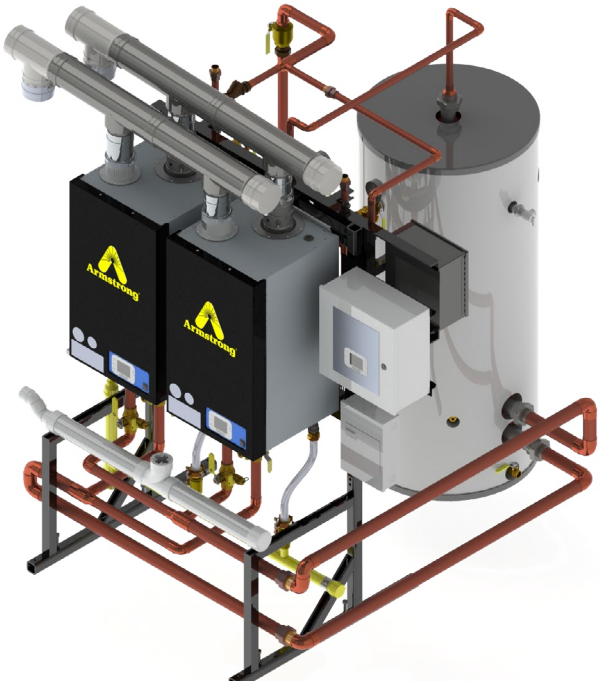
Armstrong High Efficiency Water Heaters And Heating Boilers Installation & Operations Manual



Please read and save these instructions

Armstrong®

HW-400-EN V2.6

Safety

Icon Legend

— DANGER! … Injury or death and property damage are imminent

— WARNING! … Injury or death and property damage are possible

— CAUTION! … Potential property damage, expensive repairs, and/or voiding the equipment warranty may result

BURN HAZARD! Contact with steam, hot water, or hot metal surfaces can cause severe skin burns. Skin exposure to 140°F (60°C) water or metal for only five (5) seconds may cause a second degree burn.

If the instructions following a safety icon are not followed, adverse consequences may occur – including property damage, personal injury, or, in extreme cases, death.

General Safety Guidelines:

1. This product is designed and constructed to withstand conditions expected during normal use.

2. Inappropriate use of this product could cause damage to the product and other property. It may also result in personal injury or, in extreme cases, death.

3. Installation or maintenance must be carried out in accordance with the instructions provided in this product manual by designated, qualified and competent personnel.

4. Installation shall comply with all applicable federal, state, and local sanitary, construction, plumbing and regulatory codes.

5. Improper installation, start-up, operation, maintenance, or service may void the warranty.

6. When installing, commissioning or servicing this product:

   a. ALWAYS ensure that all steam and water supply, recirculation, and return lines are isolated.

   b. ALWAYS carefully relieve any residual internal pressure in the system or connecting pipe work before breaking or loosening any plumbing joints.

   c. ALWAYS allow hot parts to cool before commencing work, to avoid the risk of burns.

   d. ALWAYS wear appropriate personal protective equipment (PPE) before carrying out any installation or maintenance work

Warning and Cautions

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 instructions. If you can not reach your gas supplier, call the fire department.

WARNING! If the information in this manual is not followed exactly, a fire or explosion may result causing property damage, personal injury or death. Injury or death and property damage are possible.

WARNING! These appliances MUST be installed by a properly licensed individual in the City and State which the unit is being installed. All start up adjustments and subsequent service work must be done by a similarly licensed contractor or a factory trained service individual. Failure to comply could result in loss of warranty and or severe personal injury, death and or substantial property damage. These instructions are required to be kept with the appliance on the left side, in the pocket provided.

WARNING!

- **The vent system is rated and designed to be 2 pipe sealed combustion only, PVC SCH 40 or CPVC SCH 40 or 80 or AL 29-4C stainless venting for all models. A factory engineered venting system may allow for exceptions; consult factory for details.**
- **This heater installation must conform to the latest edition of the "National fuel gas code" ANSI Z223.1 NFPA 54 and/or CAN/CGAB149 Installation codes. State and local codes might also apply to Installation.**
- **Where required by the authority having jurisdiction, the installation must conform to the standards for controls and safety devices for automatically fired heaters, ansi/asme heater and pressure vessel code, Section IV, along with CSD-1.**
- **The heater, gas piping, water piping, venting and electrical must be installed by trained & qualified personnel familiar with installation practices, local code, and licensing requirements.**
- **If the information in these instructions are 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.**

UL 795-2011/CSA3.4
ANSI Z21.13-2014/CSA 4.9-2014
UL 795-2011/CSA 3.4
SCAQMD 1146.2

New York
EA 425-05-E

Massachusetts
C1-0319-441

SCAQMD
Compliant Rule1146.2

CEC Listed
California Energy Commission

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General Information

How It Operates

The ABH product line is an extremely high efficiency water heating product, requiring special venting and condensate removal precautions. All high efficiency condensing appliances will require more maintenance (cleaning) than their non-condensing counterparts. Failure to do so may result in damage to the appliance that is not covered under warranty. Failure to follow all of the instructions contained in this manual may also cause premature product failure that may not be covered under warranty.

This appliance has built-in freeze protection, automatically activating the circulation pump when the internal water temperature drops below 41°F (5°C). If the internal water temperature drops to 37°F (2.8°C), a burn cycle will be initiated and will shut down as soon as the supply water temperature has reached 50°F (10°C). Power and gas must be left on for this function to operate.

The appliance's primary controller the HOT™ BCB and BDB boards operate all functions of needed control and safety. It contains sophisticated logic that allows it to operate at very precise temperatures while minimizing burner on/off cycling. When multiple units are operated as a Cascade to handle a common load, the control logic contains the ability to control all of the units as efficiently as one. Cascade operation is a factory-installed and programmed option, requiring a field wiring connection between appliances for operation.

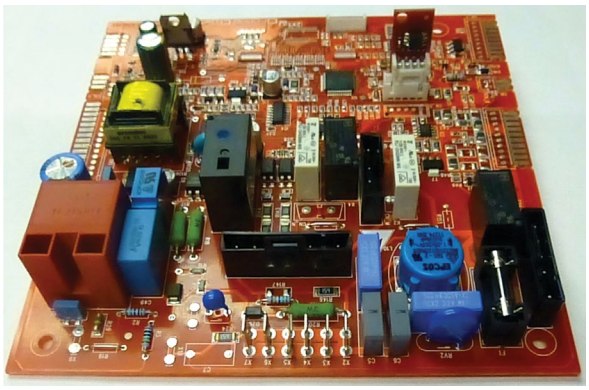
BCB= the internal Boiler Control Board.
BDB = the Boiler Display Board; human interface.
CCB = the Cascade Control Board, located in the external box.
CDB = the Cascade Display Board, human interface located in the face of the external box.

General Information - continued

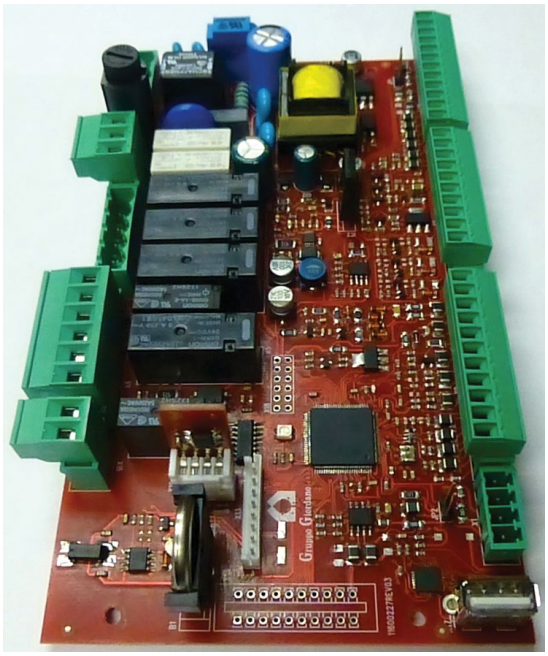
ABH Hot Controls Special Section

BDB—Boiler Display Board

BCB—Boiler Control Board

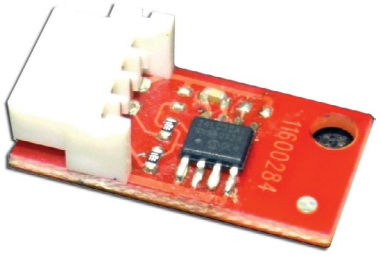


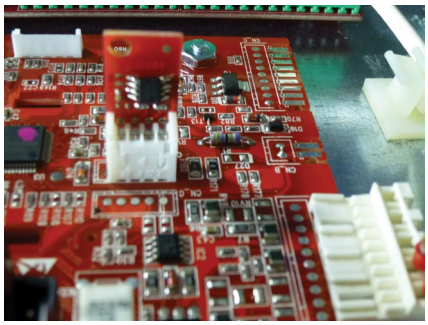
CCB – Cascade Control Board



CDB - Cascade Display Board

EDB – Eeprom Data Board – contains all operating parameters of CCB and BCB





General Information - continued

Glossary

APS
Air pressure switch

BCB
Boiler Control Board

BDB
Boiler Display Board

Blocking
Limit situation is touched, boiler OFF;
when the safe situation is restored, boiler On.

CCB
Cascade Control Board

CDB
Cascade Display Board

CH
Central Heating

Condensate
Water vapor generated as a product of combustion, which has a low pH.

DHL
Double High Limit

iDHW
Domestic Hot Water

Diverter Valve
Motorized valve with spring return

DHW
Direct Hot Water production (instantaneous)

Hard Lock Out (HLO)
A significant error or issue with the appliance or system, such as multiple failures to light or an unsafe pressure differential. An error code at this level will trigger a shutdown of the affected appliance(s). Service or repair is required.

HLO
Hard Lock Out—Manual needed to energize the boiler

HMI
Human Machine Interface

Hysterese
Blocking set temperature+ offset temperature—hysterese is starting temperature for the boiler.

ICM
Interface Cascade Manager (with or without WiFi)

Indirect Tank
Sanitary hot water tank with a built in heat exchanger

INI
Baseline data initialization, runs by default every 14 days

Lead-Lag System
If plant production is operating heavily, the lead-lag system will bring in the secondary boilers to help spread out the load. When the lead-lag system senses that production has dropped off, it then shuts those secondary boilers down again.

Modbus
For Ethernet or RS232 or RS485 bus system for Lead and Leg communication

Offset
Overriding temperature above set blocking: boiler OFF

PAVO
Zone controller

PCB
Printed circuit board—burner control board

Soft Lock Out (SLO)
Manual or App Rest needed to energize the boiler

Tank
Sanitary Hot Water Tank without internal Heat exchanger

3-Way-Valve
Motorized valve: turning to the right and to the left

Par
Parameter

n.a.
Not applicable. Constant value.

TBD
To be defined

Z-INI
First INI process

General Information - continued

ABH Dimensions

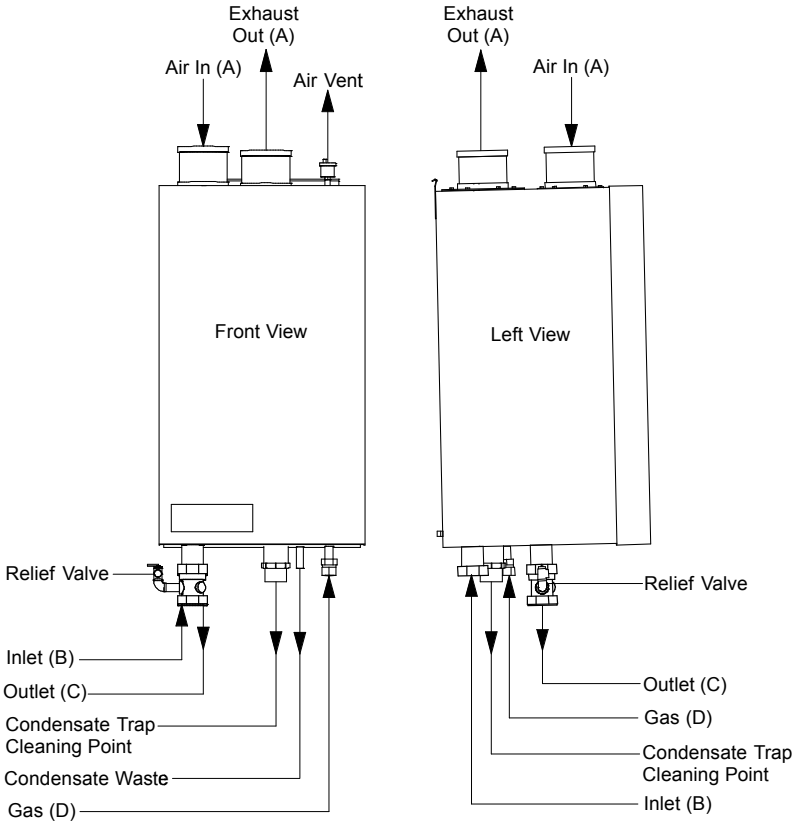


Figure 1.1 - ABH Dimensions

Table 1.1 ABH Dimensions

Model	Width		Height		Depth		A		B		C		D	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
ABH 299	18.9	480	44.9	1140	19.3	490	4	101	1.5	38	1.5	38	.75	19
ABH 399	18.9	480	45.2	1148	19.3	490	4	101	2	50	2	50	.75	19
ABH 599	18.9	480	47.2	1199	27	686	5	127	2	50	2	50	1	25

Table 1.2 ABH Information

Model	Input		Water Heater* Output		Recovery @ 100˚FΔT (55.6 ˚CΔT)		Recovery @ 80˚FΔT (44.5 ˚CΔT)		Recovery @ 60˚FΔT (33.3 ˚CΔT)		Water Flow Rate & Pressure Drop	
	BTU/hr	kW	BTU/hr	kW	GPH	LPH	GPH	LPH	GPH	LPH	GPM@FT	LPM@M
ABH 299	300,000	88	up to 291,000	up to 85	360	1363	450	1703	600	2271	16.5@22.9’	62@7M
ABH 399	399,999	117	up to 387,999	up to 114	466	1764	582	2203	776	2937	26.4@20.3’	100@6M
ABH 599	630,000	185	up to 611,100	up to 179	734	2778	917	3471	1223	4629	39.6@23.6’	150@7M

*At 97% thermal efficiency with 86ºF (38°C) incoming water to heat exchanger

**At 95% thermal efficiency with 140ºF (60°C) incoming water to heat exchanger

General Information - continued

Pre-Installation Requirements

The ABH models 299–599 are designed to be installed using a factory designed and supplied rack or frame (see Figure 1.3 for details). Consult factory for details of wall mount bracket. It can be installed in alcoves, basements, and utility rooms, as well as standard equipment rooms. Choose a location for your ABH, centralized to the piping system, along with consideration for Electrical (page 12), Gas Connection (page 14), Venting (page 19), and Condensate Drain (page 28).

The ABH heat exchanger must be level as installed, and the mounting surface must be designed to support the weight (see previous page, Table 1.2 for weights). Be sure the appliance is adequately secured to the mounting surface.

The front cover is secured by a threaded screw and two clasp style latches; it can only be installed one way. **When removing the front cover of the ABH unit, you must make sure all electric power to the appliance is turned off.** Then remove the screw at the bottom of the panel, undo the latches and remove the cover (see Figure 1.4 on the next page).

If the ABH is set up for liquefied petroleum (LP) gas, some geographic areas follow the Uniform Mechanical Code, section 304.6, "Liquefied petroleum gas burning appliances shall not be installed in a pit, basement or similar location where heavier-than-air gas might collect. Appliances so fueled shall not be installed in a below grade under-floor space or basement **unless such location is provided with an approved means for removal of unburned gas."**

Note: A water chemistry analysis should be performed prior to any installation. If the water quality exceeds any of the following levels, then a water chemistry analysis must be performed:

- **Water hardness can be no more than 12 grains (205 ppm or mg/l)**
- **TDS (total dissolved solids) can be no more than 450 ppm or mg/l**
- **PH—below 6.5 or above 7.5**

For total combined hardness over 15 grains (250 ppm or mg/l) or longer pipe lengths, contact Armstrong Hot Water, Inc. for correct pump sizing. Combined, the hardness and TDS can be no more than 450 ppm. Our internal term for this is the TCH (Total Combined Hardness).

Recommended Service Clearances

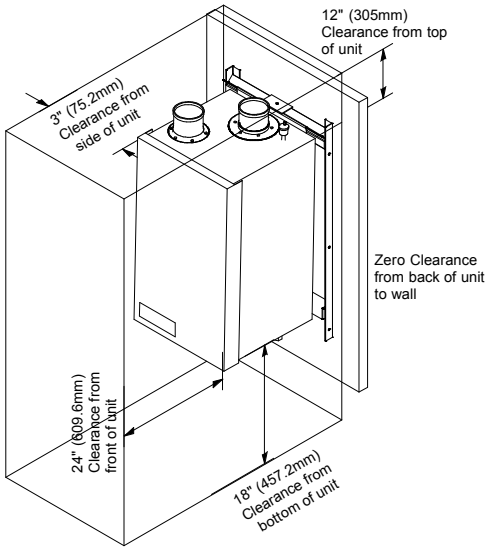


Figure 1.2 - ABH Clearances
Note: The ABH is rated at zero clearance to combustibles.

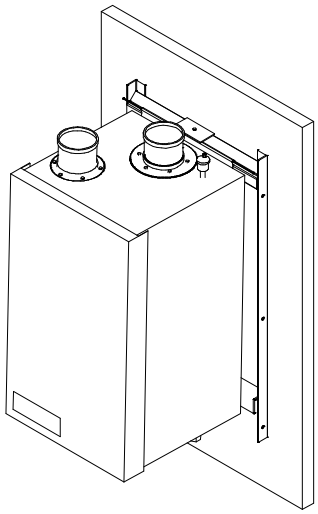


Figure 1.3 - ABH Mounting Detail

General Information - continued

1. Turn off power to unit

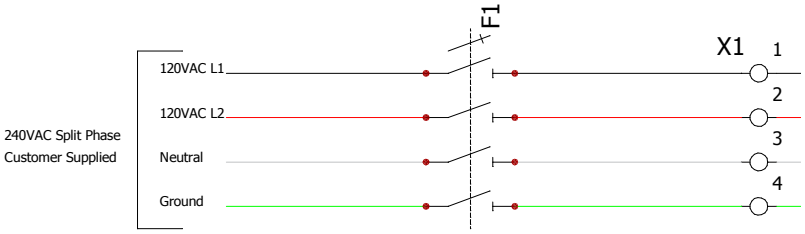
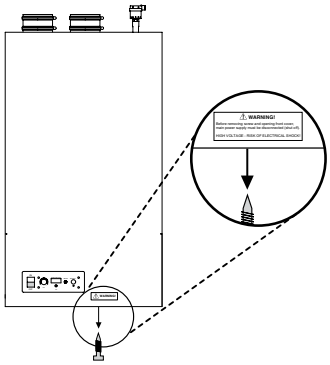


Figure 1.4 - How To Remove The Front Cover

2. Remove bottom screw(s)



WARNING! The ABH is certified as an indoor appliance. Do not install the ABH outdoors or location where it will be exposed to freezing temperatures. This includes all related piping and components. If the ABH is subjected to flood water or submersed in water, the ABH must be replaced.

NOTICE! Condensation Removal: This is a condensing, high efficiency appliance, therefore condensation removal must be addressed to avoid damage to surrounding area or appliance. See Venting Section for Condensate Requirements (page 26).

Pressure Relief Valve

WARNING! DO NOT, under any circumstances, thread a cap or plug into the relief valve! Explosion, severe personal injury, death, or major property damage may result.

This unit is supplied with a relief valve sized in accordance with ANSI/ASME Heater and Pressure Vessel Code, Section IV. The relief valve is installed near the hot water outlet. If the valve supplied is replaced, the pressure rating of the valve must not exceed the listed working pressure of this appliance, and must be rated to the proper BTU/hr capacity of the water heater. **DO NOT, under any circumstances, thread a cap or plug into the relief valve! Explosion, serious injury or death may result!** To prevent water damage, the relief valve piping must be directed to the floor or an open drain, but not connected directly. There must be a 6" space between the outlet of relief valve piping and drain or floor. Do not hook up to drain system directly without an air gap. Protect from freezing. Place no other valve between the relief valve and the unit. Do not install any reducing couplings or other restrictions in the discharge line. The discharge line must allow complete drainage of the valve and line. Manually operate the relief valve at least once a year.

Also, care must be exercised when choosing the location of this appliance, where leakage from the relief valve, leakage from related piping, or leakage from the tank or connections, will not result in damage to the surrounding areas, or to the lower floors of the building. A water heating appliance should always be located in an area with a floor drain or installed in a drain pan suitable for water heating appliances. Under no circumstances, shall Armstrong Hot Water, Inc. be held liable for any such water damage whatsoever.

Electrical

Electrical Connection / Requirements

The electrical connection for the ABH is on the bottom of the unit. There is a 1/2" knockout location for an electrical connection for the heater's incoming power connection. All electrical wiring must be performed by a qualified licensed electrician in accordance with National Electrical Code ANSI/NFPA and/or the Canadian Electrical Code, Part 1 CSA C22.1, or to any applicable local codes and standards. For your convenience, all the points for electrical connections needed to operate the ABH are labeled.

NOTE: Always check electrical ground to known earth ground; if less than 0.5 ohms, ground is sufficient (meter MUST be on lowest setting).

We recommend a simplified test, differing from one looking for building earth ground issues, it is our intent to use this test as an indicator of equipment room (boiler or water heater) electrical grounding issues, or equipment bonding issues, not prove the earth ground to the building.

