switch	HGP-A												x	x	x
72	High Gas Pressure Switch	C6097B1028												x	x	x
73	Mixing Tube Ring	13-0028/16-0039				x	x	x	x	x	x	x	x	x	x	x
74	Motorized Safety Shut Off Valve	SKP25.011U1													x	x
75	Pilot Regulator (Combination Control)	CV100B6N-22-0001												x	x	x
76	Solenoid Valve	V4295A1031				x	x	x								
		V4295A1049							x	x						
		V4295A1056									x	x	x	x		

Ref#	Part Description	Part Number	Advantus™ Models													
			All	500	600	800	1000	1200	1400	1600	1800	2000	2500	3000	3500	4000
77	Gas Valve Regulator	SKP25													x	x
78	Venturi	45900450-030B		x												
		VMU300A1046			x	x										
79	Graphite Gasket	109064		x	x	x	x									
		109730						x	x							
		109542								x	x	x	x			
		109600												x	x	x
80	Red Silicone Gasket	109691		x	x	x	x									
		109728						x	x							
		109544								x	x	x	x			
		109599												x	x	x
81	White Ceramic Gasket with Graphite Facing	109692		x	x	x	x									
		109729						x	x							
		109543						x	x	x	X	x	x			
		109601												x	x	x
82	Air Vent (inlet)	FV-4M1	x													
83	Air Vent (Outlet)	590173	x													
84	Aquastat (Breaks on rise)	L4008E1313	x													
85	Aquastat (on/off)	L6008A1242	x													
86	Contactor Relay	T92P7A22-24									x	x	x	x	x	x
87	Differential Pressure Switch	SML1210034		x	x											
		ACI/DP2-6-20-AC PM3C1EA-AAAAAA				x	x	x	x	x	x	x	x	x	x	x
88	Gas Valve Staging Control	RIBMN24Q4C-PX				x	x	x	x	x	x	x	x	x	x	x
89	Indoor Flow Switch	F61KB-11C	x													
90	Inlet Sensor	198799Z/U	x													
91	Outlet Dual Sensor	50001464-005/B	x													
92	Blocked Flue Switch	8021205256	x													
93	Stack Sensor	NTC-SENSOR-003	x													
94	Water Pressure Switch	HB26A218L	x													
95	Primary Heat Exchanger	109238		x	x											
		109240				x	x									
		109241						x	x							
		109243								x	x					
		109244										x	x			
		109245												x		
		109246													x	x