Take an Ohm meter and place one lead on a known earth ground (not the ground wire on the boiler), and place the other lead on either 1) The near boiler system piping, 2) The boiler heat exchanger, or 3) The boiler cabinet.

If any of those readings exceed 0.5 Ohms, then it is a good indicator that there may be sufficient stray current flowing through the water in the piping system to accelerate or amplify conditions that can cause pump, boiler or piping issues in the not too distant future.

If any readings are over 0.5 ohms, an electrician should be brought in to correct the problem.

The electrical requirements are for standard 208–240 volts, 50/60 Hz 15 Amp service. This unit is wired with #18 awg and internally fused for no more than 3.15 Amps. When the unit is first powered on, there is a self-setting of the electronics for 50 Hz or 60 Hz. At every power up, the electronics will take a couple of seconds to compare the pulses of the power to the pulses of the crystal, which is built into the electronics. Then all time-related functions are correct no matter the power source.

The electrical requirements are for standard 208–240 volt split phase, 50/60 Hz 15 Amp service. When the unit is first powered on, there is a self-setting of the electronics for 50 Hz or 60 Hz. At every power up, the electronics will take a couple of seconds to compare the pulses of the power to the pulses of the crystal, which is built into the electronics. Then all time-related functions are correct no matter the power source.

The standard supplied pumps are all 208–240 VAC, 60 cycle and are to be wired to terminals indicated on the appliance. In 50 cycle applications, other pumps may need to be supplied, depending on water conditions.

Internal Wiring Connection

CAUTION! The incoming power shall be connected directly to the labeled, intended connection points only. Failure to do so may result in an electrical short and the control board will have to be replaced!

DANGER! It is extremely important that this unit be properly grounded! It is very important that the building ground is inspected by a qualified electrician prior to making this connection!

Failure to confirm proper grounding and the absence of stray voltage may result in premature component failure.
See start up and commissioning documents (Start Up Checklist) for details.

Terminal G (see Appendix) in the electrical compartment must be connected to the building ground system.

The incoming 208–240 volt single phase power supply is connected to terminals L1, L2 and N (see Appendix).

It is important that the electrical power is not turned on at this time. Double check all connections and then turn the power on. The display that is provided with the ABH should now be reading the Setpoint temperature.

NOTE: See Start-Up Procedures Section Page 36 to change the temperature setting or run the appliance.

Electrical - continued

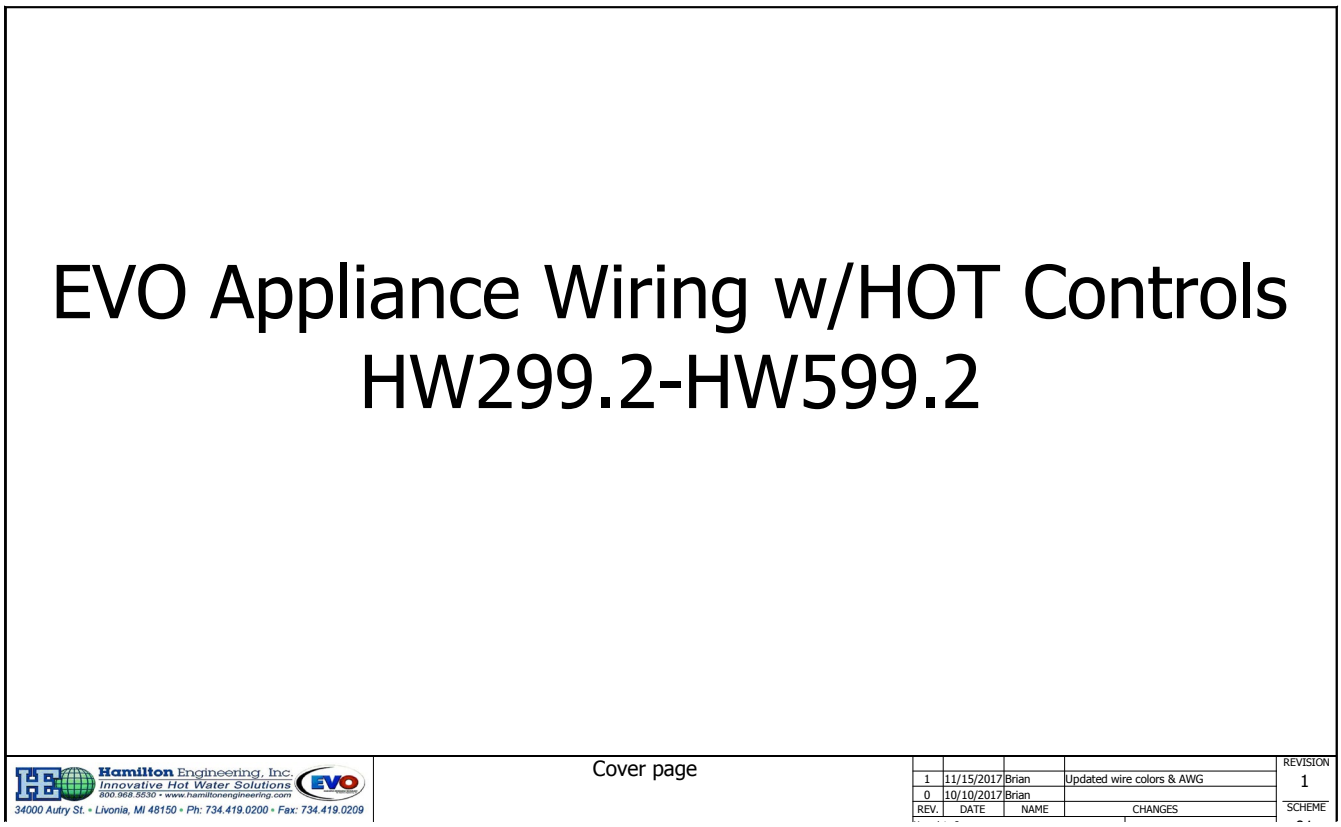


Figure 2.1 Field Wiring Connections

A. Outdoor Sensor — outdoor air sensor, set point will adjust based on outdoor air temperature (not needed if 0-10 VDC output is connected)

B. External Sensor Connection — system temperature sensor, senses water temp in a heating loop.

C. Tank Sensor — Sensor for indirect or direct DHW. An aquastat may also be connected here.

D. 0–10 VDC — connect a 0–10 VDC output here to vary set point temperature.

E. Additional Heat Demand — dry contacts that will close a thermostat on an extra heater/boiler if the boiler is at 100% of capacity.

F. Fault Service — alarm bell or light may be connected here to indicate that the boiler is a hard lockout.

G. Room Thermostat — normally jumped. A room thermostat may be connected here to enable/disable the heater/boiler.

H. Cascade Connection — communication cables get connected here and “daisy chained” to all heaters/boilers in a cascade. This is polarity sensitive.

I. 3-Way Diverter Valve — Used in a boiler system with both Heating and Indirect Hot Water.

J. P2 — Pump for indirect. Used in a boiler system with both Heating and Indirect Hot Water.

K. P1 — Wire to primary pump for boilers and heaters.

L. P3 — Wire to system pump for boilers.

Gas Connection

Gas Connection

DANGER! Failure to follow all precautions could result in fire, explosion or death!

The gas supply shall have a maximum inlet pressure of less than 14" water column (1/2 PSI) (3.44 kPa), and a minimum of 4" water column. The entire piping system, gas meter and regulator must be sized properly to prevent pressure drop greater than 1" as stated in the National Fuel Gas Code. This information is listed on the rating plate. **It is very important that you are connected to the type of gas as noted on the rating plate,** "LP" for liquefied petroleum, propane gas or "Nat" for natural or city gas. All gas connections must be approved by the local gas supplier, or utility in addition to the governing authority, prior to turning the gas supply on. It is mandatory that a drip leg be fabricated, as per the National Fuel Gas code. Once all the inspections have been performed, the piping must be leak tested. It is recommended that a soapy solution be used to detect leaks. Bubbles will appear on the pipe to indicate a leak is present. If the leak test requirement is a higher test pressure than the maximum inlet pressure, you must isolate the ABH from the gas line. In order to do this, you must shut the gas off using factory and field-installed gas cocks (following the Lighting Instructions page 36.) This will prevent high pressure from reaching the valve. Failure to do so may damage the gas valve. In the event the gas valve is exposed to a pressure greater than 14" water column, the gas valve must be replaced.

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

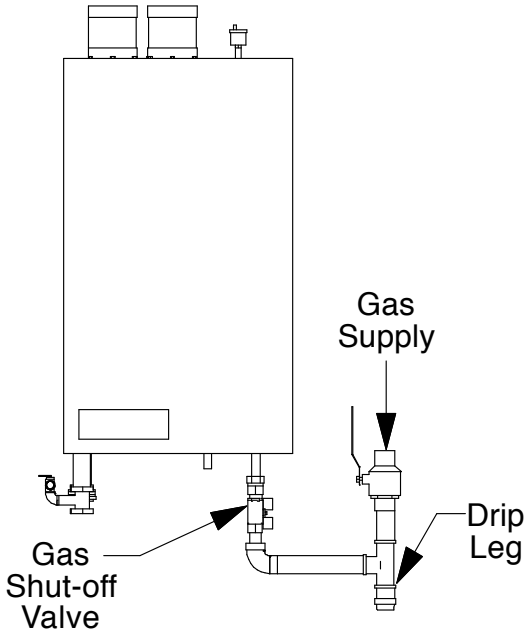


Figure 3.1 - ABH GAS CONNECTION

B. Gas Piping

The gas piping must be sized for the proper flow and length of pipe, to avoid pressure drop. Both the gas meter and the gas regulator must be properly sized for the total gas load. If you experience a pressure drop greater than 1" WC, the meter, regulator or gas line is undersized or in need of service. You can attach a manometer to port 3 of the gas valve (see Figures 3.2 and 3.3 on the following page). Alternatively, you can attach the manometer to the incoming gas drip leg, by removing the cap and installing the manometer. The gas pressure must remain between 4" and 14" during stand-by (static) mode and while in operating (dynamic) mode. **If an in-line regulator is used, it must be a minimum of 10 equivalent feet from the ABH. It is very important that the gas line is properly purged by the gas supplier or utility. Failure to properly purge the lines or improper line sizing, will result in ignition failure.** This problem is especially noticeable in NEW LP installations and also in empty tank situations. This can also occur when a utility company shuts off service to an area to provide maintenance to their lines. This gas valve must not be replaced with a conventional gas valve under any circumstances. As an additional safety feature, this gas valve is easily de-coupled from the fan inlet.

Refer to the following tables to size the supply piping to minimize pressure drop between meter or regulator and unit.

Gas Connection - Continued

Gas Tables

TABLE 3.1 Natural Gas Supply Piping

Nominal Iron Pipe	Internal Diameter	Length of Pipe - Feet (Meter)													
Size (in.)	(inches)	**10 (3)**	**20 (6)**	**30 (9)**	**40 (12)**	**50 (15)**	**60 (18**	**70 (21)**	**80 (24)**	**90 (27)**	**100 (30)**	**125 (38)**	**150 (46)**	**200 (61)**	BTUs per HR x 1,000
3/4	0.824	363 (106.4)	249 (73)	200 (58.6)	171 (50.1)	152 (44.5)	138 (40.4)	127 (37.2)	118 (34.6)	111 (32.5)	104 (30.5)	93 (27.3)	84 (24.6)	72 (21)	
1	1.049	684 (200)	470 (137.7)	377 (110.5)	323 (94.7)	286 (83.8)	259 (76)	239 (70)	222 (65)	208 (61)	197 (57.7)	174 (51)	158 (46.3)	135 (39.5)	
1-1/4	1.380	1,404 (411.5)	965 (282.8)	775 (227)	663 (194.3)	588 (172)	532 (156)	490 (143.6)	456 (133.6)	428 (125.4)	404 (118.4)	358 (105)	324 (95)	278 (81.5)	
1-1/2	1.610	2,103 (616)	1,445 (423.5)	1,161 (340.2)	993 (291)	880 (258)	798 (233.9)	734 (215)	683 (200)	641 (187.9)	605 (117.3)	536 (157)	486 (142.4)	419 (122.8)	
2	2.067	4,050 (1187)	2,784 (816)	2,235 (655)	1,913 (560.6)	1,696 (497)	1,536 (450)	1,413 (414)	1,315 (3854.4)	1,234 (361.7)	1,165 (341.4)	1,033 (302.7)	936 (274.3)	801 (235)	

(Based on 0.60 specific gravity for natural gas at 0.5" WC pressure drop; DOE standard is 1100 BTU per cubic foot of natural gas).

1 Run the gas supply line in accordance with all applicable codes.
2. Locate and install manual shut off valves in accordance with state and local requirements.

Table 3.2 Propane Supply Piping (Based On 11" WC Supply Pressure)

Nominal Iron Pipe	Internal Diameter	Length of Pipe - Feet (Meter)													
Size (in.)	**(inches)**	**10 (3)**	**20 (6)**	**30 (9)**	**40 (12)**	**50 (15)**	**60 (18)**	**70 (21)**	**80 (24)**	**90 (27)**	**100 (30)**	**125 (38)**	**150 (46)**	**200 (61)**	BTUs per HR x 1,000
3/4	0.824	567 (166)	393 (115.2)	315 (92.3)	267 (78)	237 (69.5)	217 (53.6)	196 (57.4)	185 (54.2)	173 (50.7)	162 (47.5)	146 (42.8)	132 (39)	112 (32.8)	
1	1.049	1,071 (314)	732 (214.5)	570 (167)	504 (147.7)	448 (131.3)	409 (120)	378 (110.8)	346 (101)	322 (94.4)	307 (90)	275 (80.5)	352 (103)	213 (62.4)	
1-1/4	1.380	2,205 (646)	1,496 (438.4)	1,212 (355)	1,039 (304.5)	913 (257.6)	834 (244)	771 (226)	724 (212)	677 (198.4)	630 (185)	567 (166)	511 (150)	440 (129)	
1-1/2	1.610	3,307 (969)	2,299 (673.8)	1,858 (544.5)	1,559 (457)	1,417 (415.3)	1,275 (373.7)	1,181 (346)	1,086 (318)	1,023 (300)	976 (286)	866 (253.8)	787 (230.5)	675 (198)	
2	2.067	6,221 (1823)	4,331 (1259)	3,465 (986)	2,992 (877)	2,646 (775.5)	2,394 (701.6)	2,205 (646)	2,047 (600)	1,921 (563)	1,811 (530.7)	1,606 (470.7)	1,496 (438.4)	1,260 (370)	

Gas Connection - Continued

Gas Valve Setup

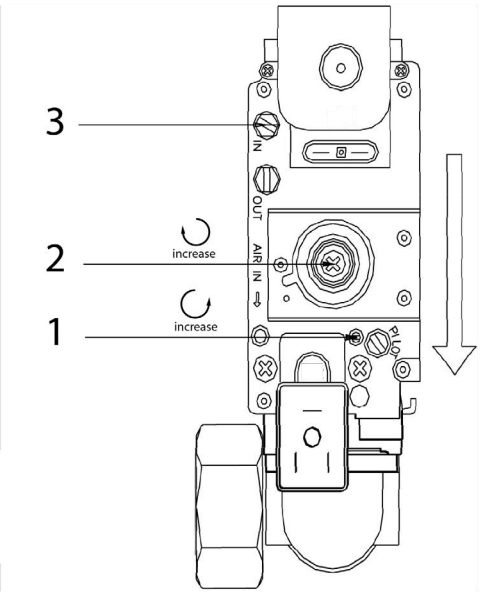


Figure 3.2 - ABH Models 299–399

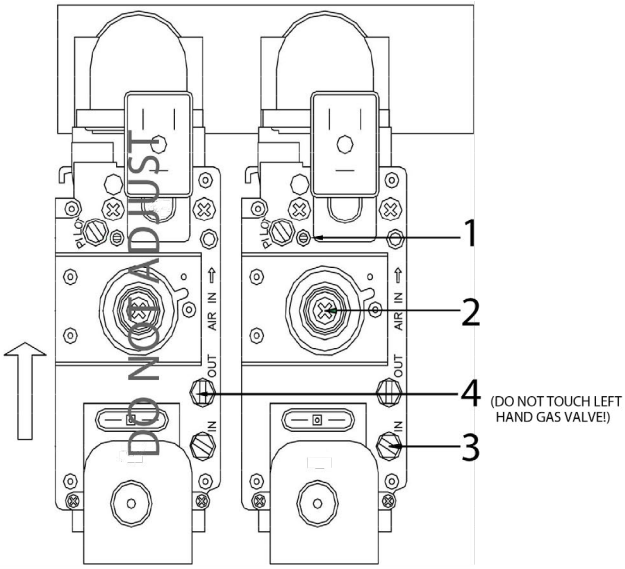


Figure 3.3 - ABH Model 599

See Start-Up Procedures Section (page 36) Before Continuing

Proper gas volume and pressure is critical to the operation of any high efficiency appliance. There are three types of measurements that must be taken to provide the data to insure product performance:

- Lock-up pressure (pressure in gas piping at appliance inlet with no load) may not exceed 14” wc. at any time!
- Minimum load at ignition of a single unit in a multiple unit rack
- Maximum load—all appliances on at full fire that are being tested and any other gas fired equipment on the same gas supply.

How and where to measure:

- All gas pressure tests must be taken at the gas manifold inlet, external to the ABH (see diagram).
- Gas pressure for minimum load should be measured the moment after the gas valve opens on a single ABH, and recorded.
- Gas pressure for maximum load shall be measured with all units on at full fire and all other connected loads on that gas supply running
- Gas pressure drop shall not exceed 1” wc. between minimum load and maximum load as described above.

Gas Connection - Continued

Figure 3.4 - Gas Pressure Testing Points

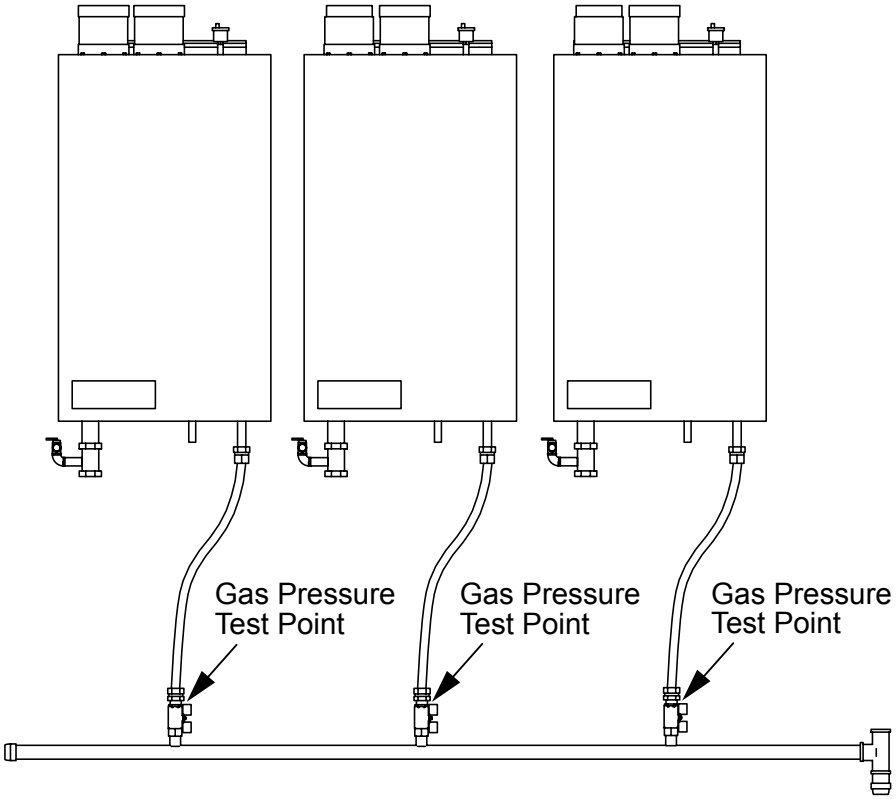


Table 3.3 Combustion & Fuel Related Adjustment Table

	Natural Gas CO_2		Natural Gas CO ppm	LP Gas CO_2		LP Gas CO ppm
	Cover On	Cover Off	Approximate, do not use for setup!	Cover On	Cover Off	Approximate, do not use for setup!
LOW FIRE	8.5%	8.3%	Less than 10	9.6%	9.4%	Less than 15
HIGH FIRE	8.8%	8.6%	Less than 110	10.0%	9.8%	Less than 120

NOTE: All adjustments must be made with the appliance door off, which will lower the CO_2 reading 0.2%. See tables above for specific readings.

When checking or replacing a gas valve, the CO_2 percentage in the flue gas is the preferred measuring method to insure proper combustion and firing rate. CO is used as the (temporary) alternate.

Changing incoming air temperature may vary the CO_2 setting slightly (~0.2–0.6%) after initial set up. This is not cause for concern or reason to set up again. After one year of operation, set up is required again.

If your appliance will be operated in an area that has inlet air temperature variations greater than 80ºF, please use the following table in adjusting your CO_2 for optimum performance.

Table 3.4 Co2 Adjustment Table

Inlet air ΔT variation	Setup at minimum incoming air temperature	Setup at maximum incoming air temperature
80ºF (26.7ºC)	Reduce CO_2 0.2%	Increase CO_2 0.2%
100ºF (37.8ºC)	Reduce CO_2 0.3%	Increase CO_2 0.3%
120ºF (48.9ºC)	Reduce CO_2 0.4%	Increase CO_2 0.4%

Gas Connection - Continued

Setting The Maximum Load

A means of sampling the leaving flue gas is built into the vent connector on top of the appliance. Remove the rubber plug for testing and replace when testing is completed. This plug MUST be in place during normal operation.

Enter the service function from the setup menu. After the service function is active, fan speed percentage can be set. This should be set to 100% to achieve maximum fan speed for high fire combustion setting.

If necessary, turn the adjusting slot [1], which sets the high fire performance, either counterclockwise to increase the CO_2 percentage or clockwise to reduce the CO_2 percentage, as shown in Figures 3.2 and 3.3, page 15. Appropriate CO_2 percentages are shown in Table 3.3 above.

Table 3.5 Fan Speed Requirements

HW 299		
Fan Type	**Maximum RPM**	**Minimum RPM**
EBM	6300	1575
Ametek	6500	1625

HW 399		
Fan Type	**Maximum RPM**	**Minimum RPM**
EBM	6200	1798
Ametek	7200	1800

HW 599		
Fan Type	**Maximum RPM**	**Minimum RPM**
EBM	5800	1624
Ametek	9300	2511

Setting The Minimum Load

Set the minimum load once the maximum load has been set, set the fan speed in the service function to the minimum RPM setting. In order to set or adjust the minimum load, turn the screw [2] for the minimum setting (first remove the protective cap). Turn the screw clockwise to increase or counter clockwise to decrease the CO2 percentage. On the HW 599, you only are allowed to set the gas valve at the right side; the left gas valve is set by the manufacturer. **See Gas Valve Maintenance/Replacement Section for special instructions on replacing both gas valves in a model 599.**

1. If the measuring process takes more than 40 minutes, the appliance will return to the automatic mode. If so required, enter the Service function another time.
2. When you are done setting the valve, press stop in the Service function to return to normal run mode

Please do not forget to replace the protective cap on the gas valve!

Gas Conversion

If the appliance is to be converted in the field for using Propane (LPG), the following steps must be taken:

- Turn screw [1] clockwise (Figure 3.2) ¾ of one turn (270°) on models 299 and 1 full turn (360°) on model HW399.
- On model HW599 (Figure 3.3) turn screw on left hand valve closed (clockwise) and turn right valve 1-¾ f a full turn clockwise.
- Run the appliance. If the burner does not ignite after four starting efforts, turn the screw [1] one half turn back (180°) (counter clockwise).
- After conversion, follow the steps in for setting the maximum and minimum loads, using the LP gas values shown in Table 3.3.

Gas Connection - Continued

Gas Valve Maintenance/Replacement

1. When checking or replacing a gas valve, the CO_2 percentage in the flue gas is the preferred measuring method to insure proper combustion and firing rate. CO is used as the alternate.

2. Gas valve replacement for the HW 599:

The left hand gas valve (which is normally factory-set and sealed and must not be adjusted) must be set up to factory specifications before any combustion related adjustments can be performed on the right hand valve. An electronic manometer must be used, as it will be set to a scale of 0.01" WC.

The adjustment screw [1] (see Figure 3.3,) normally used for setting maximum flow rate must be turned counterclockwise until it begins to click when turned. The screw will not fall out, but will be fully retracted at this point.**This is for Natural Gas, for LP gas, close the left hand valve (clockwise) until it is closed down.**

The digital manometer must now be connected to the outlet pressure tapping [4] on the left hand valve only (marked do not adjust in Figure 3.3), and the appliance fired. It must be placed in the service mode and held at the minimum firing rate (**1653 rpm** fan speed). With the appliance firing at this rate, adjust the offset (minimum firing rate) screw [2] to a pressure of “0” +/- .0.01" WC. **Be sure the manometer has been zeroed out prior to making this setting.**

Once this operation is complete, you may follow the instructions for setting the minimum and maximum firing rate as shown in the Setting Maximum Load and Setting Minimum Load Sections for the **right hand gas valve only.**

WARNING! Failure to follow all precautions could result in fire, explosion, or death!

Venting

Approved Venting Materials

All vent pipe materials and fittings must comply with the following:			
Item	Material	Standards for installation in:	
		United States	Canada
Vent pipe and fittings	AL 29-4C Stainless	ANSI/ASTM UL1738	UL1738
	PVC schedule 40*	ANSI/ASTM D1785	CPVC and PVC venting must be ULC-S636 Certified. IPEX is an approved vent manufacturer in Canada supplying vent material listed to ULC-S636.
	CPVC schedule 40	ANSI/ASTM F441	
	Polypropylene	ULC-S636	ULC-S636
Pipe cement & primer	PVC	ANSI/ASTM D2564	IPEX System 636 Cements & Primers
	CPVC	ANSI/ASTM F493	
NOTICE: DO NOT USE CELLULAR (FOAM) CORE PIPE			

NOTE: Venting system may contain one or more of the above materials.

The ABH is a direct vent appliance. The ABH is listed as a Category IV. Condensing Appliance. (The ABH Venting is rated at Zero Clearance to combustibles.)

SPECIAL VENTING SYSTEM DESIGN NOTES! The ABH efficiency testing and ratings are based on a sealed, two pipe vent system; however, many other vent configurations are available as factory engineered solutions. Please contact the factory if exceptions are required for your installation.

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.

WARNING! This vent system will operate with a positive pressure in the vent pipe. Do not connect vent connectors serving appliances by natural draft into any portion of mechanical draft systems operating under pressure.

NOTE: For concrete construction or to meet certain fire codes, exhaust and inlet piping at the wall penetration to the ABH must be CPVC Schedule 40 or 80 or stainless. The balance from the penetrated wall to the outside may be PVC Schedule 40 or 80.

NOTE: If set points exceed 140ºF, use of PVC is NOT recommended, even though product is approved as such. Contact Armstrong Hot Water, Inc. for further clarification.

Venting The ABH

Table 4.1 Venting Specifications

Model	Vent Diameter in (mm)	Standard Vent Type	Optional Vent Type	Minimum Combined Vent Length ft (m)	Maximum Combined Length ft (m)
HW 299	4" (101.5)	Plastic	Stainless	6' (1.8) + (2) 90º elbows	225' (68.6)
HW 399	4" (101.5)	Plastic	Stainless	6' (1.8) + (2) 90º elbows	180' (55)
HW 599	5" 127)	Stainless	Plastic - 6"*	6' (1.8) + (2) 90º elbows	200' (51)

**The use of 6" PVC will require the purchase of aspecial adapter from Armstrong Hot Water, Inc.*

Venting - continued

Table 4.2 Equivalent Feet	
Fittings or Piping	**Equivalent Feet (m)**
90 degree elbow	5' (1.5)
45 degree elbow	3' (0.9)
Coupling	0 (0)
Air inlet elbow	6' (1.8)
Exhaust coupling	1'(0.3)

The inlet and exhaust pipes on the top of the cabinet should be the diameter and material indicated in the Venting Specifications Table above. It is very important that you plan the location properly to eliminate long pipe runs and excessive fittings. Inlet pipe size must not be reduced. Do not combine the inlet air or exhaust with any other inlet or exhaust pipe including either to an additional similar appliance, unless you have purchased an engineered Common Venting System from Armstrong Hot Water, Inc. The joints must be properly cleaned, primed and cemented if plastic, and sealed per the manufacturer's instructions if stainless. The piping must also be properly supported as per Local and National Standard Plumbing Codes. It is important that the piping must be clean and free from burrs, debris, ragged ends and particles of PVC (if applicable).

Exhaust piping should be sloped back to the connection on the ABH, at least 1/4" per foot to remove additional condensate that forms within the pipe. The total combined length of pipe (intake piping plus exhaust piping added together) including elbow allowances intake and exhaust should not exceed the length shown in the vent table. The minimum combined vent length should not be less than a combined length of 6' (1.8m) plus two 90° elbows. Choose your vent termination locations carefully. You must also make certain that exhaust gas does not re-circulate back into the intake pipe. You must place them in an open area and follow the following guidelines:

NOTICE! The following are code restrictions for the location of the flue gas vent terminal. Compliance to these requirements doesn't insure a satisfactory installation; good common sense must also be applied. It is important to make sure that exhaust gases are not recirculated into the inlet air of the ABH. If there is any doubt, contact the factory BEFORE installing.

1. Never vent into a walkway, patio area, alley or otherwise public area less than 7'(2.1m) from the ground. (See detail below references Fig. A.12.9 in the National Fuel Gas Code 2009 "Exit Terminals of Mechanical Draft and Direct-Venting Systems;" see Figure 4.1.

2. Never vent over or under a window or a doorway where the exhaust plume or condensation liquid will cause obtrusive or dangerous conditions. (Refer to National Fuel Gas Code, CAN B149).

3. Never install a heat saver or similar product to capture waste heat from exhaust.

4. Always have a vent location at least 12" (305mm) above maximum snow level.

5. Always have vent a minimum of 24" (609mm) above ground level, away from shrubs and bushes.

6. Follow local gas codes in your region or refer to National Fuel Gas Code, Can B149.

7. Always have at least 36" (914mm) distance from an inside corner of the outside walls.

8. Maintain at least 48" (1219mm) clearance to electric, gas meters, windows, exhaust fans, chimneys, inlets or mechanical vents.

9. VERY IMPORTANT! The inlet air connection must be connected to outside air and should be located no closer than 8" (203mm) and no further than 24" (809mm) t othe exhaust.

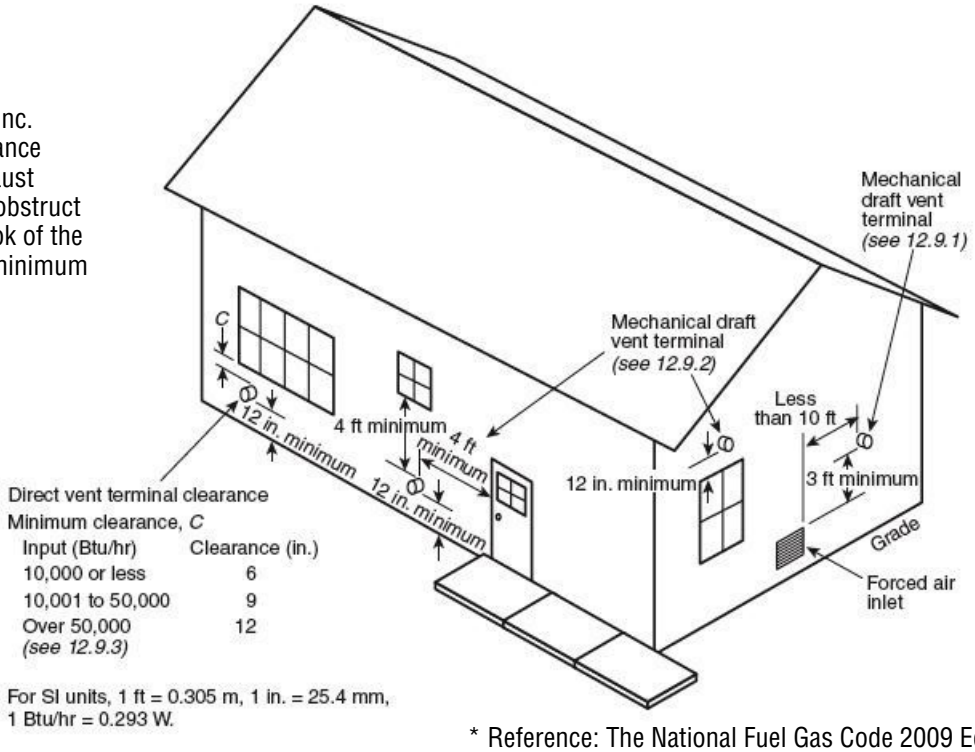
10. Always place screens in all openings in intake and exhaust to prevent foreign matter from entering the ABH.

11. The vent intake and exhaust must be properly cleaned and glued if plastic, and sealed per the manufacturer's directions if stainless for a pressure tight joint. Several methods for venting the ABH can be found in Figures 4.2 through 4.6 of this section. Use these layouts as guidelines: certain site conditions such as multiple roof lines/pitches may require venting modifications (consult Armstrong Hot Water, Inc.).

Venting - continued

Figure 4.1

*NOTE: Armstrong Hot Water, Inc. recommends a minimum clearance of 4 feet (1.2m) where the exhaust plume caused by the unit may obstruct views or affect the cosmetic look of the building. In canada, there is a minimum clearance of 10 feet (3m).



* Reference: The National Fuel Gas Code 2009 Edition

Through-the-Wall Vent Termination

1. A through-the-wall mechanical draft venting system shall terminate at least 3 ft (0.9 m) above any forced air inlet located within 10 ft (3 m).

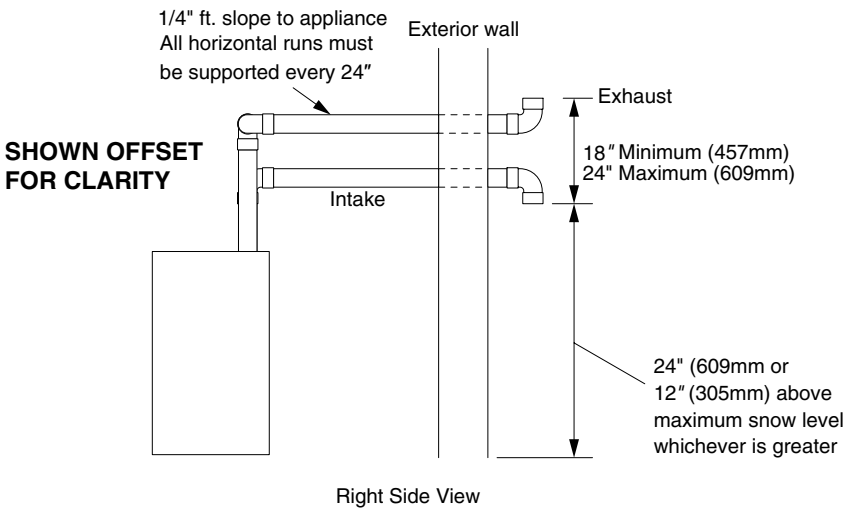
   Exception No. 1: This provision shall not apply to the combustion air intake of a direct vent appliance.
   Exception No. 2: This provision shall not apply to the separation of the integral outdoor air inlet and flue gas discharge of listed outdoor appliances.

2. A through-the-wall mechanical draft venting system of other than direct vent type shall terminate at least 4 ft (1.2 m) below, 4 ft (1.2 m) horizontally from, or 1 ft (300 mm) above any door, operable window, or gravity air inlet into any building. The bottom of the vent terminal shall be located at least 12 in. (300 mm) above finished ground level.

3. The through-the-wall vent terminal of a direct vent appliance with an input of 10,000 Btu/hr (3 kW) or less shall be located at least 6 in. (150 mm) from any air opening into a building, an appliance with an input over 10,000 Btu/hr (3 kW) but not over 50,000 Btu/hr (14.7 kW) shall be installed with a 9 in. (230 mm) vent termination clearance, and an appliance with an input over 50,000 Btu/hr (14.7 kW) shall have at least a 12 in. (300 mm) vent termination clearance. The bottom of the vent terminal and the air intake shall be located at least 12 in. (300 mm) above finished ground level.

Venting - continued

Figure 4.2 - Sidewall Vent With Down Elbow (Intake) & Up Elbow (Exhaust)



**IMPORTANT NOTE: All vent pipes must be glued, properly supported and the exhaust must be pitched a minimum of a 1/4" per foot back to the heater (to allow drainage of condensate). All stainless venting must be sealed at each joint per manufacturer's instructions.

NOTE: Exhaust must not terminate beneath an overhang!

VENTING FOR MULTIPLE UNITS, with vents all on same horizontal plane, spaced at least 8 inches apart, and at level of highest unit.

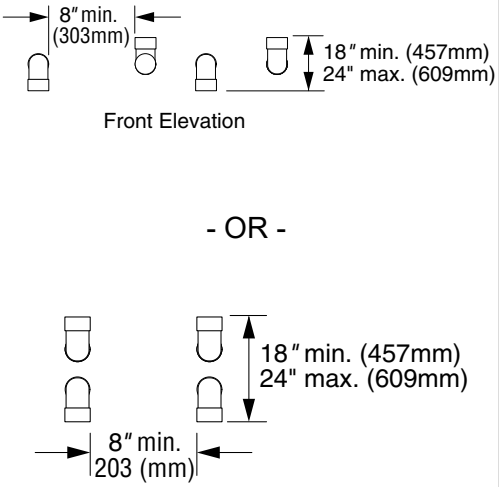
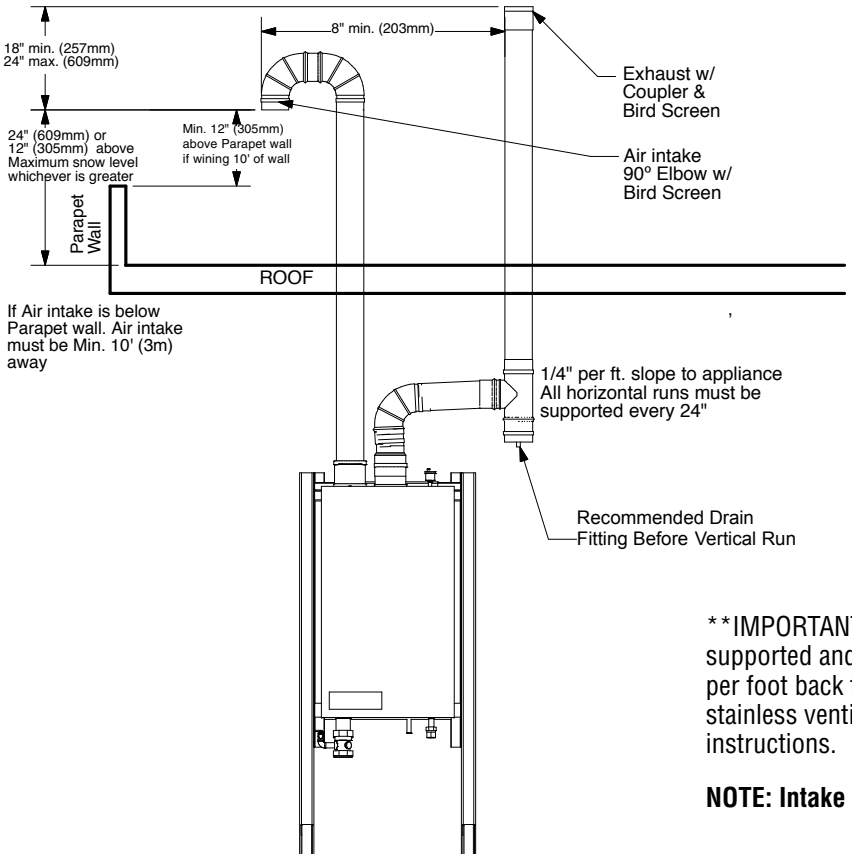


Figure 4.3 - Vertical Vent With Double Elbow (Intake) & Coupling (Exhaust)

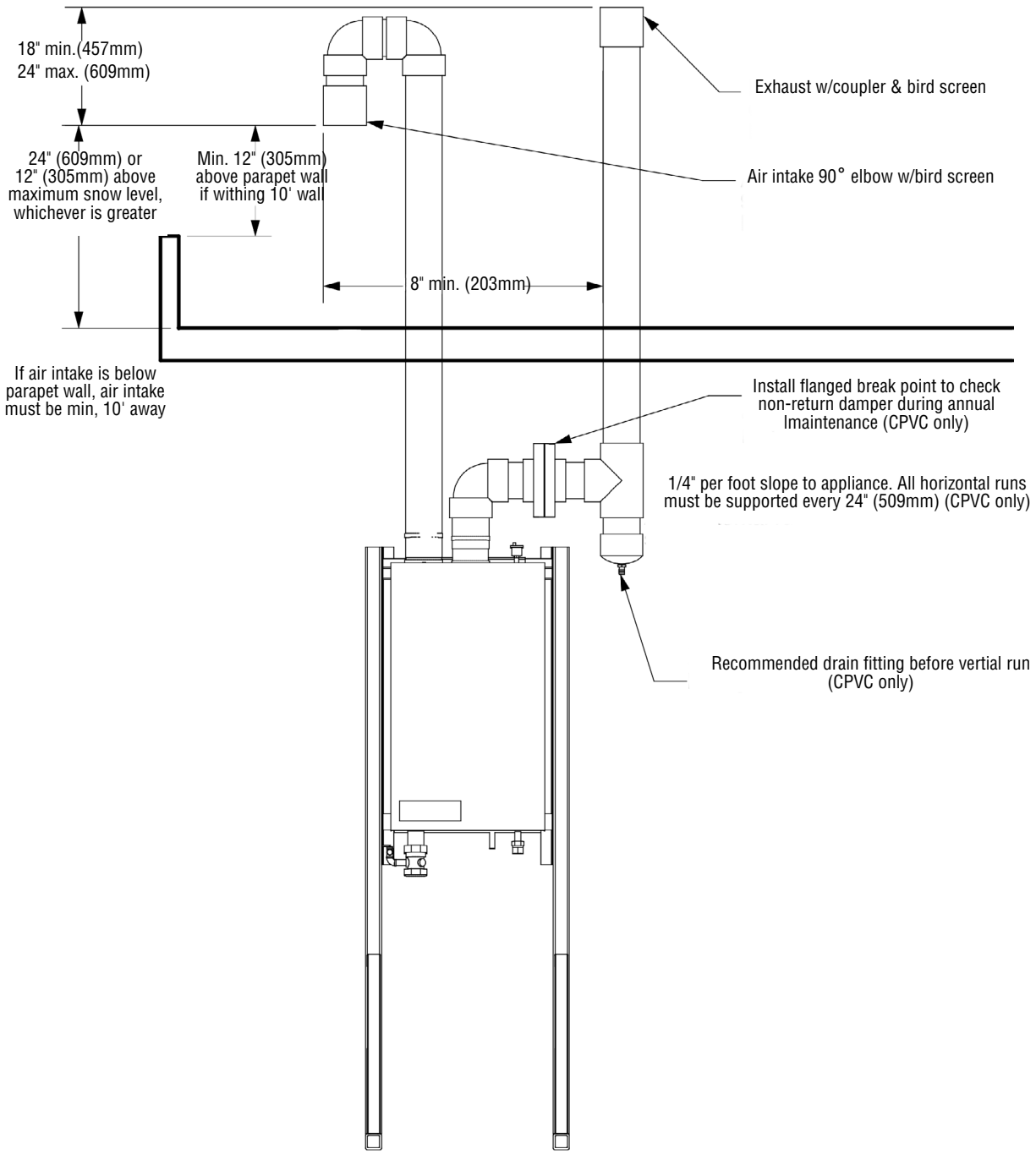


**IMPORTANT NOTE: All vent pipes must be glued, properly supported and the exhaust must be pitched a minimum of a 1/4" per foot back to the heater (to allow drainage of condensate). All stainless venting must be sealed at each joint per manufacturer's instructions.