PART 13 ELECTRICAL DIAGRAMS

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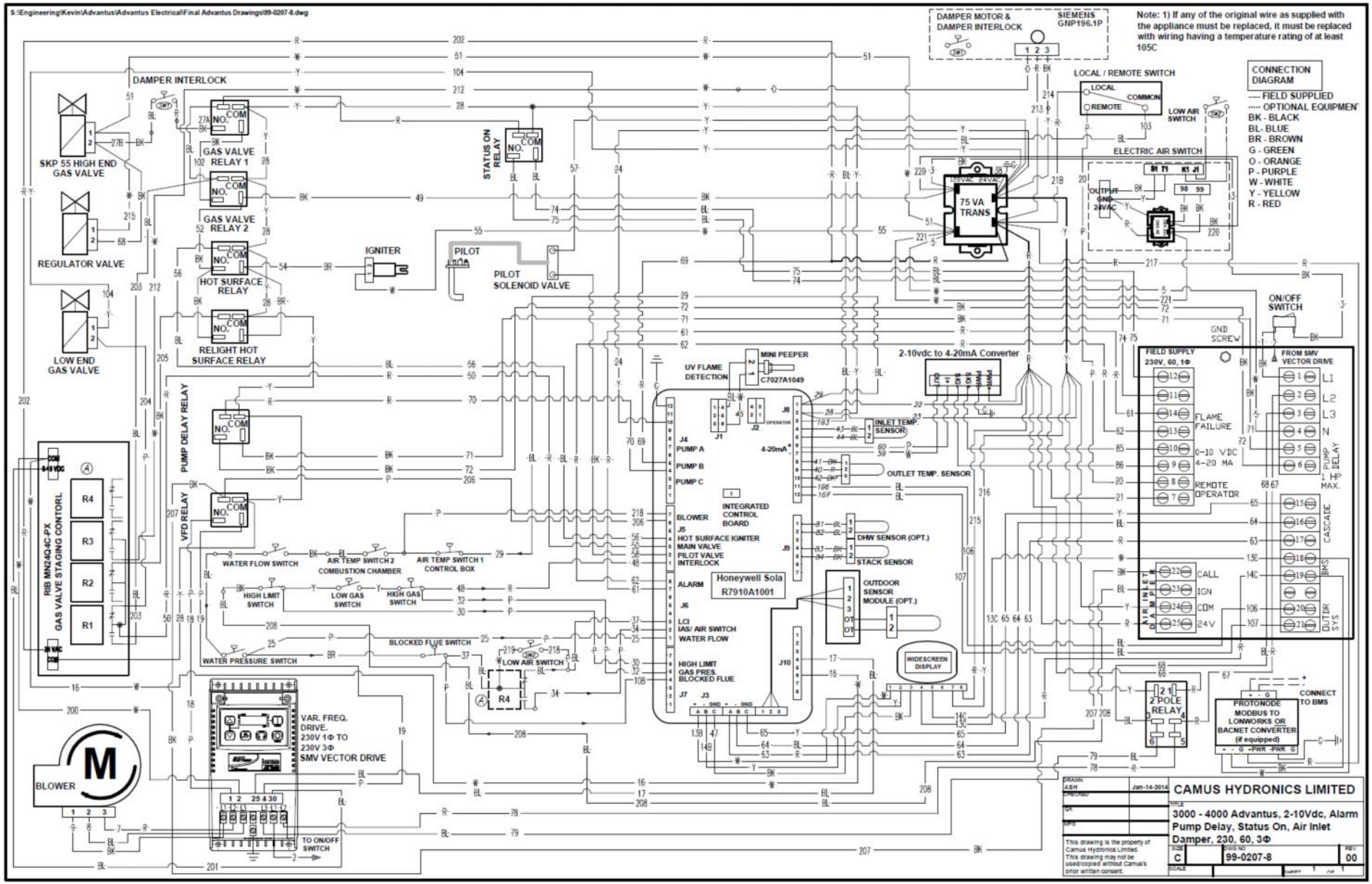
DAMPER MOTOR & DAMPER INTERLOCK
SIEMENS GNP191.1P
Note: 1) If any of the original wire as supplied with the appliance must be replaced, it must be replaced with wiring having a temperature rating of at least 105C
CONNECTION DIAGRAM
---- FIELD SUPPLIED
----- OPTIONAL EQUIPMEN
BK - BLACK
BL- BLUE
BR - BROWN
G - GREEN
O - ORANGE
P - PURPLE
W - WHITE
Y - YELLOW
R - RED
GRY - GRAY
DAMPER INTERLOCK
SKP 55 HIGH END GAS VALVE
REGULATOR VALVE
LOW END GAS VALVE
GAS VALVE RELAY 1
GAS VALVE RELAY 2
HOT SURFACE RELAY
RELIGHT HOT SURFACE RELAY
IGNITER
LOCAL / REMOTE SWITCH
LOCAL
COMMON
REMOTE
LOW AIR SWITCH
ELECTRIC AIR SWITCH
75 VA TRANS
ON/OFF SWITCH
GND SCREW
FIELD SUPPLY 115V, 60, 1Φ
FLAME FAILURE
0-10 VDC 4-20 MA
REMOTE OPERATOR
PUMP RELAY 1/6 HP MAX.
CASCADE
BMS
OUTDR SYS
MINI PEEPER
C7027A1049
UV FLAME DETECTION
INTEGRATED CONTROL BOARD
Honeywell Sola R7910A1001
PUMP A
PUMP B
PUMP C
BLOWER
HOT SURFACE IGNITER
GAS VALVE INTERLOCK
ALARM
LCI
IAS/ AIR SWITCH WATER FLOW
HIGH LIMIT GAS PRES. BLOCKED FLUE
4-20mA
INLET TEMP. SENSOR
OUTLET TEMP. SENSOR
DHW SENSOR (OPT.)
STACK SENSOR
OUTDOOR SENSOR MODULE (OPT.)
WIDESCREEN DISPLAY
E-Stop (Opt.)
WATER FLOW SWITCH
AIR TEMP SWITCH 2 COMBUSTION CHAMBER
AIR TEMP SWITCH 1 CONTROL BOX
HIGH LIMIT SWITCH