NOTE: Intake must take into account any parapet walls.

Venting - continued

Figure 4.4 - Vertical Vent With PVC/CPVC



Venting - continued

Diagrams For Room Air Venting Termination

If you're using room air, your unit should be set up this way:

CAUTION! Flue Gas will condense as it exits the vent termination. This condensate can freeze on exterior building surfaces which may cause discoloration of these surfaces. Consideration should be given to the plume of condensation that exits the exhaust which may affect the cosmetic appearance of the building.

Figure 4.5 - Vertical Termination

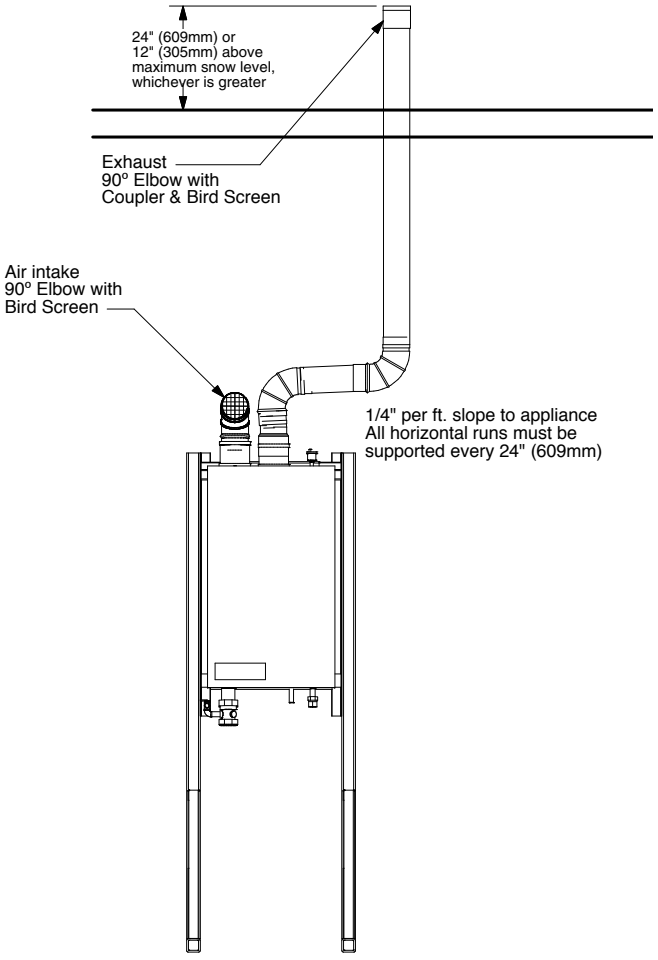
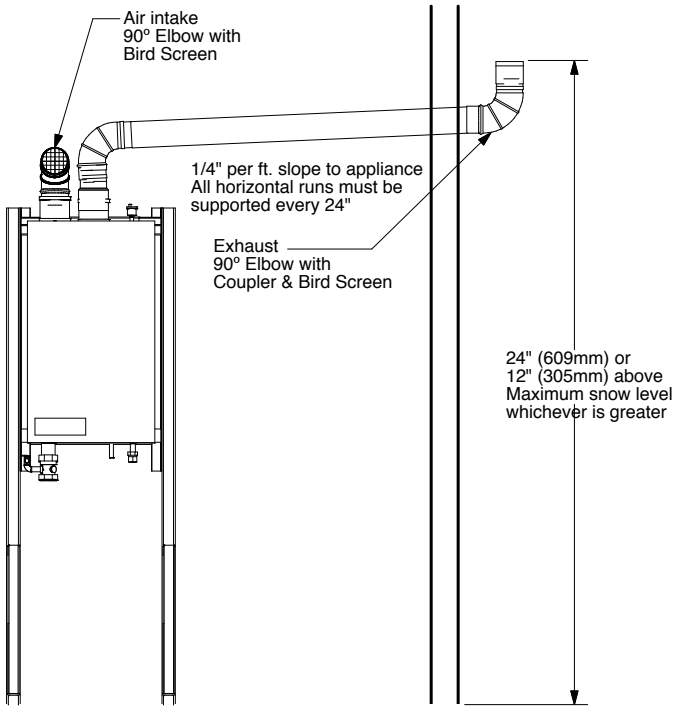


Figure 4.6 - Sidewall Termination



As long as the boiler room remains under a positive pressure under all operating conditions of the building, this is a perfectly acceptable option. Generally, all this requires is an external free air source; typically just two properly sized openings to the outdoors. Installations done in this manner must comply with ANSI Z223.1, NFPA 54—National Fuel Gas Code 2009 section 9.3, and any specific local codes that may require additional combustion air be provided. For the latest edition, see Technical Bulletin–TB 003. This would be our preferred alternate to our standard manual specifications.

NOTE: Stated efficiencies are based on ducted air; using room air may effect efficiency.

Venting - continued

Inlet Air Vent

You may use the same material as used for exhaust or any material that is the same diameter that provides a pressure tight connection. THIS IS ONLY FOR INLET AIR, NOT FOR EXHAUST PIPING!

The air inlet must be a minimum of 12" (305mm) vertically above the maximum snow level. It is very important that there are no other vents, chimneys or air inlets in any direction for at least 48" (1220mm).

All venting must be properly supported. The ABH is not intended to support any venting whatsoever. All piping, glue, solvents, cleaners, fittings and components, must conform to ASTM (American Society for Testing and Materials), and ANSI (American National Standards Institute).

Venting Runs That Exceed Maximum Combined Length

If the combined venting length of a heater's exhaust/inlet air system exceeds the Maximum Combined Length called out in Table 4.1 contact Armstrong Hot Water, Inc. for an engineered venting calculation. Do not proceed without calling Armstrong Hot Water, Inc.

VENT CALCULATION EXAMPLE: Installation requires the following material for both inlet and exhaust piping for the ABH HW 299.2 (maximum combined equivalent length is 225 feet (69m)).

Required: 6 Pcs. 90° elbow (6 x 5 = 30 equivalent feet) (1.8m x 1.5m = 9.1m)	= 30 equivalent feet (9.1m)
Required: 20' (6m) of Plastic PVC Pipe (20 x 1 = 20 equivalent feet) (6m x .3m = 6m)	= 20 equivalent feet (6m)
Required: Inlet air in vertical termination (2) 90° elbows + bird screen)	= 11 equivalent feet (3.3m)
Required: Exhaust coupling	= 1 equivalent foot (.3m)
Total Friction Loss in equivalent feet	= 62 equivalent feet (18.9m)

This Vent System Is Ok

DANGER! The ABH is not intended to be common vented with any other existing appliance! Multiple ABH products may be common vented, only if using an engineered system by Armstrong Hot Water, Inc.

Heater Removal From An Existing Common Vent System

At the time of removal of an existing heater, the following steps shall be followed with each appliance that remains connected to the common venting system placed in operation, while the other appliances that remain connected to common venting system are not operating.

1. Seal any unused openings in the common venting system. The ABH venting is NOT to be combined with this older venting system!
2. Visually inspect the venting system for proper size and horizontal pitch to determine if there is blockage, leakage, corrosion or other deficiencies that could cause an unsafe condition.
3. If practical, close all building doors, windows and all doors between the space in which the appliance remains connected to the common venting system and other spaces in the building. Turn on clothes dryers and any appliances not connected to the common venting system. Turn on any exhaust fans, such as range hoods and bathroom exhausts, at maximum speed. Do not operate a summer exhaust fan. Close all fireplace dampers.
4. Place the appliance being inspected in operation. Follow the lighting instructions. Adjust the thermostat so the appliance will operate continuously.

Venting - continued

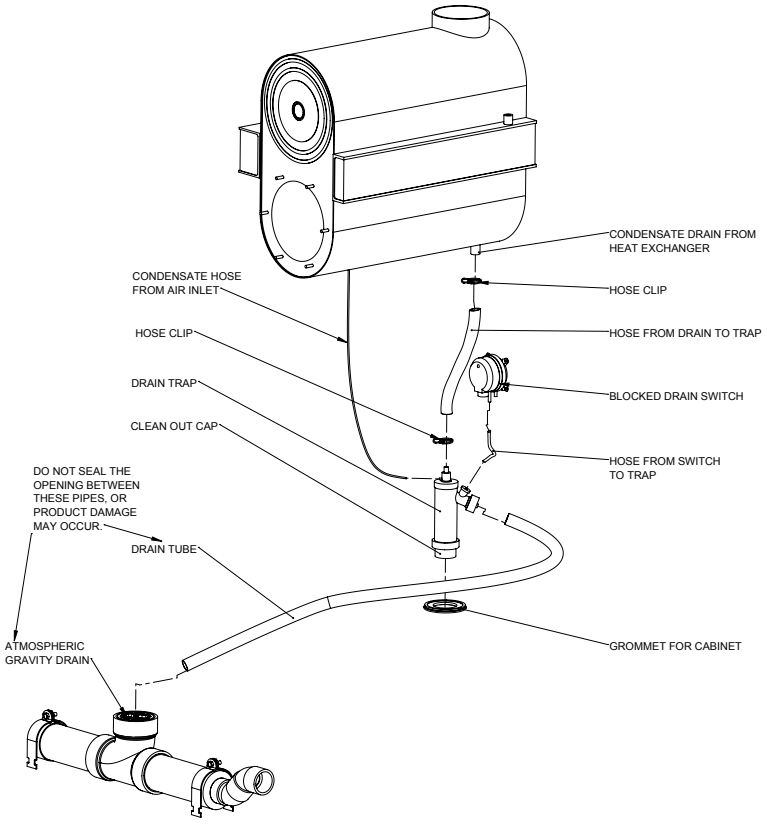
5. Test for spillage at the draft hood relief opening after 5 minutes of main burner operation. Use the flame of a match or candle or smoke from a cigarette.
6. After it has been determined that each appliance remaining connected to common venting system properly vents when tested as outlined, return doors, windows, exhaust fans, fireplace dampers and any other gas burning appliance to their previous condition of use.
7. Any improper operation of the common venting system should be corrected so the installation conforms with the National Fuel Gas Code, ANSI Z223.1. 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 Appendix G in the National Fuel Gas Code, ANSI Z 223.1

Condensate Requirements

This is a condensing high efficiency appliance, therefore this unit has a condensate removal system. Condensate is nothing more than water vapor derived from the combustion products, similar to an automobile when it is initially started. This condensate does have a low pH and should be treated with a Condensate Neutralizer Filter. This filter contains either lime or marble rocks, which will neutralize the condensate. The outlet of the filter is sized for 1.5" PVC pipe. **It is very important that the condensate line is sloped away from and down to a suitable inside drain.** A condensate neutralizer and a condensate pump kit are available from Armstrong Hot Water, Inc. It is also very important that the condensate line is not exposed to freezing temperatures, or any other type of blockage. Plastic tubing or PVC pipe should be the only materials used for the condensate line. Steel, brass, copper or others will be subject to corrosion and deterioration. A second vent may be necessary to prevent condensate line vacuum lock if a long horizontal run is used. The ABH appliance has an automatic safety device that will shut it down in the event of a condensate drain blockage. Please test annually.

Maximum volume of condensate produced is 11 gallons (41L) per hour per 1,000,000 BTU of gas burned.

Figure 4.7 - Condensate Drain Detail



NOTE: Heat exchanger MUST be level or pitched slightly to the rear.

WARNING! In a common vent system, DO NOT POWER THE UNIT OFF! Equipment damage may occur. To disable operation, turn off gas, NOT power. If you have any questions, please contact Armstrong Hot Water, Inc.

Piping

Hydronic Heating Boiler Piping

ABH is designed to function in a closed loop (minimum) 12 PSIG (.8barg) System. Never let the ABH operate without a minimum of 10 PSI water pressure, this assures that the ABH heat exchanger can be completely purged of air, failure to do so could cause damage. It is important to note that the ABH Boiler is flow dependent for proper efficiency and life expectancy; therefore, primary-secondary piping or use of a low loss header design is always recommended, as shown in the Figure 5.1 below. Each ABH Heating Boiler System should have an Air Eliminator, in addition to the heat exchanger mounted air vent, which will remove air from the Hydronic System. Always follow good piping practices. Observe minimum 1" (25.4mm) clearance to combustibles around all uninsulated hot water pipes, or when openings around pipes are not protected by non-combustible materials. On an ABH installed above the level of the highest heat transfer device, some state and local codes require a low water cut off device at the time of installation by the installer. A water flow switch is provided as standard and will take the place of a low water cut-off. If the ABH supplies hot water to heating coils in air handler units, flow control valves or other devices must be installed to prevent gravity circulation of boiler water in the coils during the cooling cycle.

Basic piping connection steps are listed below. A drawing, specific to your application can be obtained from your distributor or Armstrong Hot Water, Inc., which will guide you through proper installation of the ABH.

1. Pipe properly, in accordance with generally accepted piping principals or Armstrong Hot Water, Inc. specific documents.
2. Connect system return to the pipe entering the ABH closest to the back.
3. Connect system supply to the pipe leaving the ABH containing the Relief Valve.
4. Install Drain Valve on system supply.

NOTE: The ABH cannot be drained of water without purging the unit with air pressure, 15 PSIG (1barg) minimum. The system's air vent must be closed during this process.

Figure 5.1 - Boiler Piping

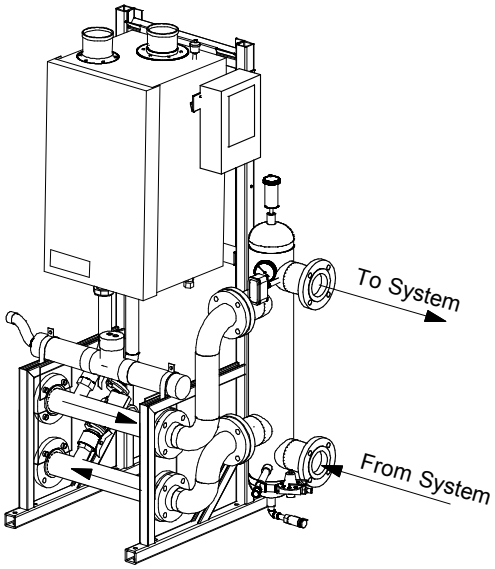


Table 5.1 Boiler Piping

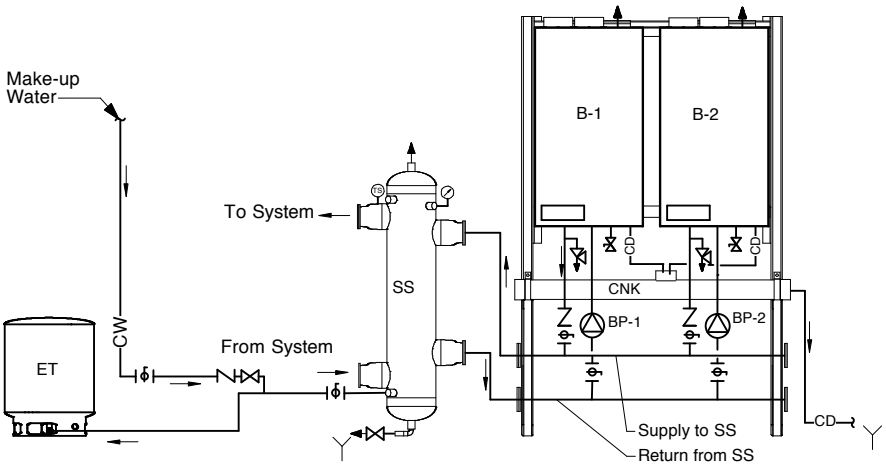
Model	Boiler Only GPM ΔP (LPM)	Design ΔT		Minimum Manifold Pipe Size			
				Single	Double	Triple	Quad
HW 299	11 @ 9.3' (41.5 - 2.8)	51.8° F	28.8° C	1.5"	1.5"	2"	2"
HW 399	17.6 @ 8.5' (66.6 - 3.5)	43.2° F	24.0° C	1.5"	2"	2"	2.5"
HW 599	26.4 @ 9.4' (100-2.8)	45.3° F	25.2° C	1.5"	2"	2.5"	3"

NOTE: Flow rates shown above are for clean, closed loop systems.

Piping - continued

Boiler Schematic Drawings

Two Boiler Schematic To Armstrong System Separator



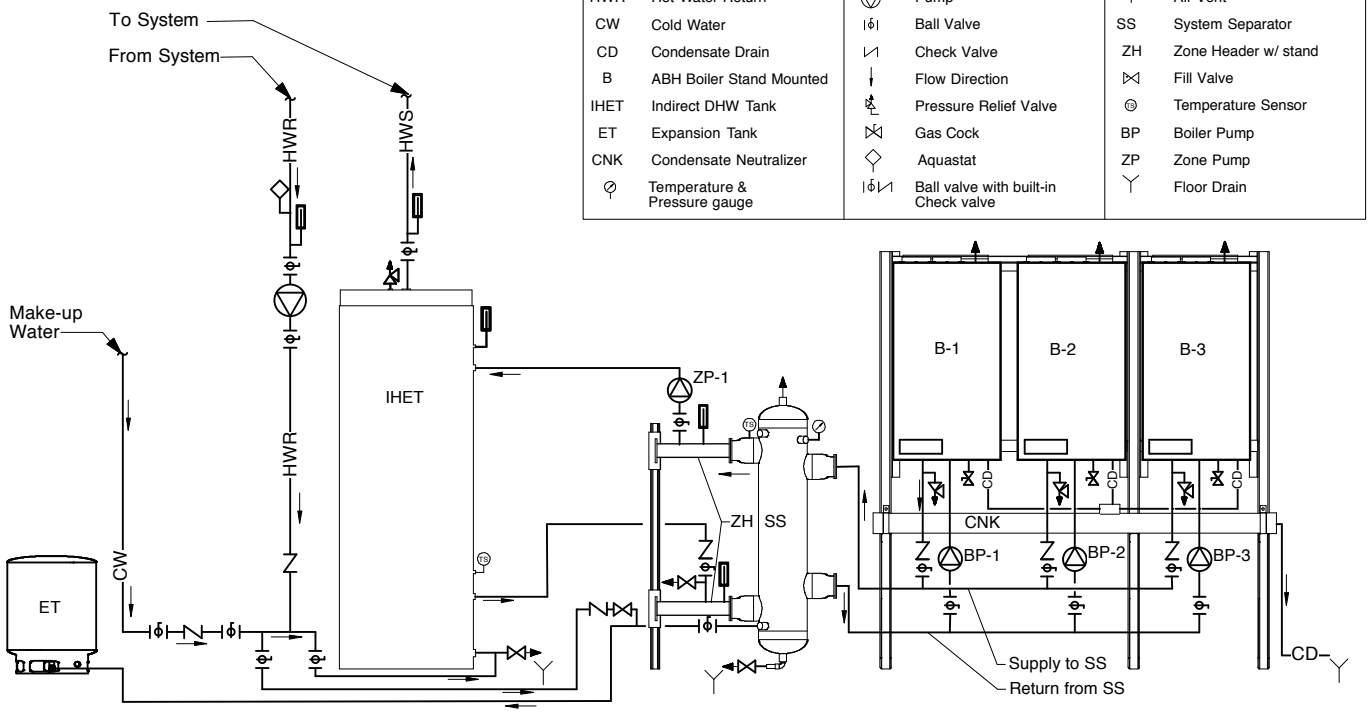
LEGEND

HWS	Hot Water Supply		Thermometer		
HWR	Hot Water Return		Pump		
CW	Cold Water		Ball valve		
CD	Condensate Drain		Fill Valve		
B	ABH Boiler Stand Mounted		Flow direction		
ET	Expansion Tank		Pressure Relief valve		
CNK	Condensate Neutralizer		Gas cock		
SS	System Separator		Floor Drain		
	Drain Valve		Temperature Sensor		
	Air Vent	BP	Boiler pump		
	Temperature & Pressure gauge		Ball Valve with built-in Check Valve		

Three Boiler Schematic To System Separator With One Zone For Indirect Hot Water Tank

LEGEND

HWS	Hot Water Supply		Thermometer		Drain Valve
HWR	Hot Water Return		Pump		Air Vent
CW	Cold Water		Ball Valve	SS	System Separator
CD	Condensate Drain		Check Valve	ZH	Zone Header w/ stand
B	ABH Boiler Stand Mounted		Flow Direction		Fill Valve
IHET	Indirect DHW Tank		Pressure Relief Valve		Temperature Sensor
ET	Expansion Tank		Gas Cock	BP	Boiler Pump
CNK	Condensate Neutralizer		Aquastat	ZP	Zone Pump
	Temperature & Pressure gauge		Ball valve with built-in Check valve		Floor Drain



IMPORTANT NOTE: The above are representative drawings; must conform to local codes. Consult factory for Custom System Solutions.

Piping - continued

Fill & Purge Heating System

1. Attach hose to balance and purge hose connector and run to drain.
2. Close the other side of the balance and purge valve.
3. Open first zone balance and purge valve, so as to let the water flow out of the hose. If zone valves are used, open zone valves one at a time, manually. (NOTE: please check manufacturer's instructions prior to opening valves manually, so as not to damage the valve.)
4. Manually operate fill valve regulator. When water runs out of hose, connected to the balance and purge valve, in steady stream (with no air bubbles), close balance and purge valve to stop the water from flowing. Disconnect hose and connect to next zone to be purged.
5. Repeat procedure for additional zones (one at a time).

Upon completion, make sure that the fill valve is in automatic position and each zone balance and purge valve is in the open position and zone valves are positioned for automatic operation.

NOTE: Installations that incorporate Standing Iron Radiators and systems with manual high point vents:

Follow the above procedure, then starting with nearest manual air vent, open vent until water flows out; close vent. Repeat procedure, working your way toward furthest air vent. It may be necessary to install a basket strainer or filtration in an older hydronic system where larger amounts of sediment may be present. Periodic cleaning of the strainer may be necessary.

For boiler water and/or odd water systems, please make note of these additional guidelines:

- **Thoroughly flush the system (without boiler connected) to remove sediment. The high-efficiency heat exchanger can be damaged by build-up or corrosion due to sediment.**
- **Do not use petroleum-based cleaning or sealing compounds in the boiler system. Gaskets and seals in the system may be damaged. This can result in substantial property damage.**
- **Do not use 'homemade cures' or 'boiler patent medicines'. Serious damage to the boiler, personnel, and/or property may result.**
- **Continual fresh make-up water will reduce boiler life. Mineral buildup in the heat exchanger reduces heat transfer, overheats the stainless steel heat exchanger, and causes failure. Addition of oxygen carried in by makeup water can cause internal corrosion in system components. Leaks in boiler or piping must be repaired at once to prevent makeup water.**

Removing Air From The Heat Exchanger

The ABH 299–599 has an automatic air vent on the top of the appliance and the air vent cap must be loosened to allow trapped air to escape when the appliance is initially filled and put into operation. If this air vent should start to leak, there are two possible solutions:

- Close the cap—the air vent is not needed anymore after the heat exchanger has been purged of air. This air vent MUST be operable if the appliance is drained and refilled.
- Replace the air vent. When replacing the air vent, the water must be shut off and pressure released first.

Piping - continued

Water Heating Piping

1. Use only the pipe sizes shown and a pump meeting the listed specifications in the following tables:

   *NOTE: Individual Appliance Piping pressure drop used in the tables is based on 20 feet of straight pipe, 6 elbows, 2 tees, 2 full port ball valves and 2 unions.

2. The city cold water supply to the water heating system should be connected between the heater outlet and the storage tank or the storage tank directly. This will help minimize unnecessary short cycling due to small hot water draws. Higher efficiency can be obtained through use of our optional CWIS™ - Cold Water Injection System in any Armstrong Hot Water, Inc. Storage Tank.

3. Isolation valves should be installed on each heater and on the cold and hot water system connections.

Upon completion of piping, fill and properly purge of all air. Open all valves and start circulating pump. Consult Armstrong Hot Water, Inc. for specific piping diagrams for your application.

NOTE: Minimum pump selection is based on piping sizes shown above and water hardness not to exceed 15 grains per gallon and total maximum equivalent piping length of 60 feet.

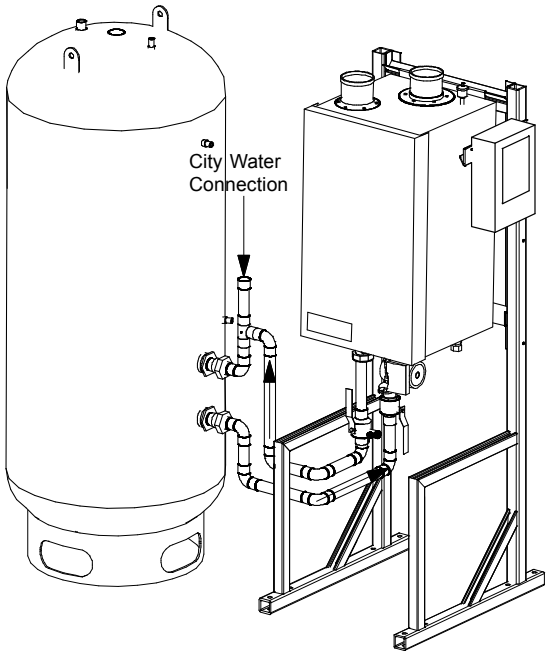


Table 5.2 Water Heater Piping

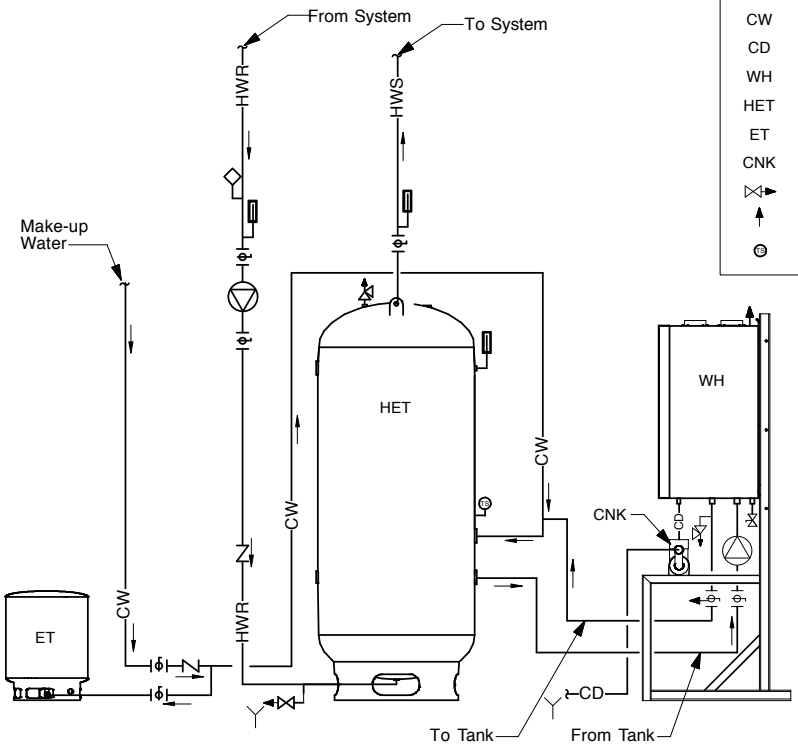
Model	GPM ΔP* (LPM)	Design ΔT		Minimum Manifold Pipe Size			
				Single	Double	Triple	Quad
HW 299	16.5 @ 22.9' 52.5-7m	35.3° F	19.6° C	1.5"	2"	2"	2.5"
HW 399	26.4 @ 20.3' 100-6m	29.4° F	16.3° C	2"	2"	2.5"	3"
HW 599	39.6 @ 23.6' 150-7m	30.9° F	17.1° C	2"	2.5"	3"	4"

*Water heater and piping as described above.

Piping - continued

Water Heating Schematic Drawings

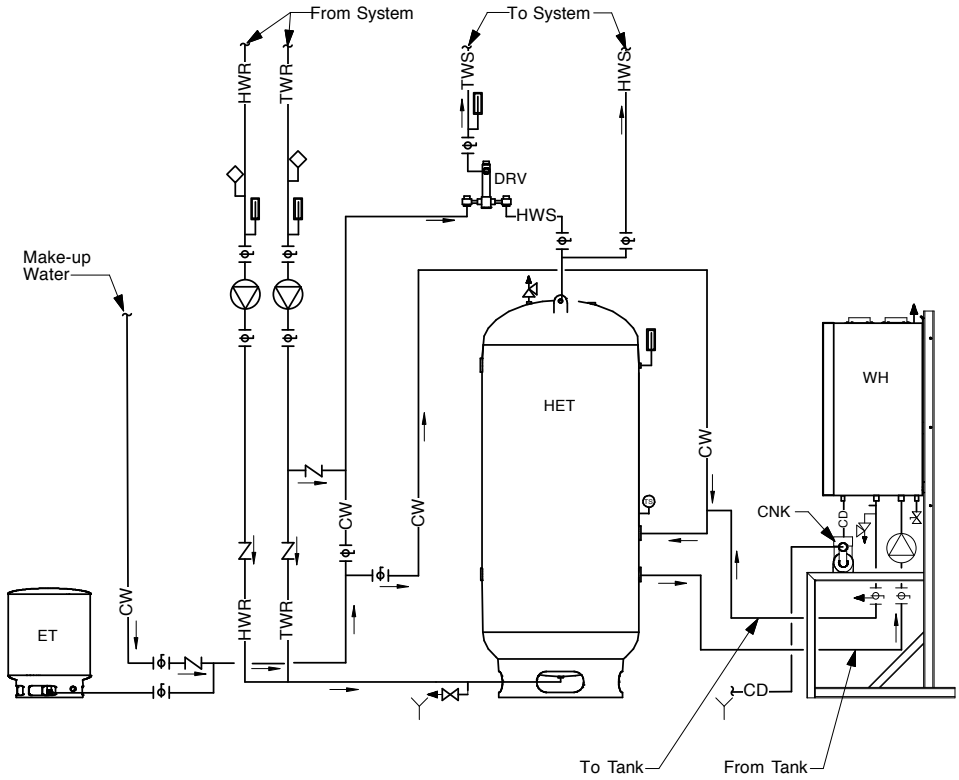
One Water Heater Schematic To Single Tank



LEGEND

HWS	Hot Water Supply		Thermometer
HWR	Hot Water Return		Pump
CW	Cold Water		Ball valve
CD	Condensate Drain		Check valve
WH	Water Heater with Stand		Aquastat
HET	Storage Tank		Flow direction
ET	Expansion Tank		Pressure Relief valve
CNK	Condensate Neutralizer		Ball Valve with built-in Drain Valve
	Drain valve		Gas cock
	Air vent		Floor drain
	Temperature Sensor		

One Water Heater Schematic To Single Tank With Mixing Valves



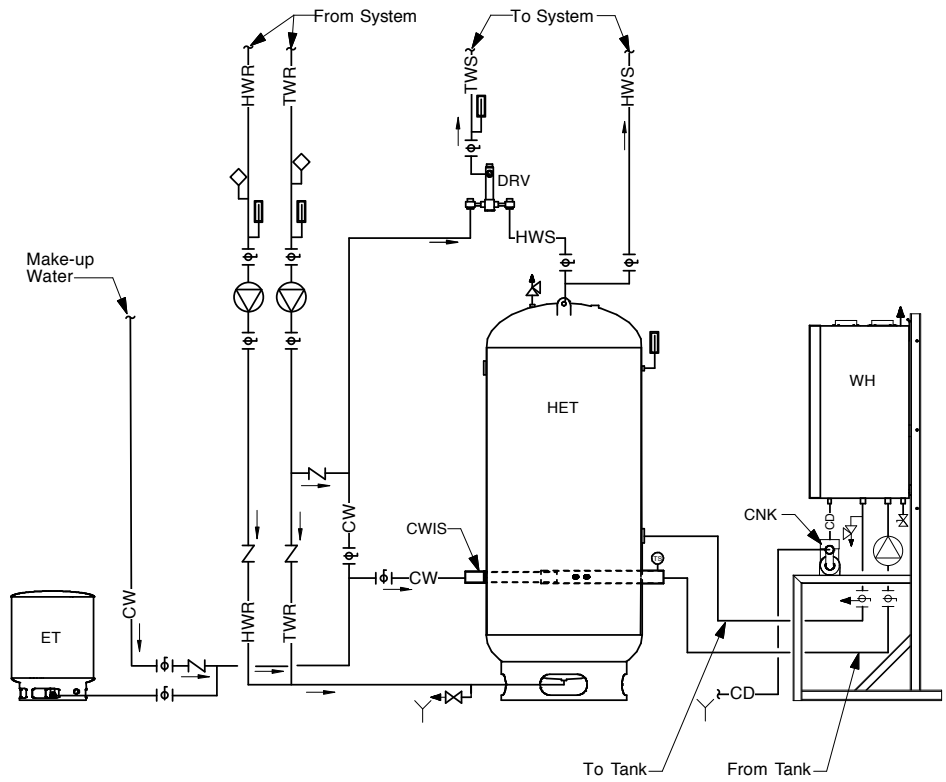
LEGEND

HWS	Hot Water Supply
HWR	Hot Water Return
CW	Cold Water
TWS	Tempered Water Supply
TWR	Tempered Water Return
CD	Condensate Drain
WH	Water Heater with Stand
HET	Storage Tank
ET	Expansion Tank
CNK	Condensate Neutralizer
DRV	Digital Recirculation Valve
	Thermometer
	Pump
	Ball valve
	Check valve
	Aquastat
	Flow direction
	Pressure Relief valve
	Ball Valve with built-in Drain Valve
	Gas cock
	Drain valve
	Air vent
	Temperature Sensor
	Floor drain

IMPORTANT NOTE: The above are representative drawings; must conform to local codes. Consult factory for Custom System Solutions.

Piping - continued

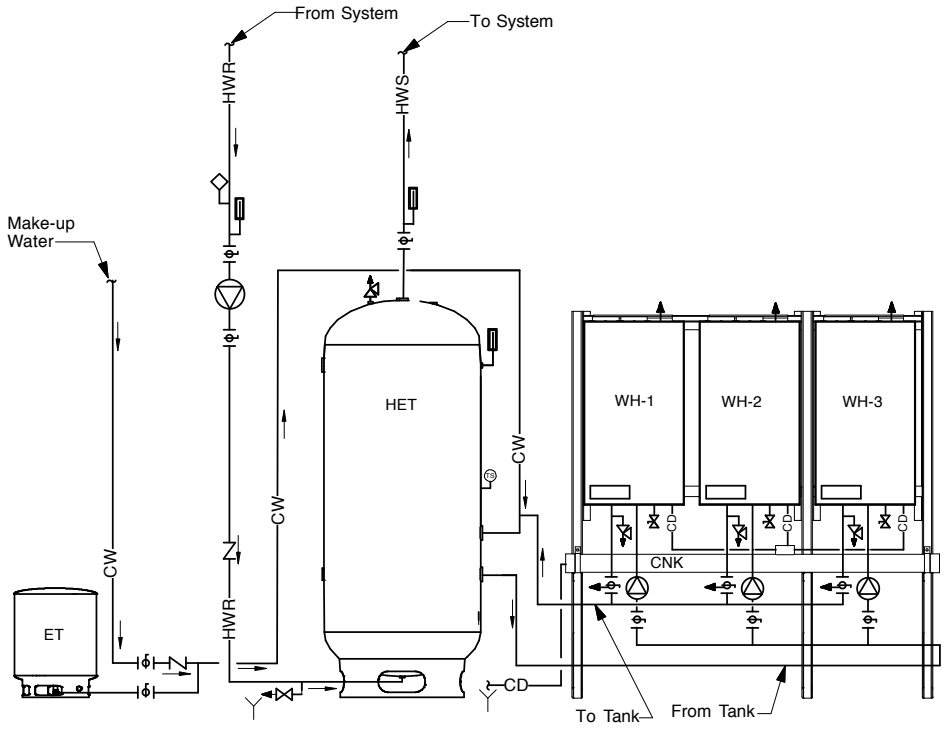
One Water Heater Schematic To Single Tank With Mixing Valve And CWIS™



LEGEND

HWS	Hot Water Supply
HWR	Hot Water Return
CW	Cold Water
TWS	Tempered Water Supply
TWR	Tempered Water Return
CD	Condensate Drain
WH	Water Heater with Stand
HET	Storage Tank
ET	Expansion Tank
CNK	Condensate Neutralizer
DRV	Digital Recirculation Valve
	Thermometer
	Pump
	Ball valve
	Check valve
	Aquastat
	Flow direction
	Pressure Relief valve
	Ball Valve with built-in Drain Valve
	Gas cock
	Drain valve
	Air vent
	Temperature Sensor
	Floor drain
CWIS	Cold Water Injection System

Three Water Heater Schematic To Single Tank



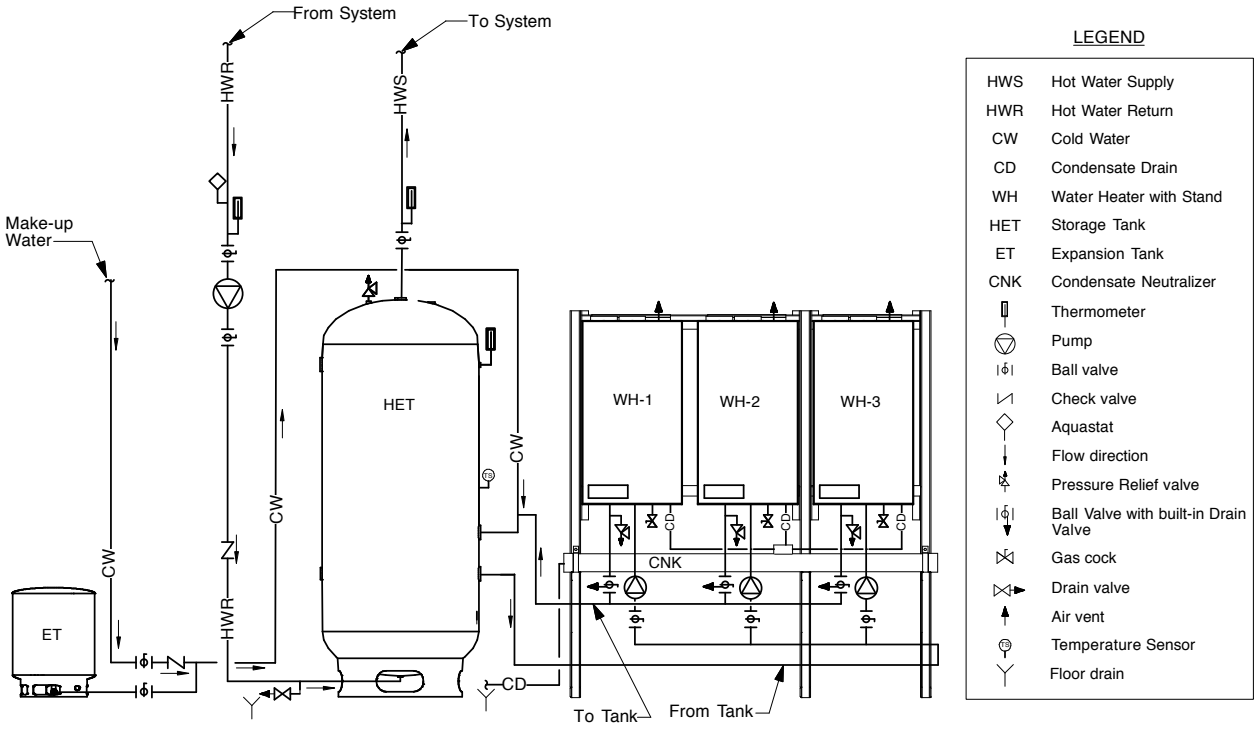
LEGEND

HWS	Hot Water Supply
HWR	Hot Water Return
CW	Cold Water
CD	Condensate Drain
WH	Water Heater with Stand
HET	Storage Tank
ET	Expansion Tank
CNK	Condensate Neutralizer
	Thermometer
	Pump
	Ball valve
	Check valve
	Aquastat
	Flow direction
	Pressure Relief valve
	Ball Valve with built-in Drain Valve
	Gas cock
	Drain valve
	Air vent
	Temperature Sensor
	Floor drain

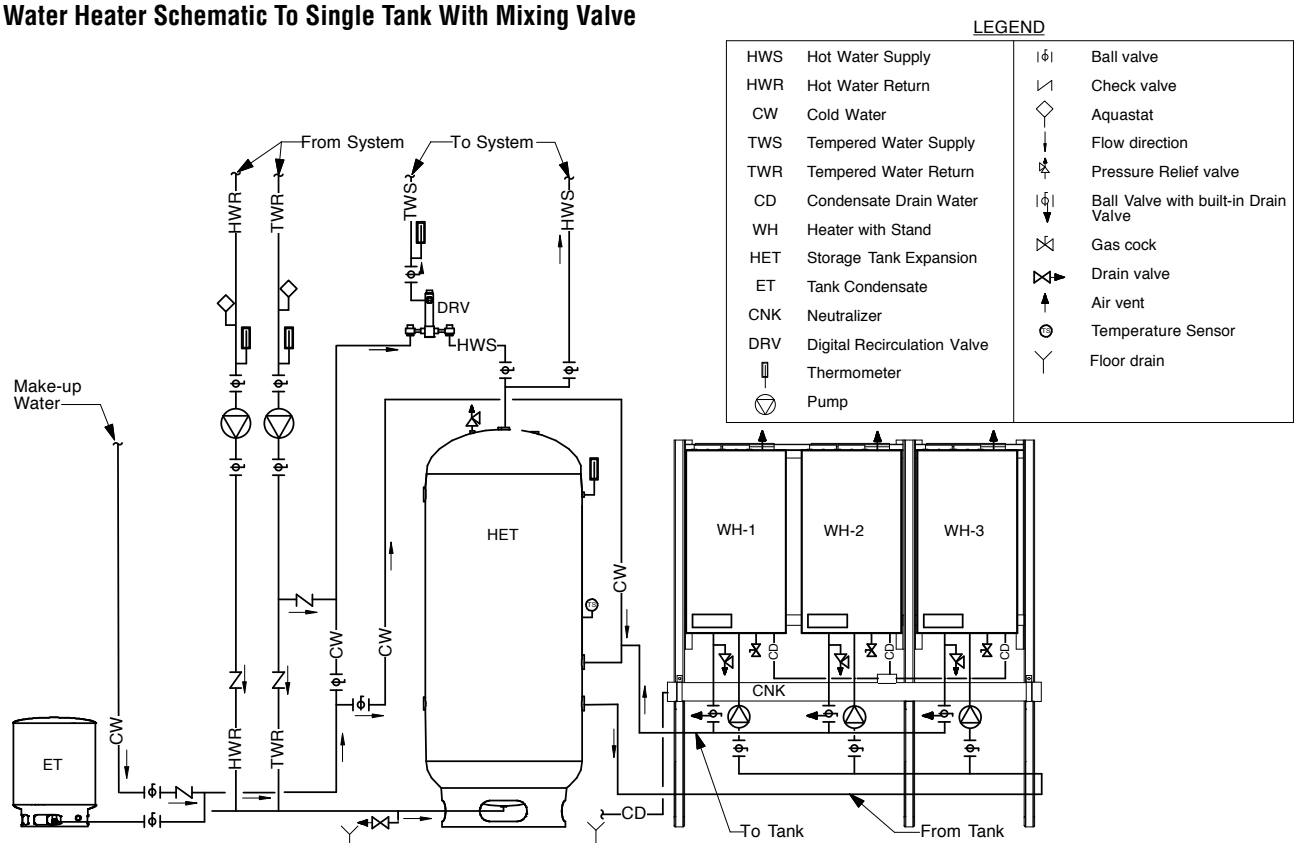
IMPORTANT NOTE: The above are representative drawings; must conform to local codes. Consult factory for Custom System Solutions.