LOW GAS SWITCH
HIGH GAS SWITCH
BLOCKED FLUE SWITCH
WATER PRESSURE SWITCH
LOW AIR SWITCH
RIB MN24Q4C-PX GAS VALVE STAGING CONTORL
R4
R3
R2
R1
VAR. FREQ. DRIVE. 115V 1Φ TO 230V 3Φ SMV VECTOR DRIVE
BLOWER
PROTONODE MODBUS TO LONWORKS OR BACNET CONVERTER (if equipped)
CONNECT TO BMS
DRAWN ASH
Jun-11-2015
CHECKED
QA
APPD
CAMUS HYDRONICS LIMITED
TYPE
800 - 1600 Advantus, 4-20 mA, Alarm, 115, 60, 1Φ
This drawing is the property of Camus Hydronics Limited. This drawing may not be used/copied without Camus's prior written consent.
SIZE C
DWG NO 99-0205-1
REV 02
SCALE
SHEET 1 OF 1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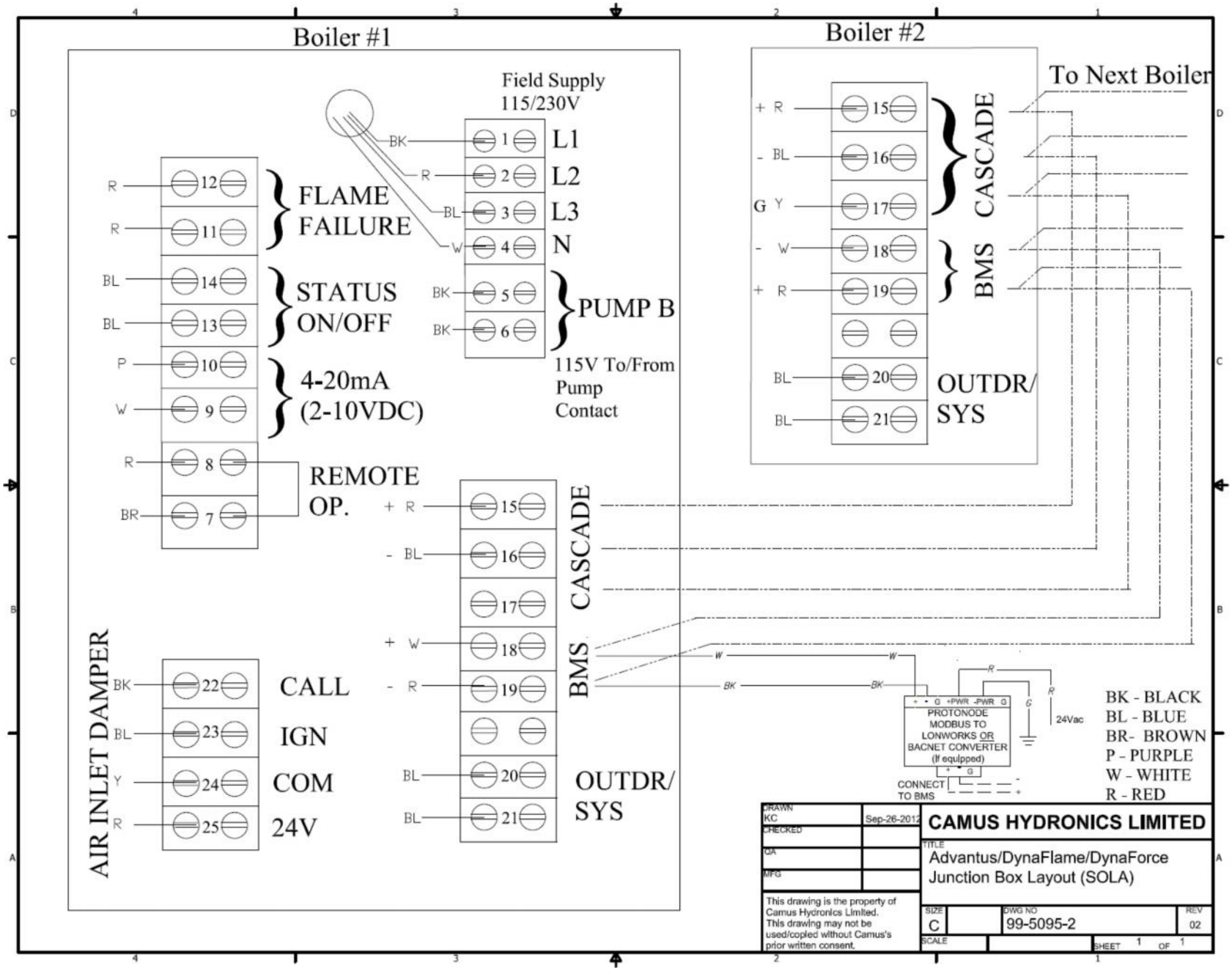
DAMPER MOTOR & DAMPER INTERLOCK
SIEMENS GNP196.1P
Note: 1) If any of the original wire as supplied with the appliance must be replaced, it must be replaced with wiring having a temperature rating of at least 105C
CONNECTION DIAGRAM
---- FIELD SUPPLIED
----- OPTIONAL EQUIPMENT
BK - BLACK
BL - BLUE
BR - BROWN
G - GREEN
O - ORANGE
P - PURPLE
W - WHITE
Y - YELLOW
R - RED
DAMPER INTERLOCK
LOCAL / REMOTE SWITCH
LOCAL
COMMON
REMOTE
LOW AIR SWITCH
ELECTRIC AIR SWITCH
SKP 55 HIGH END GAS VALVE
GAS VALVE RELAY 1
GAS VALVE RELAY 2
STATUS ON RELAY
REGULATOR VALVE
HOT SURFACE RELAY
IGNITER
PILOT
PILOT SOLENOID VALVE
75 VA TRANS
LOW END GAS VALVE
RELIGHT HOT SURFACE RELAY
ON/OFF SWITCH
GND SCREW
MINI PEEPER