Piping - continued

Three Water Heater Schematic To Single Tank



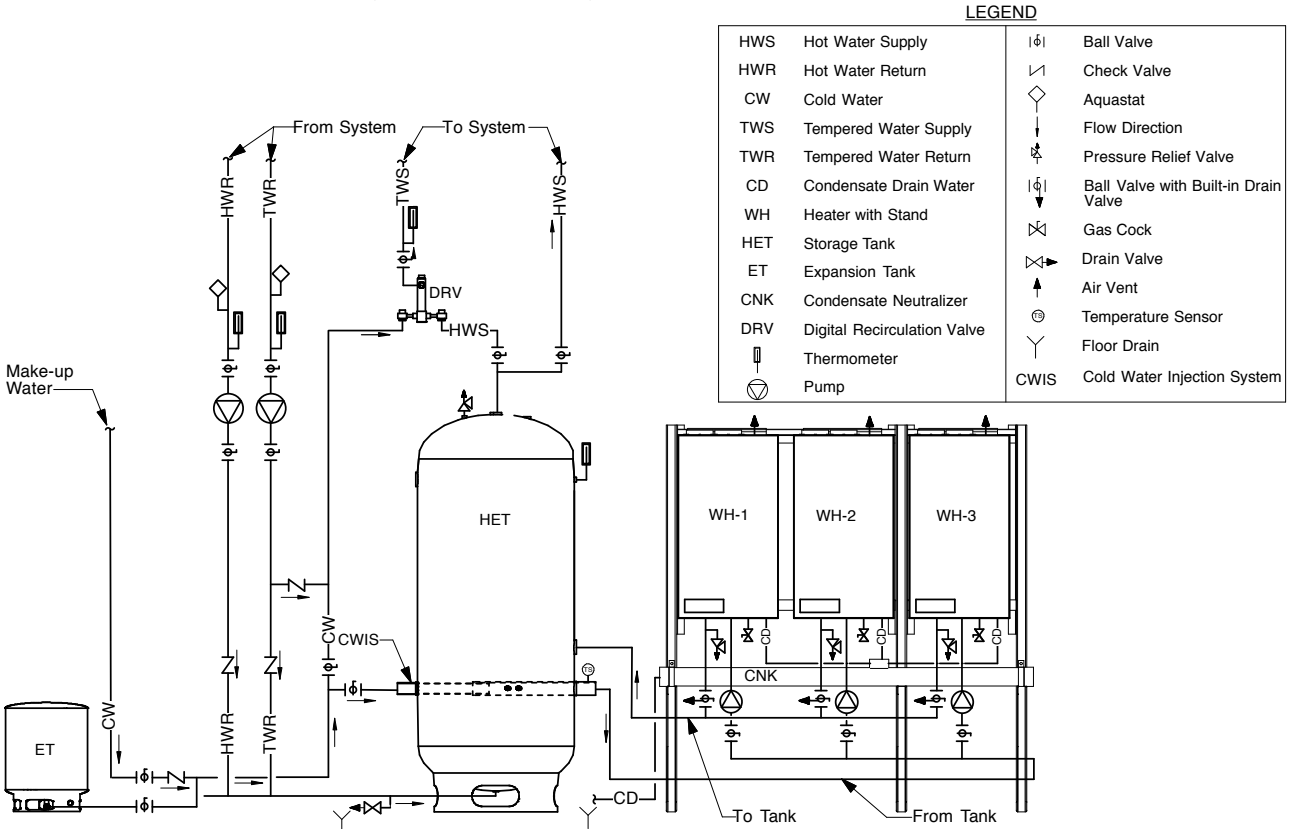
Three Water Heater Schematic To Single Tank With Mixing Valve



IMPORTANT NOTE: The above are representative drawings; must conform to local codes. Consult factory for Custom System Solutions.

Piping - continued

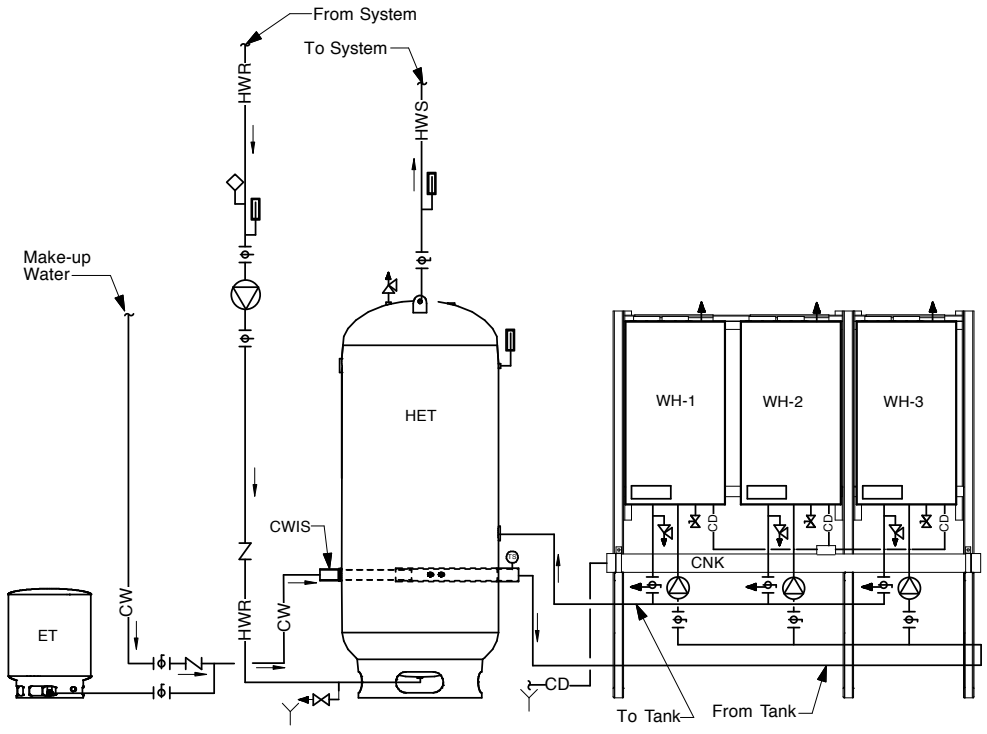
Three Water Heater Schematic To Single Tank With Mixing Valve And CWIS™



LEGEND

HWS	Hot Water Supply
HWR	Hot Water Return
CW	Cold Water
TWS	Tempered Water Supply
TWR	Tempered Water Return
CD	Condensate Drain Water
WH	Heater with Stand
HET	Storage Tank
ET	Expansion Tank
CNK	Condensate Neutralizer
DRV	Digital Recirculation Valve
	Thermometer
	Pump
	Ball Valve
	Check Valve
	Aquastat
	Flow Direction
	Pressure Relief Valve
	Ball Valve with Built-in Drain Valve
	Gas Cock
	Drain Valve
	Air Vent
	Temperature Sensor
	Floor Drain
CWIS	Cold Water Injection System

Three Water Heater Schematic To Single Tank With CWIS™



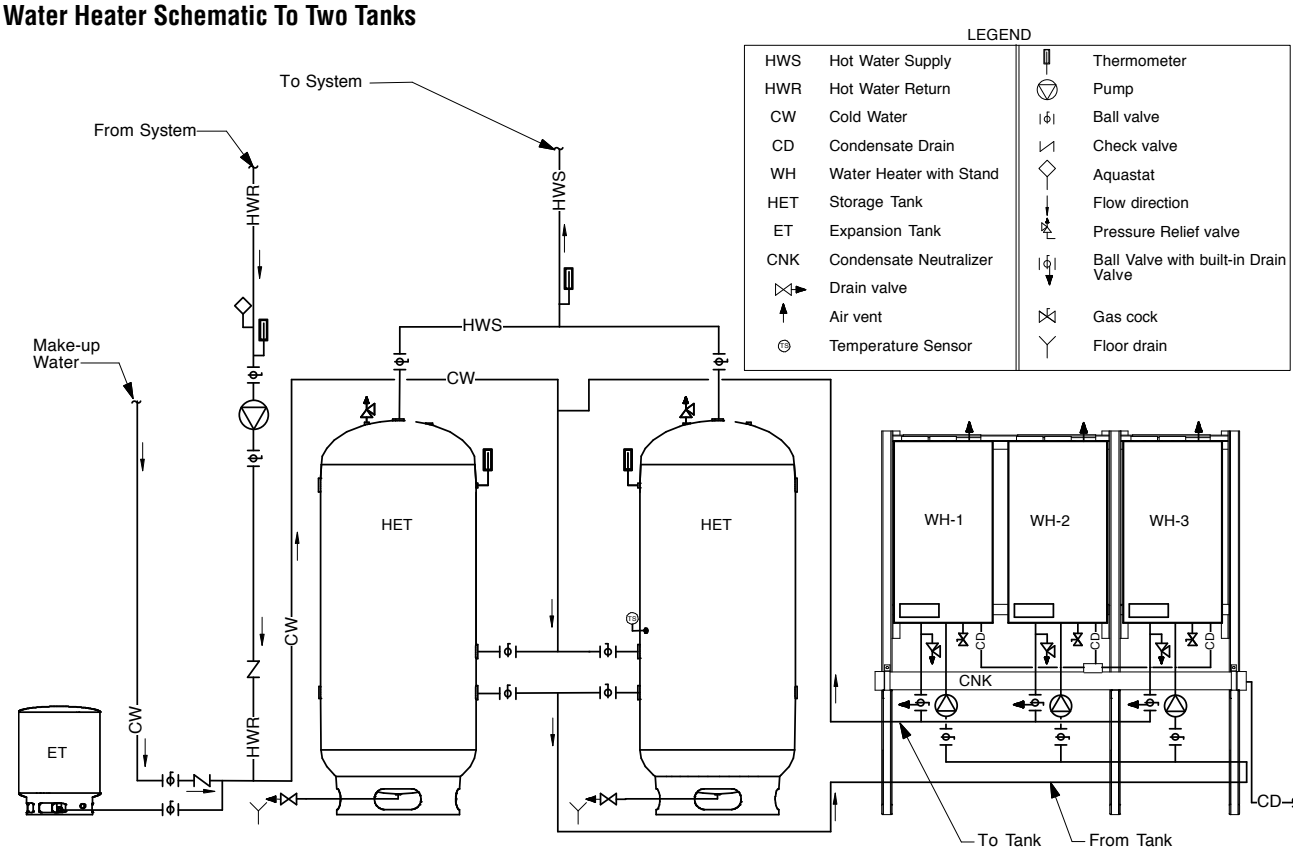
LEGEND

HWS	Hot Water Supply
HWR	Hot Water Return
CW	Cold Water
CD	Condensate Drain
WH	Water Heater with Stand
HET	Storage Tank
ET	Expansion Tank
CNK	Condensate Neutralizer
	Thermometer
	Pump
	Ball valve
	Check valve
	Aquastat
	Flow direction
	Pressure Relief valve
	Ball Valve with built-in Drain Valve
	Gas cock
	Drain valve
	Air vent
	Temperature Sensor
	Floor drain
CWIS	Cold Water Injection System

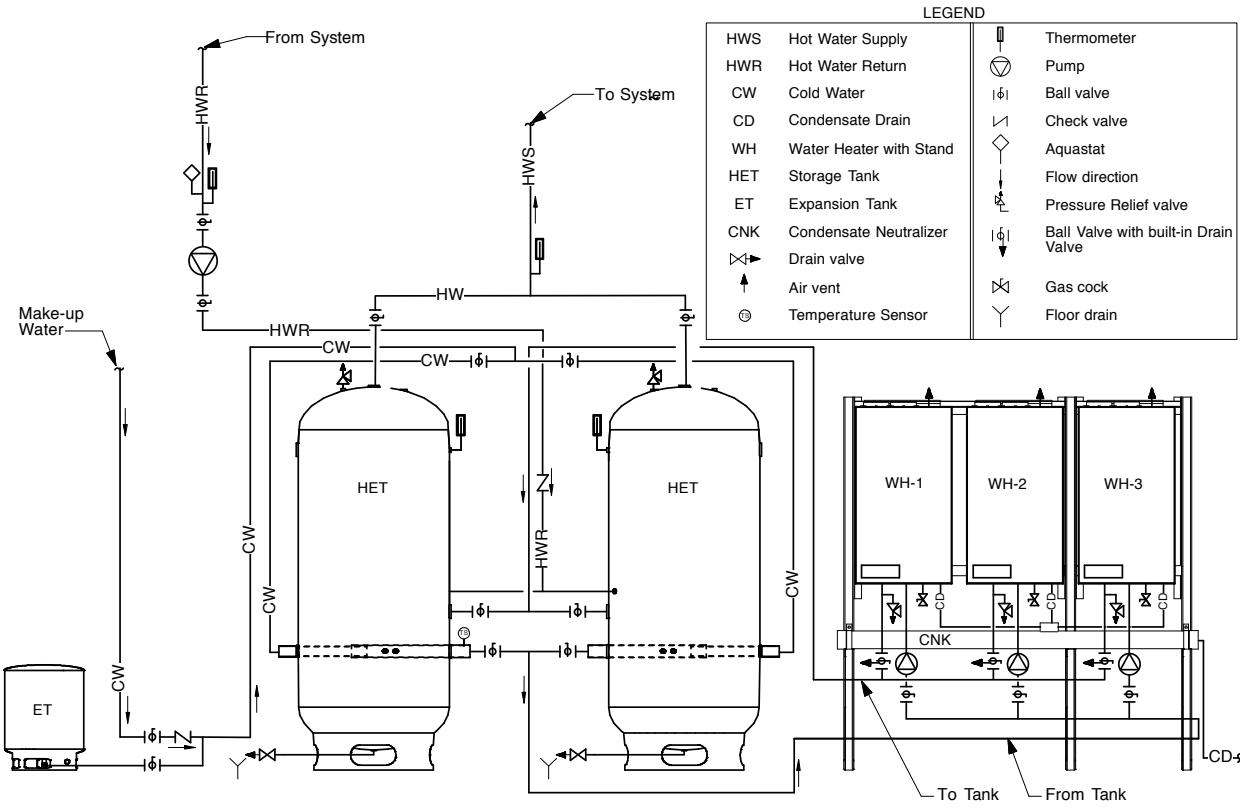
IMPORTANT NOTE: The above are representative drawings; must conform to local codes. Consult factory for Custom System Solutions.

Piping - continued

Three Water Heater Schematic To Two Tanks



Three Water Heater Schematic To Two Tanks With CWIS™



IMPORTANT NOTE: The above are representative drawings; must conform to local codes. Consult factory for Custom System Solutions.

Start-Up Procedures

Items To Be Checked Before Lighting The ABH

It is recommended that you read the General Information Section (page 6-11) to get a better understanding of how the ABH operates before you start the unit and use the Start-Up Checklist as a check and to document and confirm all conditions are correct. All ABH start ups should be conducted by properly qualified professionals.

1. Make sure that you follow the lighting instructions before running the ABH.
2. Check and make sure the circulating pump is running, and that the pressure transducers and/or flow switch are operating correctly.
3. Make sure that the Gas is turned on outside the bottom of the cabinet of the ABH.
4. Double check to be sure the temperature setting is correct.
5. Make sure the unit is properly grounded and the electrical wiring meets the requirements of the Electrical section (page 12–13).
6. Make sure that no valves are placed between the relief valve and the appliance. The relief valve must be installed in such a manner that the discharge will be conducted to a suitable place for disposal when relief occurs. Ensure that no reducing coupling or other restriction is installed in the discharge line, and that the discharge line is installed to allow complete drainage of both the valve and the line.
7. Turn on the power to the ABH. The Setpoint Temperature of the ABH will appear in the display at this time. If a fault code appears, correct the fault before operating. The ABH will now run its pre-purge and ignition cycles, then begin heating, which will be indicated by the orange flame in the lower right corner of the display..

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

Lighting Instructions

For Your Own Safety, Read Before Operating!

1. This appliance does not have a pilot light. It is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.
2. BEFORE OPERATING smell all around the appliance area for gas. Be sure to smell next to thefloor 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 neighbor's phone. Follow the gas suppliers' instructions.
   - If you cannot reach your gas supplier, call the fire department.
3. Turn on gas shutoff valve (located outside the cabinet on the bottom of the appliance) so that the handle is aligned with the gas pipe. 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.
4. 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.
5. The ABH Heater shall be installed so the gas ignition system components are protected from water (dripping, spraying, rain, etc.) during appliance operation and service (circulator replacement, condensate trap, control replacement, etc.).

Start-Up Procedures - continued

Operating Instructions

1. STOP! Make sure you have read the safety information above.
2. Turn off all electric power to the appliance.
3. This appliance is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.
4. Turn gas shutoff valve clockwise to “off” The handle will be horizontal; do not force it.
5. Wait five (5) minutes to clear out any gas. If you then smell gas, STOP! Follow the instructions from Section B: Lighting Instructions in the safety information. If you don’t smell gas, go to the next step.
6. Turn the gas shutoff valve counter clockwise to “on” The handle will be vertical.
7. Turn on all electric power to appliance.
8. Set the thermostat to the desired setting.
9. If the appliance will not operate, follow the instructions “To Turn Off Gas To Appliance” (Servicing, page 47 and call your service technician or gas supplier.

Adjusting The Temperature On The ABH Display

Enter the menu labeled Setpoint in the upper right of the display to set the desired operating water temperature. On a boiler, this will be based on the leaving water temperature. On a water heater it will be based either on a connected external (storage tank) sensor, or, if there is none connected, it will operate based on the incoming water temperature. The range is factory-set at 50–160°F for water heaters and 50–195°F for boilers. Other special ranges are available by contacting the factory. **If other temperature settings are required, contact Armstrong Hot Water, Inc.** Other special parameters may be set by entering a password in the display, varying from end user, installer, advanced, and factory levels. The display can show either °F or °C set in the setup menu, then display options.

Sequence Of Operation

BURN HAZARD! Water temperature over 125ºF (51.6ºC)can cause severe burns instantly, or death from scalds. Children, the disabled, and the elderly are at highest risk of being scalded. See instruction manual before setting temperature at water heater. Feel water before bathing or showering! Temperature limiting valves are available.

1. When power is first applied to the control, the control display will read the temperature Setpoint. The control will initially run through a self-diagnostic routine and then go into its operating mode. If there is no call for heat, the system will go into an idle state.
2. If the thermostat is calling for heat, the control module will determine if the water temperature is below the programmed set point value minus the switching differential. It will then initiate a heating cycle.
3. The control then performs selected system diagnostic checks. If all checks are successfully passed, a pre-purge cycle is initiated (the blower will be on at 80%).
4. When the pre-purge period is complete, power is applied to the spark ignitor for 4.5 seconds. Approximately 1/2 second later, flame is verified. If a flame is not verified during the trial-for-ignition, the gas valve is immediately closed and the control will return to Step 3. After four trials, if a flame is not verified, the control will go into a lockout mode. If a flame is confirmed, the control enters the heating mode. The firing rate will be based on the control’s proprietary algorithm.
5. When water temperature reaches the temperature set point value, the burner will be at minimum firing rate.If,when firing at minimum rate, it reaches temperature setpoint plus offset, the gas valve closes and the control enters a post-purge state (the blower will be on at 80%). At any time if an external thermostat is being used and becomes satisfied, the gas valve will be closed immediately.

Start-Up Procedures - continued

6. When the post-purge is complete, the control enters an idle state while continuing to monitor temperature and the state of other system devices. If a call-for-heat is received, the control will automatically return to Step 2 in sequence and repeat the entire operating cycle.
7. Built in freeze protection: all models will automatically turn the pump on if the heat exchanger reaches 41°F (5°C) and the burner if it reaches 37°F (2.8°C), it will turn off at 50°F (10°C).

   NOTE: Power must be left on for this protection to function.

During the idle state and heat state, if the control detects an improper operating state from external devices, such as the high-limit switch, the control will illuminate an error code in the display.

0–10V Direct Control

Direct Control

In the situation where direct control of the appliance is desired (such as from a Building Management System), the appliance can be programmed to receive a 0–10 volt DC signal to control operation.

> N**ote: This operation is only possible in individually-controlled units (i.e.: not Cascaded) and when each is individually vented.**

There are two variations of this kind of external control: Load Control and Set Point Control. In Load Control, the voltage signal controls the burner firing rate. In Set Point Control, the voltage signal controls the temperature set point of the appliance. (This is similar to how the appliance is controlled when operating without an outside signal.)

Setting up Direct Control

There are three steps required to set up this mode of operation. First, connect the incoming voltage signal to pins 5 and 6 on the control board (see page 11.)

Next, remove the jumper from the remote thermostat terminals (pins 11 and 12, see page 11). If this is not done, the appliance will fire based on its internal set point when the voltage drops below 1.0VDC. If the appliance is set up with any other external signal here, this should be removed as well, or that external signal will take over when the 0-10VDC control signal drops below 1.0VDC

Next, go to Parameter S18 (PS18) in the Parameter menu and choose the appropriate control setting. (include picture of menu or HMI page)

The PS18 settings are:

- 0=Off (default setting--no external control, any external voltage signal ignored)
- 1=Load Control
- 2=Set Point Control

Load Control mode (PS18=1)

When a 0-10VDC input is used for load control, the range of 0-10VDC corresponds directly to a modulation percentage (burner firing rate). An input of 10.0VDC results in the maximum default fan speed (modulation) for that appliance, and 1.0VDC results in the minimum default fan speed. The fan speed displayed on the appliance will depend on the range of the fan for that particular appliance.

Type	Minimum Fan Setting (1.0VDC)	Maximum Fan Setting (10.0VDC)	Voltage increment
299	25%	100%	8.33% fan speed
399	25%	100%	8.33% fan speed
599	27%	100%	8.11% fan speed

Start-Up Procedures - continued

The following is an example of the effect of changing the voltage signal on an appliance in Load Control mode:

- The operational range of a 399.x fan is 25%–100%
- 0-0.9V = Appliance off
- 1.0V = 25% Fan speed
- 1.3V = 27% Fan speed (3% modulation)
- 4.0V = 49% Fan speed (33% modulation)
- 6.8V = 72% Fan speed (64% modulation)
- 8.9V = 91% Fan speed (88% modulation)+
- 10.0V = 100% Fan speed (100% modulation)
- Each volt = 8.33% fan speed or 11.11% modulation

Set Point Control mode (PS18=2)

When a 0–10VDC input is used for Set Point Control, the range of 0–10VDC corresponds directly to the temperature set point. Contact customer support for assistance with using this mode.

Servicing

Servicing The ABH

1. Shut off the power supply to the appliance (See Figure 1.4, page 11).
2. Remove the front cover security screw(s).
3. Undo the two latches at the bottom of the cover (if applicable).
4. Remove the cover.

Placing The ABH Into Normal Operation

1. Replace the front cover in the normal position.
2. Close the latches on the bottom of the cabinet (if applicable).
3. Replace the security screw(s).
4. Turn on the power supply to the appliance.

Table 7.1 CCB Soft Lock Out (SLO) Codes

Code	Cause	Recommended Action
CCB01	Sensor S1 fault	Check that the S1 sensor is connected
CCB02	Sensor S2 fault	Check that the S2 sensor is connected
CCB03	Sensor S3 fault	Check that the S3 sensor is connected
CCB04	Sensor S4/SZ1 fault	Check that the S4/SZ1 sensor is connected
CCB05	Sensor S5/SZ2 fault	Check that the S5/SZ2 sensor is connected
CCB06	Sensor S6 fault	Check that the S6 sensor is connected
CCB07	Sensor SZ3 fault	Check that the SZ3 sensor is connected
CCB08	Sensor zone 4 fault	Check that the zone 4 sensor is connected
CCB09	Sensor zone 5 fault	Check that the zone 5 sensor is connected
CCB10	Sensor zone 6 fault	Check that the zone 6 sensor is connected
CCB11	Sensor zone 7 fault	Check that the zone 7 sensor is connected
CCB12	Sensor zone 8 fault	Check that the zone 8 sensor is connected
CCB15	Communication error via Modbus programming	Quantity of programmed appliances does not match quantity of connected appliances.
CCB20–CCB27	Communication error with a specific appliance; A = CCB 20… H = CCB 27	Check specific appliance to see that it is powered on, if yes, then check all communication connections at display and main boards
CCB200	EEPROM fault	Check that the EEPROM is connected properly

Servicing - continued

*Codes may appear with an A, B, or C as a suffix denoting the number of times the code has appeared since the last Initialization (INI). Some SLO's are accompanied by a reduction of the maximum firing rate; A=80%, B=50%, C=30%. After the C suffix appears, the next code of that kind becomes an HLO (manual reset required).

Table 7.2 BCB Soft Lock Out (SLO) Codes

Code	Cause	Recommended Action
A1*	Excessive pressure differential (ΔP) on water side of heat exchanger	Check for scaling or blockage on water side of heat exchanger, also check pump performance. If this SLO is indicated while the unit is firing, it is doing so at a reduced BTU input; low enough to stay below that maximum ΔP set point.
B01	Pressure too high at condensate drain connection during Stand By	Look for condensate backing up into combustion side of heat exchanger.
B02	Pressure too high at condensate drain connection during pre-purge	Insure condensate drain system is flowing freely, and vent is clear of obstructions. Also, be sure the Z-INI has been initiated.
B03	Pressure too low at condensate drain connection during pre-purge	Check for condensate (water) in the condensate neutralizer (if equipped) or the condensate trap at appliance outlet. If it is dry, add water to form trap. The appliance also will initiate an auto-filling process for the condensate trap, indicated on the screen during this operation. Also, be sure the Z-INI has been initiated.
B04	Pressure at flue/condensate sensor is too low	Check flue gas vent connection or sensor connection located at condensate drain line. Also check for a disconnected or open condensate drain line and last, look for a leak in the heat exchanger outer casing (behind the insulation).
DW7*	Temperature rise (ΔT) through heat exchanger is too high	Unit is operating at a reduced BTU input - check for scaling or blockage on water side of heat exchanger, also check pump performance.
FL05*	Flue gas temperature too high	Unit is burning at a reduced BTU input rate. The cause of the high flue gas temperature should be investigated and corrected ASAP
FL09*	Fouling of the fire side of the heat exchanger	Unit is burning at a reduced BTU input rate. A combustion side inspection and cleaning should be scheduled ASAP.
FL13	Flue gas sensor (T5) fault (not connected or open status)	Check the condition of the connectors and wires from the card edge connector at the board to the flue gas sensor on the appliance.
FL14	Flue gas sensor (T5) fault (short circuit status)	Take an OHM reading at the connector on the flue gas sensor - compare it to the chart on page 47 replace if out of range.
G01*	Gas supply pressure too low	If this occurs at the beginning of an ignition cycle, this SLO will stay until the pressure is high enough for proper ignition. If this occurs while the unit is firing, and it continues to fire, it is doing so at a reduced BTU input low enough to stay above that minimum pressure set point.
H01	Outlet sensor (T1.1, 1.2) fault (not connected or open status)	Check the condition of the connectors and wires from the card edge connector at the board to the outlet sensor on the appliance.
H02	Inlet sensor (T2) fault (not connected or open status)	Check the condition of the connectors and wires from the card edge connector at the board to the inlet sensor on the appliance.
H04	Outlet sensor (T1.1, 1.2) fault (short circuit status)	Take an OHM reading on the outlet sensor - compare it to the chart on page 47 replace if out of range.
H05	Inlet sensor (T2) fault (short circuit status)	Take an OHM reading on the inlet sensor - compare it to the chart on page 47 replace if out of range.
H07/09	Calibration between inlet (T2) and outlet (T1) water temperature sensors indicates too great a differential.	Test both sensors against the actual temperature and OHMs as shown in the chart on page 47, replace as required. The appliance will continue to operate, but at a reduced input until the required correction has been resolved.
H11	High ΔT	See Coil Anti-scaling Prevention, page 52
H24*	High Limit set point has been exceeded	Appliance restarts, but at a reduced input; after 3 restarts, the appliance gets a Manual Lock Out (HLO) and needs the cause resolved immediately. Possible causes are high ΔT, temperature setpoint versus high limit setting too close or bad sensor.
ID01	First INI process data missing	Run the Z-INI; starting Initialization numbers must be tested and the saved for all connected sensors in a number of conditions.
ID02	EMB EEPROM fault (2)	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.

Servicing - continued

Table 7.2 BCB Soft Lock Out (SLO) Codes - Continued		
Code	**Cause**	**Recommended Action**
ID03	EMB EEPROM fault (1)	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.
ID04	Internal fault (gv1)	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.
ID05	Internal fault (gv2)	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.
ID06	Internal fault (gv3)	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.
ID09	Fan speed error	Cycle power off, check the four-wire fan connection; wires and each end at connectors. If all ok, cycle power back on and if fan Speed error reappears, replace fan.
ID11	Flame proof indicated without flame present	Cycle power off, check Igniter, Ignition cable and cable ends, if moisture present, dry thoroughly. Cycle power back on.
ID13	Low voltage to appliance	Check voltage - this fault occurs when the supply voltage is more than 10% less than rated supply.
ID14	High voltage to appliance	Check voltage - this fault occurs when the supply voltage is more than 15% greater than rated supply.
ID16 A	External sensor (T6) fault (not connected or open status)	Check the condition of the connectors and wires from the card edge connector at the board to the terminal strip to the external sensor in the piping or Low Loss Header.
ID16 B	External sensor (T6) fault (short circuit status)	Take an OHM reading on the wires from the external sensor in the piping or low lass header - compare it to the chart on page 47 replace if out of range.
ID19 A	Tank sensor (T3) fault (not connected or open status)	Check the condition of the connectors and wires from the card edge connector at the board to the terminal strip to the storage tank sensor.
ID19 B	Tank sensor (T3) fault (short circuit status)	Take an OHM reading on the wires from the storage tank sensor - compare it to the chart on page 47 replace if out of range.
ID20 A	Outdoor sensor (T4) fault (not connected or open status)	Check the condition of the connectors and wires from the card edge connector at the board to the terminal strip to the outdoor air sensor.
ID20 B	Outdoor sensor (T4) fault (short circuit status)	Take an OHM reading on the wires from the outdoor air sensor - compare it to the chart on page 47 replace if out of range.
ID87	Actual fan speed is lower than specified fan speed, during speed up.	The appliance is waiting to allow the fan time to reach the required rpm, if it does not achieve it in 30 seconds, ID88 will become the new fault code.
ID88	Actual fan speed did not reach required rpm in the time allotted.	If the actual fan speed is more than +/- parameter F20 rpm off the set fan speed after pre-purge time ID88 is shown. This fault will correct itself after the correct fan speed is achieved.
ID89	T1.1-T1.2 ΔT fault	The ΔT on the duplex outlet sensor (T1.1 & T1.2) is greater than 18˚F. Test both sensors against the actual temperature and OHMs as shown in the chart on page 47, replace as required.
ID95	EEPROM key blank	EEPROM key is blank with no data
ID97	EEPROM key missing	EEPROM key is not connected or not communicating
P04*	No water flow from the pump	Check for pump electrical issues i.e. no power to the pump, pump motor is seized, pump is constantly powered and running.
P05*	Reduced water flow through appliance	Check for partially closed valves, pump impeller fouling etc. Appliance is operating at a reduced BTU capacity to avoid heat exchanger damage.
S13	Additional safety fault	Check the status of the additional safety input switch when call for heat is established, and P7 time elapsed, and continuously thereafter during a burn cycle.
W01*	Maximum water pressure exceeded	Water pressure too high (within 10% of pressure relief valve rating), confirm cause and correct. Unit is operating at a reduced BTU capacity to try and avoid the relief valve opening.
W04*	Water pressure is less than minimum setting	Water pressure too low (within 10% of minimum pressure required), confirm cause and correct. Unit is operating at a reduced BTU capacity to try and avoid any damage to the heat exchanger.

Servicing - continued

ABH Hot™ Controls Hard Lockout Codes

Table 7.3 BCB Hard Lockout (HLO) Codes

Code	Cause	Recommended Action
A1/A2	Excessive pressure differential (ΔP) on water side of heat exchanger	Check for scaling or blockage on water side of heat exchanger, also check pump performance.
B03	Neutralizer/trap has little or no Condensate (water)	Fill neutralizer (or trap if not a factory neutralizer) with water to avoid flue gases spilling into the room through a dry trap.
B04	Pressure at flue/condensate sensor is too low	Check flue gas vent connection or sensor connection located at condensate drain line. Also check for a disconnected or open condensate drain line and last, look for a leak in the heat exchanger outer casing (behind the insulation).
DW7	Temperature rise (ΔT) through heat exchanger is too high	Appliance has been through multiple tests and checks including operating at a reduced input to avoid this shut down. The ΔP across the heat exchanger indicates reduced water flow. Check the pump performance, check for partially closed valves and if all ok, perform a descaling operation on the water side of the heat exchanger.
FL01	Flue gas temperature has exceeded the maximum safe level set in the operating parameters	Flue gas temperature setting has been exceeded by a significant amount even after operation at a reduced firing rate. Check entire burner assembly, if ok, then a complete fire side cleaning must be initiated immediately.
FL05	Flue gas temperature too high	Unit is burning at a reduced BTU input rate. The cause of the high flue gas should be investigated and corrected ASAP - See FL01
FL09	Fire side of heat exchanger is severely fouled	Remove burner and check condition of fire side of tubes in the burner area.
G01	Gas pressure too low	Find cause of low pressure and correct; piping or regulator sizing is the general culprit
G03	Gas pressure too high during a burn cycle	Correct the cause of the high gas pressure - either adjust regulator or replace and repair as required - maximum allowed by code is 14"w.c.
H15/H16	Water temperature limit set point exceeded	Check set point(s), sensors, pumping etc. Correct cause of high water temperature
H24	Water Temperature Manual Reset High Limit set point exceeded	Check set point(s), sensors, pumping etc. Correct cause of high water temperature
ID01	First INI process data missing	Run the Z-INI; starting Initialization numbers must be tested and the saved for all connected sensors in a number of conditions.
ID02	EMB EEPROM fault (2)	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.
ID03	No valid data on microcontroller Flash memory	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.
ID04	Internal fault (gv1)	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.
ID05	Internal fault (gv2)	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.
ID06	Internal fault (gv3)	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.
ID09	Fan speed error	Cycle power off, check the four-wire fan connection; wires and each end at connectors. If all ok, cycle power back on and if fan Speed error reappears, replace fan.
ID12	Flue thermostat open.	Check for open flue temperature switch, if parameter S24=1
ID89	Fan is not running	Either fan is not running (check wiring or replace), or factory programming has been altered (consult factory).
ID96	Wrong EEPROM key connected	Install proper EMB EEPROM, if it cannot be found, contact the factory for assistance - be sure to have model and serial number of the appliance in question.
ID99	BDB Reset action finished	There have been too many resets, a concerted effort must be made to find the cause of the fault and correct it. This is a timed action, and the unit cannot be reset until the time has elapsed. Contact the factory with further questions. This fault will require both a power reset and then an on-screen fault reset via the HISTORY tab.

Table 7.3 BCB Hard Lockout (HLO) Codes - continued		
Code	**Cause**	**Recommended Action**
IG2/IG3	Too many restarts or relights after no-flame.	Appliance has been through multiple tests and checks including trying to ignite at different inputs to avoid this shut down. Combustion related items must be checked, including air/gas ratio, ignition cable and igniter.
IG4/IG5	Too many restarts or relights after no-flame.	Appliance has been through multiple tests and checks including trying to ignite at different inputs to avoid this shut down. Combustion related items must be checked, including air/gas ratio, ignition cable and igniter.
IG19	Too many attempts for ignition	Appliance has been through multiple tests and checks including trying to ignite at different inputs to avoid this shut down. Combustion related items must be checked, including air/gas ratio, ignition cable and igniter.
IG27	Too many attempts for ignition	Appliance has been through multiple tests and checks including trying to ignite at different inputs to avoid this shut down. Combustion related items must be checked, including air/gas ratio, ignition cable and igniter.
P04	Low or no water flow	Check for pump electrical issues i.e. no power to the pump, pump motor is seized, pump is constantly powered and running.
P05	Water flow too low through appliance	Check for partially closed valves, pump impeller fouling etc.
P06	Water flow blocked during a burn cycle (proof of flow)	Check for partially closed valves, pump impeller fouling etc.
W04	Minimum water pressure	Water pressure too low (within 10% of minimum pressure required), confirm cause and correct.

NOTE: In many cases, a "hard lockout" will indicate that there is something wrong with the appliance, that should be serviced or repaired.

EXAMPLE:

If there is a loss of flow due to an air bubble passing through the appliance (sensed via the water pressure transducers), the appliance will shut down and display a temporary fault of P04 or P05 A, B, or C. When flow resumes and a waiting time has elapsed, the control board will perform a pre-start diagnostic and then resume a burn cycle.

To Turn Off Gas To The Appliance

1. Set the thermostat to lowest setting.
2. Turn off power switch on front of unit.
3. Turn off all electric power to the appliance if service is to be performed.
4. Turn gas shutoff valve clockwise to "off." Handle will be horizontal. Do not force.

Pump & Wiring Control

The ABH HOT™ control board has an on-board relay for controlling the circulating pump. On a call for heat, the pump will start, allowing the water flow proving circuit to be made and the pre-start diagnostic to continue. After the call for heat has been satisfied, the pump will continue to run for the factory programmed period of time (1 minute) and then shut off. For water heating applications an external temperature sensor must be mounted in the water storage tank. For heating applications, the call for heat must come from an external source (room thermostat etc.).

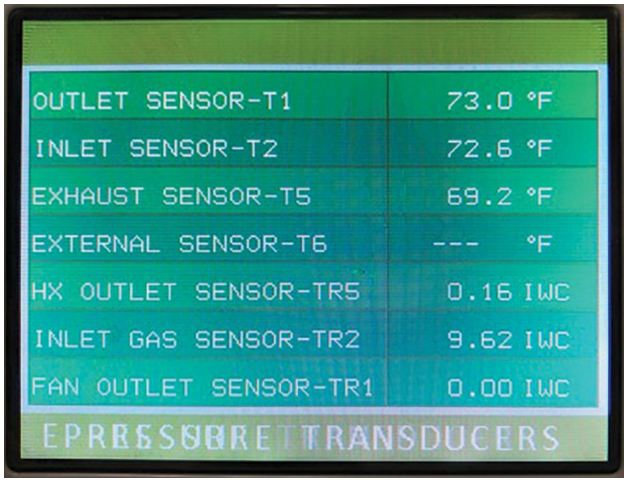
To Turn Off Gas To The Appliance

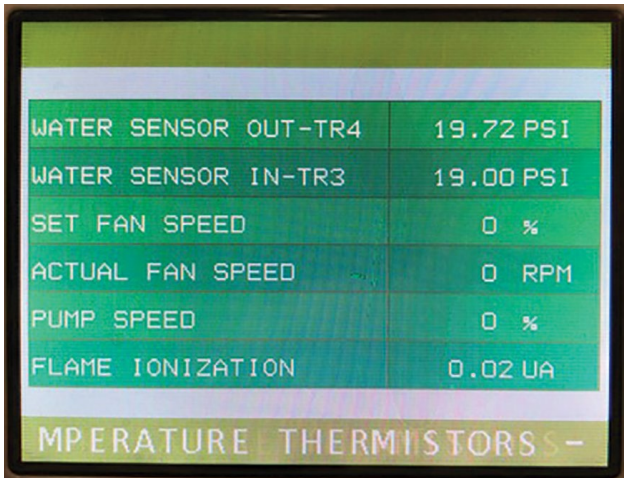
1. Set the thermostat to lowest setting.
2. Turn off power switch on front of unit.
3. Turn off all electric power to the appliance if service is to be performed.
4. Turn gas shutoff valve clockwise to "off." Handle will be horizontal. Do not force.

Servicing - continued

Status Readings

Figure 7.4 - Status Reading Instructions





Sensor list and other details on screens will vary from system to system.

ABH Sensor Resistance Table

Table 7.5 ABH Sensor Resistance Table

Temperature (°F)	Resistance (Ohm)	Temperature (°C)	Resistance (Ohm)
32	32550	0	32550
41	25340	5	25340
50	19870	10	19870
59	15700	15	15700
68	12490	20	12490
77	10000	25	10000
86	8059	30	8059
95	6535	35	6535
104	5330	40	5330
113	4372	45	4372
122	3605	50	3605
131	2989	55	2989
140	2490	60	2490
149	2084	65	2084
158	1753	70	1753
167	1481	75	1481
176	1256	80	1256
185	1070	85	1070
194	915	90	915
203	786	95	786

Maintenance

Periodic Maintenance of Heater and Inspections

All high efficiency condensing appliances will require more regular maintenance (cleaning) than their non-condensing counterparts. Failure to do so may result in damage to the appliance that is not covered under warranty. Failure to follow all of the instructions contained in this manual may also cause premature product failure that may not be covered under warranty.

Periodic maintenance should be performed at least once a year by a qualified service technician to ensure that all the equipment is in safe, efficient operation. **Failure to do so may eliminate warranty coverage.** In the first year of operation, it is highly recommended that inspections of all connection points and the combustion chamber be done at three month intervals, any signs of fouling or leaks must be thoroughly investigated immediately as failure to do so may void warranty. Assuming no cause for excessive fouling is found, then the period of months from initial start up that it was found that cleaning was required, shall become the required future minimum cleaning interval, but at no time should it exceed 12 months. The owner MUST make necessary arrangements with a qualified heating contractor for proper maintenance of the heater. Installer must also inform the owner that the lack of proper care and maintenance of the heater may result in a hazardous condition and lack of warranty coverage. The installer should discuss the contents of the User's Information Manual with the owner.