C7027A1049
UV FLAME DETECTION
2-10vdc to 4-20mA Converter
FIELD SUPPLY 230V, 60, 1Φ
FROM SMV VECTOR DRIVE
L1
L2
L3
N
PUMP DELAY
HP MAX.
FLAME FAILURE
0-10 VDC
4-20 MA
REMOTE OPERATOR
CASCADE
BMS
OUTDR STS
CALL
IGN
COM
24V
FIELD INLET
PUMP DELAY RELAY
VFD RELAY
RIB MN24Q4C-PX
GAS VALVE STAGING CONTORL
R4
R3
R2
R1
J4
PUMP A
PUMP B
PUMP C
BLOWER
J5
HOT SURFACE IGNITER
MAIN VALVE
PILOT VALVE
INTERLOCK
ALARM
J6
LCI
IAS/ AIR SWITCH
WATER FLOW
HIGH LIMIT
GAS PRES.
BLOCKED FLUE
J7
J3
J1
J2
J8
J9
J10
INTEGRATED CONTROL BOARD
Honeywell Sola
R7910A1001
4-20mA
INLET TEMP. SENSOR
OUTLET TEMP. SENSOR
DHW SENSOR (OPT.)
STACK SENSOR
OUTDOOR SENSOR MODULE (OPT.)
WIDESCREEN DISPLAY
WATER FLOW SWITCH
AIR TEMP SWITCH 2 COMBUSTION CHAMBER
AIR TEMP SWITCH 1 CONTROL BOX
HIGH LIMIT SWITCH
LOW GAS SWITCH
HIGH GAS SWITCH
BLOCKED FLUE SWITCH
WATER PRESSURE SWITCH
LOW AIR SWITCH
2 POLE RELAY
PROTONODE MODBUS TO LONWORKS OR BACNET CONVERTER (if equipped)
CONNECT TO BMS
VAR. FREQ. DRIVE. 230V 1Φ TO 230V 3Φ SMV VECTOR DRIVE
BLOWER
TO ON/OFF SWITCH
CAMUS HYDRONICS LIMITED
3000 - 4000 Advantus, 2-10Vdc, Alarm Pump Delay, Status On, Air Inlet Damper, 230, 60, 3Φ
DRAWN ASH Jan-14-2014
CHECKED
QA
APD
This drawing is the property of Camus Hydronics Limited. This drawing may not be used/copied without Camus's prior written consent.
SIZE C
DWG NO 99-0207-8
REV 00
SCALE
SHEET 1 OF 1


Boiler #1
Boiler #2
Field Supply
115/230V
To Next Boiler
L1
L2
L3
N
FLAME FAILURE
STATUS ON/OFF
PUMP B
4-20mA (2-10VDC)
115V To/From Pump Contact
REMOTE OP.
CASCADE
BMS
OUTDR/ SYS
AIR INLET DAMPER
CALL
IGN
COM
24V
PROTONODE MODBUS TO LONWORKS OR BACNET CONVERTER (If equipped)
CONNECT TO BMS
24Vac
BK - BLACK
BL - BLUE
BR- BROWN
P - PURPLE
W - WHITE
R - RED
CAMUS HYDRONICS LIMITED
Advantus/DynaFlame/DynaForce Junction Box Layout (SOLA)
DRAWN KC
Sep-26-2012
CHECKED
QA
MFG
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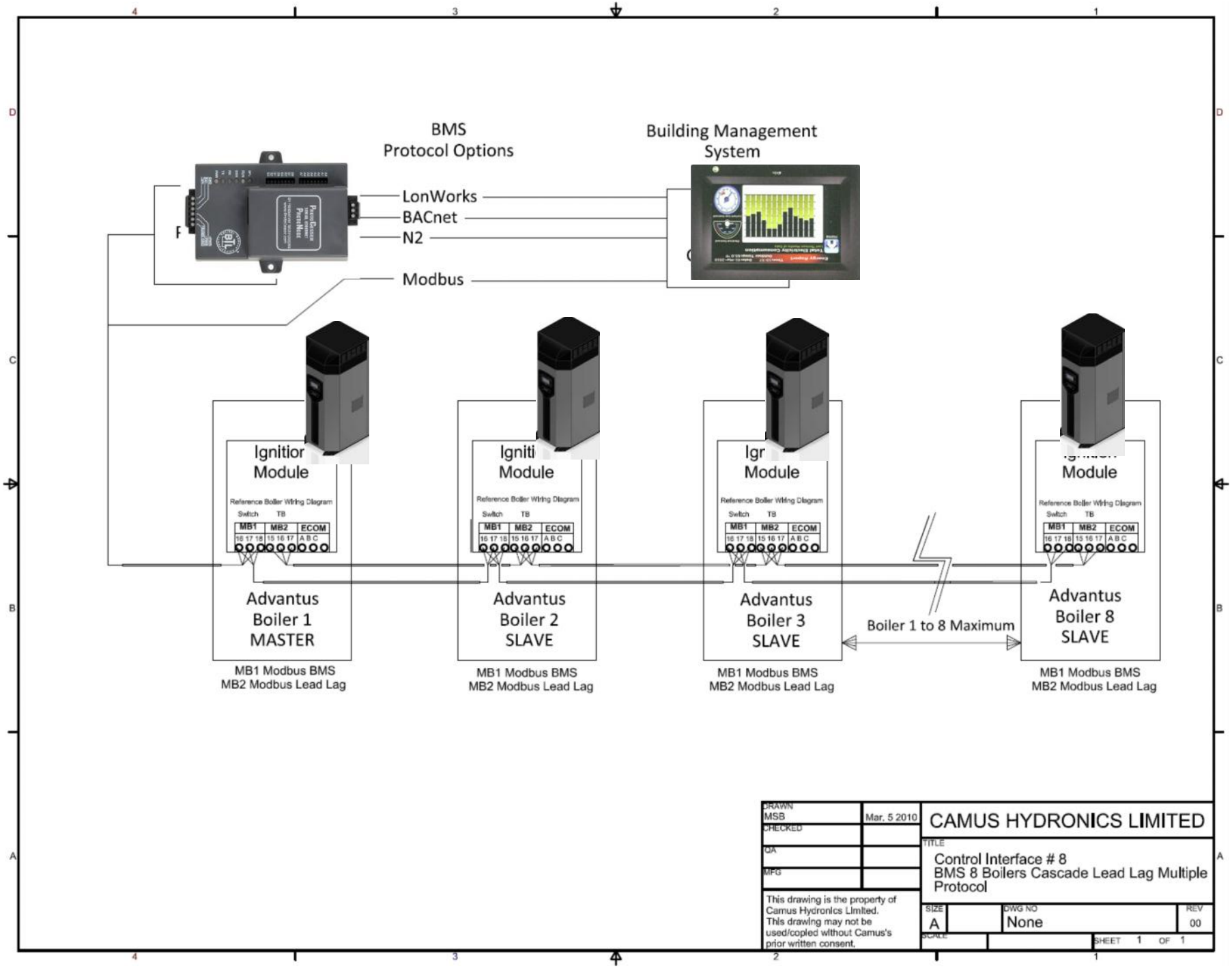
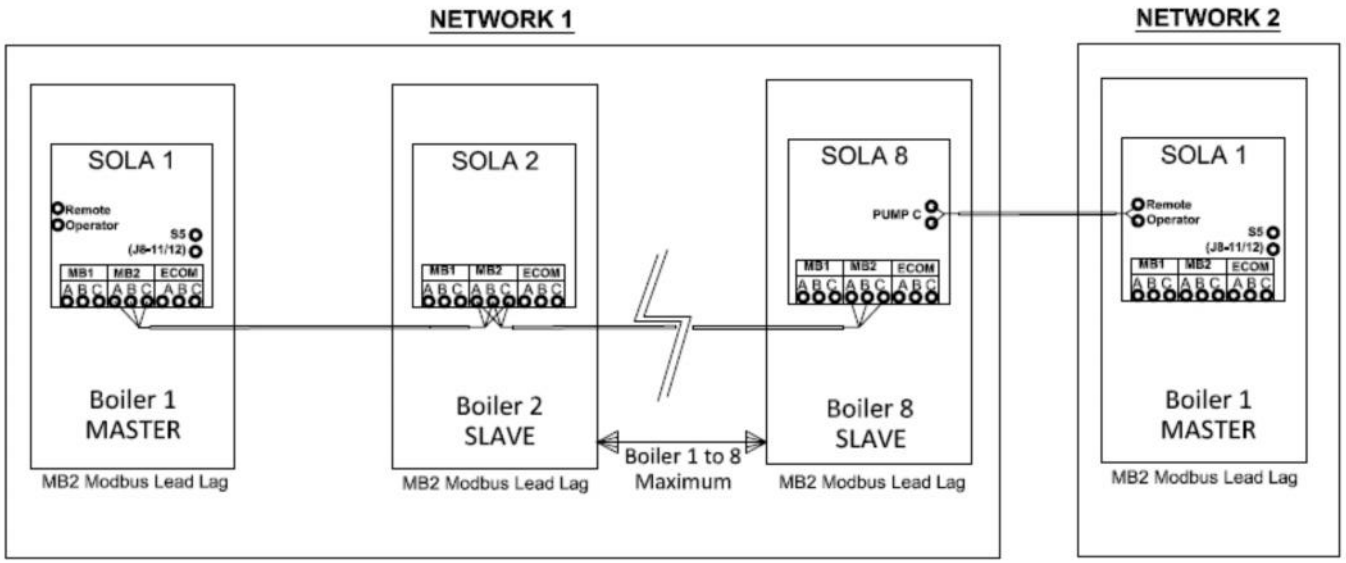
SIZE C
DWG NO 99-5095-2
REV 02
SCALE
SHEET 1 OF 1


BMS
Protocol Options
Building Management
System
LonWorks
BACnet
N2
Modbus
Ignitior
Module
Igniti
Module
Igr
Module
Module
Reference Boiler Wiring Diagram
Switch
TB
MB1
MB2
ECOM
16 17 18 15 16 17 A B C
Advantus
Boiler 1
MASTER
Advantus
Boiler 2
SLAVE
Advantus
Boiler 3
SLAVE
Boiler 1 to 8 Maximum
Advantus
Boiler 8
SLAVE
MB1 Modbus BMS
MB2 Modbus Lead Lag
MB1 Modbus BMS
MB2 Modbus Lead Lag
MB1 Modbus BMS
MB2 Modbus Lead Lag
MB1 Modbus BMS
MB2 Modbus Lead Lag
DRAWN
MSB
Mar. 5 2010
CHECKED
QA
MFG
This drawing is the property of Camus Hydronics Limited. This drawing may not be used/copied without Camus's prior written consent.
CAMUS HYDRONICS LIMITED
TITLE
Control Interface # 8
BMS 8 Boilers Cascade Lead Lag Multiple Protocol
SIZE
A
DWG NO
None
REV
00
SCALE
SHEET 1 OF 1

HONEYWELL SOLA LEAD LAG OPERATION UP TO 9 BOILERS



Sensor Wiring:

Each Network must have independent S5 (Lead Lag) sensors and they must be positioned closely together in building piping and wired to respective SOLA 1.
Network 1 Outdoor sensor is to be wired to S5 (J8-11/12), if applicable.
Network 2 Outdoor sensor is to be wired to ECOM using Outdoor Reset Module (W8735S1000), if applicable.

Operation:

Network 1 supports up to 8 boilers operating in lead lag with SOLA 1 acting as the master. Based on Lead Lag sensor this will govern if additional boilers in Network 1 is required. Refer to I&O Manual for additional details on lead lag operation within a single network.
Network 2 supports up to a maximum of 4 boilers operating in lead lag.
Network 1 SOLA 8 Pump C contacts are wired to Network 2 SOLA 1 Remote Operator Contacts
Network 1 SOLA 8 activates Network 2 SOLA 1 through the use of Pump C contact on R7910A1001. Pump C is activated on a time delay algorithm, where the timer is initiated when SOLA 8 begins ignition sequence.
Pump C Time Delay (Register #293) = Interstage Delay (Default: 2 mins) x Number of Boilers
Network 2 operates independently of Network 1.

Note:

Due to rotation of leaders in Network 1; SOLA 8 may become lead boiler. Operation is not impacted regardless of lead boiler in Network 1 as all boilers in Network 1 will attempt to start before Network 2 boilers are activated.
Lead lag setpoint: Network 2 < Network 1 (Default: 2 deg F lower)

WARNING:
This drawing shows suggested control and interface configuration.

DRAWN KC	May 26 2014	CAMUS HYDRONICS LIMITED
CHECKED		TITLE: Honeywell SOLA Lead Lag Operation Up to 9 Boilers
QA		
MFG		

S:\Engineering\Kevin\DynaFlow Electrical\99-0220 R00.dwg

SIZE	DWG NO	REV
A	99-0220	00

SCALE | SHEET 1 OF 1

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 surrounds 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	Advantus™	Years In Service	Advantus™
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 150ºF between the water temperature at inlet and appliance temperature or operating at temperatures exceeding 210°F (AVH & AVW).

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 lasts
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 CERTIFIED!

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!

CAMUS®
Hydronics Ltd.