Annual Inspection

(See the Maintenance Checklist for required tools and materials)

An inspection should cover, at a minimum, the following areas:

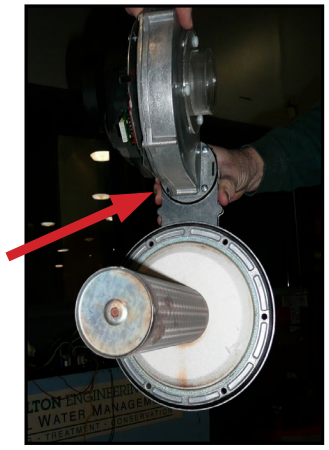
- Inspect all fittings, controls and connections for leaks, damage, or fouling
- Fire side:
  - Heat exchanger
  - Burner and ignitor
  - Burner door and rear wall insulation
- Drain system components:
  - Hoses & clamps
  - Trap assembly
  - Condensate neutralizer
- Test all safeties and operating controls
- Water side temperature rise (ΔT) test

Inspection And Cleaning (photos illustrating each step follow sets of instructions)

CAUTION! Before removing the door of the appliance, switch off the electrical power supply to it.

- Remove the front cover and check the sensors, transducers, all pipes, lines and connections, and the heat exchanger (top, bottom) for traces of water and water leakage.
- Inspect the top of the casing and/or the top of the appliance for water leakage or traces of water from the air supply pipe or the air vent (if applicable).
- Dismantle the burner unit: remove the (6) 6mm nuts (with a 10mm socket), the ignition cable, the power and speed control plugs, and the ground wire from the fan, and remove the burner/fan unit from the heat exchanger and cabinet.
- After the burner door is removed, it should be thoroughly inspected before being put back into service. There are two gaskets on the burner door; the first is the inner rope gasket, which is permanently affixed to the burner door. If this gasket is completely compressed (having no sealing ability), the door must be replaced. The second gasket is on the perimeter and is made of rubber; this gasket is easily replaced, and comes as a standard part of a maintenance kit (and should always be replaced during the annual maintenance procedure.

NOTE: Over-tightening the M6 nuts may cause the threaded rods on the front of the heat exchanger to break! If excess resistance is encountered when installing a M6 nut, discard that nut and use one of the spares shipped with the unit. The maximum torque for assembling a burner door nut is 5.9 ft-lb or 70.8 in-lb. Use a torque wrench suitable for this torque range to tighten the nuts.



Complete burner, door & fan assembly removed for inspection

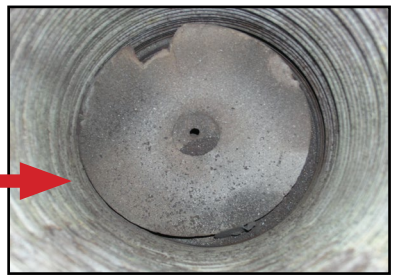
Maintenance - continued

- Remove and inspect the rear fiberboard. If any resistance is encountered with the removal of the screw securing the fiberboard in place, do not exert undo force; break the fiberboard out to provide access to the screw. Apply penetrating oil to the screw, let it sit, then remove. See photos below for details. Replace only after cleaning procedure. Use a new fiberboard if moisture has fouled it or if there is any physical damage preventing it from protecting the rear wall, such as cracks or warping. Warped fiberboards will allow the back wall to overheat, this could lead to a breach of the back wall. This will also cause a loss of efficiency and a rise in stack temperature.

  NOTE: Failure to replace front and rear fiberboard when damaged may result in irreparable damage to the appliance!







Both of these must be replaced!

- Check the fire side of the heat exchanger: only clean loose residue from the heat exchanger coil, use a vacuum cleaner and nylon brush, and do not push the residue between the openings of the coils if at all possible as this may impede the flow of the products of combustion.
- Use inspection mirror to check all heat passage spaces between coils, and using a short, thin putty knife or strip of stainless steel, remove all debris. **These passages MUST be free and clear for proper heat transfer to occur.** Rinse well all loose debris that was pushed down to the bottom of the condensate collection tray.
- It is recommended to only use clear water to rinse any remaining residue away—the water will automatically flow to the condensate drain point.
- **If surface or coil gap fouling still exists after the above measures have been taken, the heat exchanger requires additional cleaning.** Use a non-acid based cleaning solution, such as Fernox F3, to thoroughly soak the remaining residue. Brush clean and then completely rinse all residue and cleaning solution down the condensate drain assembly. Repeat if necessary.

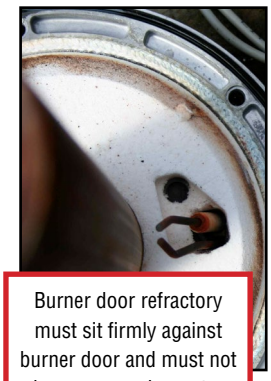
  (See complete cleaning instructions on page 49-51)


Maintenance - continued

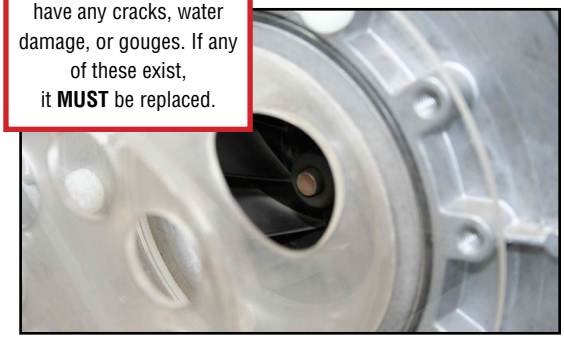
- Check the distance from the electrode to the burner; there should be a 3/8" gap in between the two. If the existing electrode pins must be adjusted for proper gap, caution must be exercised, as they will likely be brittle from exposure to the flame; try to bend them as close to the burner door insulation as possible using two pair of pliers; one to support the rod, and one to bend with. New electrodes will be less susceptible to breakage during adjustment. The metal surface of the electrodes should also be carefully cleaned with emery cloth.

  NOTE: Do not make any adjustments or cleaning with the electrode still mounted to the burner door, as damage to refractory may result!

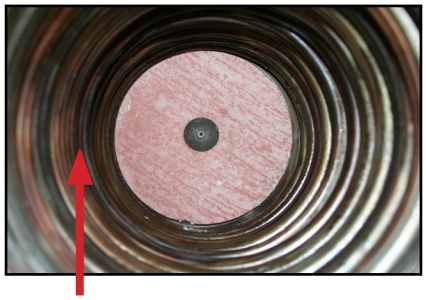
- Dismantle the air gas mixing plate or chamber on the suction side of the fan and check for fouling. If required, clean the fan blade wheel and the air gas mixing box.
- Reassemble the burner chamber, making sure there is no moisture on any of the fireside components.



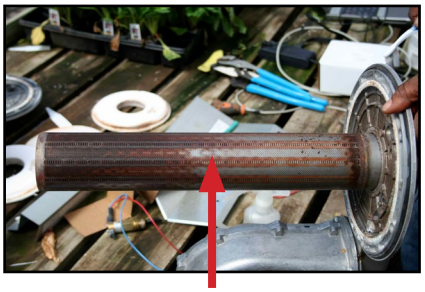
Burner door refractory must sit firmly against burner door and must not have any cracks, water damage, or gouges. If any of these exist, it **MUST** be replaced.



Cleaned heat exchanger - prior to rear wall installation



Cleaned heat exchanger - after rear wall installation



Burner & door assembly - prior to fiberboard installation

Maintenance - continued

Testing

The following steps require the power supply be turned back on; extreme caution must be exercised when performing service with the power supply on and the door off.

- When turning the appliance back on, listen for significant noises from the fan and pump. Also, inspect for leaks at the pump connections.
- Enter the status menu from the home screen to access the sensor readings, and record each reading, making sure that all sensors and thermometers are reading the same, with the heat off.
- Fire the appliance on maximum output for 5 minutes, in order to check the ΔT from the inlet sensor to the outlet sensor.
  - If the ΔT reading is out of design range by more than 10% or there is an A1 or A2 error on the display, refer to coil cleaning instructions below. Record ΔT to track any increases from one year to the next.

Table 7.6 Flow and Pressure Drop Heat Exchanger only - (GPM and Feet of Head @ 68°F)

				Hydronic Applications					DHW Applications				
Model	BTU/hr. (HW/hr) Input	Minimum Flow Rate must be clean water system*	ΔP at Minimum Flow Rate - ft. of head	Hydronic* Pipe Size	Design ΔT Hydronic* @ 95% efficiency °F	°C	GPM (LPM)	Head (M)	DHW Pipe Size	Design ΔT DHW @ 97% efficiency °F	°C	GPM (LPM)	Head (M)
HWH 299	300,000 (87.9)	8.5	5.1	1.5”	51.8	28.8	11 (41.7)	9.3 (2.8)					
HWD 299	300,000 (87.9)								1.5”	35.3	19.6	16.5 (62.5)	21.1 (6.4)
HWH 399	399,999 (117.2)	11.31	3.9	1.5”	43.2	24.0	17.6 (66.6)	9.4 (2.8)					
HWD 399	399,999 (117.2)								2”	29.4	16.3	26.4 (100)	19.2 (5.9)
HWH 599	630,000 (185)	17.8	5.1	1.5”	45.3	25.2	26.4 (100)	9.4 (2.8)					
HWD 599	630,000 (185)								2”	30.9	17.1	39.6 (150)	21.5 (6.5)

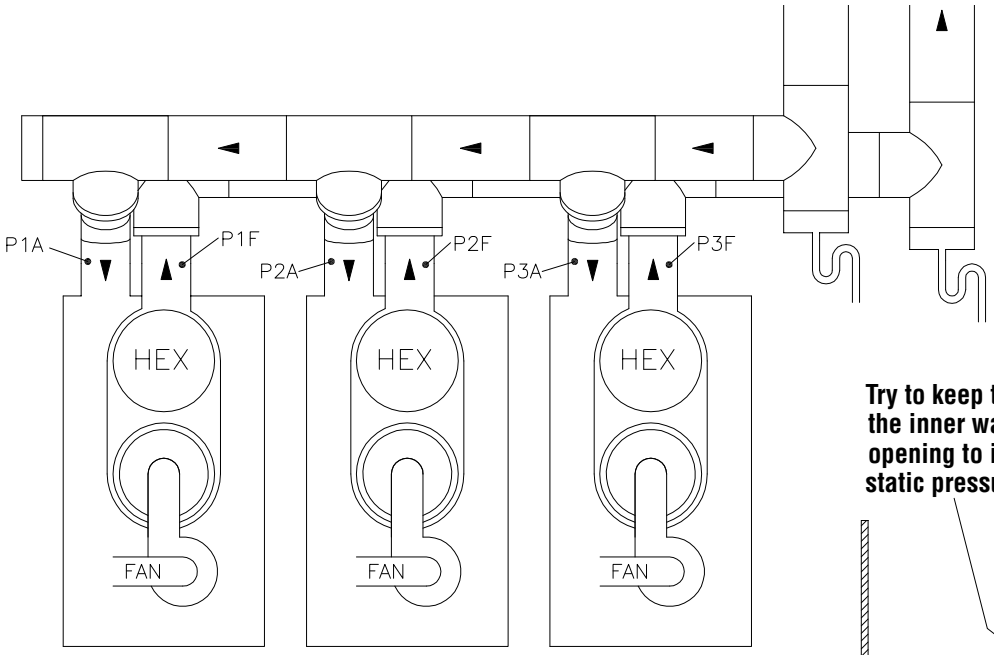
* Must be closed loop system with clean, treated water.

- Fire the appliance on maximum output, and measure and adjust the CO_2 percentage as required.
- Fire the appliance on minimum output, and measure and adjust the CO_2 percentage as required.
- If there are an unusual number of G01 faults or if combustion is off significantly, gas supply pressure must be verified at static (no load) and full building load conditions.
- See Table 3.3, page 17 for specific settings.
- Inspect intake and exhaust screens at the termination point for signs of contamination (i.e. leaves, twigs, etc).
- A differential pressure (ΔP) reading should be taken across the exhaust and inlet air connection points of each appliance to confirm that it is below the maximum shown below.

NOTE: The inlet air pressure should be negative.

Model	Air Pressure (ΔP)
HW299	< .7" wc
HW399	< 1" wc
HW599	< .86" wc

Maintenance - continued



P (1, 2, 3) A
These will be negative pressures relative to atmosphere

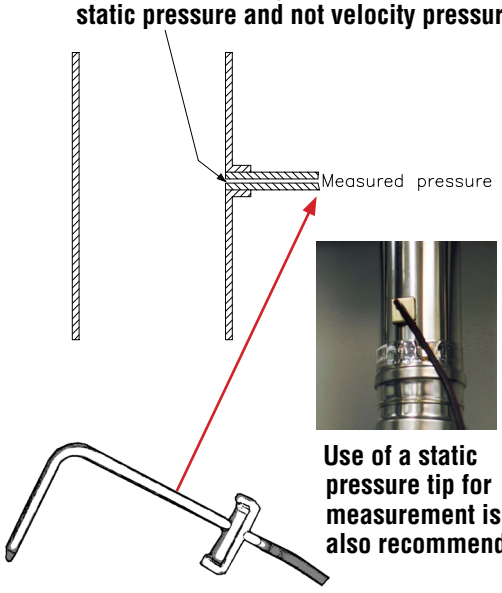
P (1, 2, 3) F
These will be positive pressures relative to atmosphere

Example
P1A = -0.32” wc
P1F = 0.4” wc
Then the total pressure drop is:
ΔP total = -(P1A) + P1F = -0.32 + 0.4 = 0.72” wc
Calculations are done with:

- All boilers at high fire
- Water temperature 160/180ºF (gives the hottest flue gasses)
- All readings must be taken with boiler front cover installed

Doing the measurements under these conditions will give the most accurate results. There may be minor differences between appliances.

Try to keep the measuring hose flat with the inner wall of the pipe. Use a small opening to insure you are measuring static pressure and not velocity pressure



Use of a static pressure tip for measurement is also recommended

- A pH test must be performed at the exit point of the condensate neutralizer with litmus paper to test for acidity. pH level should be within 6.6–7.0. If the pH is less than 6.6, replace neutralizing medium.
- Checking the minimum and maximum settings on the display must be performed as a final check.
- All findings and concerns should be discussed with the appliance owner after the inspection is complete.

Maintenance - continued

Condensate Trap Cleaning Instructions

The condensate trap and entire drain system attached to it (above the neutralizer) should be cleaned at least once every year.

1. Turn off the power to the ABH.
2. Place a bucket under the condensate trap. Use caution when removing the clean-out cap, as the trap is full of condensate and it may be hot.
3. Remove the condensate clean-out cap, and be sure the bucket is under the open drain trap assembly to catch the debris and water.
4. Rinse out the clean-out cap in a sink to remove any dirt or buildup that may have accumulated.

5. Condensate drain assembly should now be checked for non-restricted flow throughout the entire assembly.

6. Reinstall the clean-out cap on the condensate trap.
7. Turn on the power to the ABH.
8. Make sure the hose from the condensate trap is not submerged too far into the neutralizer, there should be an air gap between the highest level of condensate and the outlet hose from the trap.
9. Monitor the condensate drain until flow has been established.Monitor the condensate drain until flow has been established.

Maintenance - continued

Combustion Chamber Coil Cleaning Instructions*

***Before beginning this procedure, you must have the following items on hand:**

- Nylon brush - **DO NOT use brass, stainless or steel brushes.**
- Water
- Vacuum cleaner
- Fernox F3 Cleaner
- Fernox F1 Inhibitor Protector (boilers only)
- Fernox DS 40
- Towel for clean up and plastic sheeting to protect electronics.

NOTE: If electronics do get wet, DO NOT turn on power to appliance until they have been thoroughly dried, as component failure may result.

Fire Side Cleaning

1. Shut down the ABH by using the following steps:

   - Turn off the power, close the gas valve, and shut down the unit. Wait for the unit to be cool to the touch.
   - Remove the clean-out cap and place drain bucket according to the directions above.
   - Remove the Molex plugs from the fan.
   - Remove the (6) 6mm nuts from the burner plate assembly to access the coils.
   - Pull the entire burner plate assembly towards you and remove rear target wall.

2. Vacuum first and then use the nylon brush to scrub coils to remove any buildup. Vacuum the debris from the coils.

3. Using a spray bottle filled with water or a hose under low pressure to avoid water spraying on electronics (be sure to cover them to protect against water damage), spray the coils liberally, making sure the water penetrates and funnels down through the condensate hose. If the condensate hose is blocked, try to knock any debris loose with a small screwdriver. Replace hose if not completely clean.

4. **If surface or coil gap fouling still exists after the above measures have been taken, the heat exchanger requires additional cleaning.** Use a **non-acid** based cleaning solution, such as Fernox F3, to thoroughly soak the remaining residue. Brush clean and then completely rinse all residue and cleaning solution down the condensate drain assembly. It may take several applications of the F3, followed by a rinsing, to completely clean the coil surfaces. Use a spray bottle for **each** (F3 and clear water). Repeat if necessary.

5. Be sure that water is flowing freely through the bottom casing of the heat exchanger and the drain is not plugged. At this point, the ABH should be ready to power back up.

6. Before powering up the ABH follow the steps below:

   - Re-install the burner assembly and rear target wall (fiberboard insulation)
   - Replace the (6) 6mm nuts to the burner plate, following appropriate tightening pattern and torque.
   - Re-connect the Molex plugs.
   - Re-set system thermostats.
   - Replace the clean-out cap.
   - Turn the ABH back on** and monitor the condensate drain until flow has been established.
   - Re-connect the condensate hose to the outside connection.

Maintenance - continued

Water Side Cleaning (de-scaling kit is required for this process, please consult factory)

1. Shut down the ABH and clean by using the following steps for **heaters:**

   - Turn off the power, close the gas valve, and shut down the unit. Wait for the unit to be cool to the touch.
   - For water heaters, close both inlet and outlet water valves to isolate the appliance.
   - Open the drain valve to let out all the water from the appliance, and circulate **Fernox DS 40 Cleaner*** in reverse of normal flow, to flush out any build up that may have occurred in the coils.
   - Flush with water to eliminate any of Fernox DS 40 Cleaner that may have been left behind.
   - Close the drain valve and open the inlet and outlet water valves to put the appliance back online.

2. Shut down the ABH and clean by using the following steps for **boilers:**

   - Turn off the power, close the gas valve, and shut down the unit. Wait for the unit to be cool to the touch
   - At the chemical injection point first add the appropriate number of bottles of **Fernox DS 40 Cleaner*** to the system, based on total system water volume. Follow the cleaning instructions on the bottle.
   - Open the drain valve to let out all the water from the appliance, and circulate Fernox DS 40 Cleaner in reverse of normal flow, to flush out any build up that may have occurred in the coils.
   - Flush the system of all the Fernox DS 40.
   - After the system has been flushed, add the Fernox F1 Inhibitor Protector (for closed-loop boiler applications only) to the system at the chemical injection point and leave in the system. One bottle of Fernox F1 treats approximately 26 gallons of water. Please follow instructions on the bottle for specific mixing ratios.

Detailed instructions on Water Side Cleaning can be found in LIT91195 Water Side Cleaning Procedure, available on our website.

****NOTE: When firing up the boiler for the first few times you may experience some fluttering of the gas burner that may result in a flame lockout. This is normal and will require you to re-cycle the unit until this clears up. This is caused by water still present in the combustion chamber.**

After all cleaning has been done, it is recommended that a combustion analysis and testing, as shown on page 50, be completed. See the Start-Up Checklist and Cascade Start-Up Procedures for details.

***Note: Fernox DS 40 is a heat activated de-scaling solution. It must be heated to 160º–180ºF to clean efficiently. Follow Fernox instructions to ensure a fully clean heat exchanger.**

Maintenance - continued

ABH Controls

DANGER! It is extremely important that you check for leaks when reconnecting the gas valve and make sure the exhaust vent is no longer blocked. Failure to do so may result in severe personal injury or death.

The following components are found on the control panel on the front of the appliance.

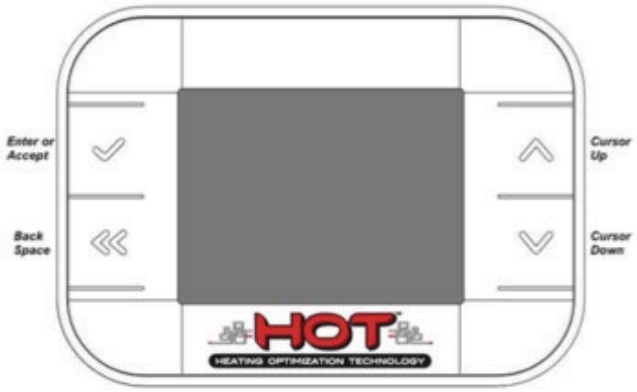
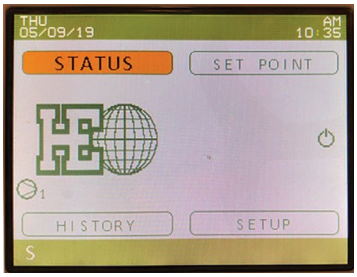


Figure 8.3 - ABH Control Panel

Standby Status



Normal Operating Status

Looking at the controls on the front of the appliance,

1. POWER on/off switch
2. SETPOINT knob, temperature control (and fan speed control knob during service mode)

Maintenance - continued

BOILER CONTROL BOARD (BCB) SCREENS

In the main screen it is possible to see:

- Hamilton logo
- Set point value
- Type of system (icons)
- Date and time
- Labels for navigation through the controller (STATUS, SET POINT, HISTORY, SETUP)
- Information and tips
- Alarms (soft lockout yellow and hard lockout red)

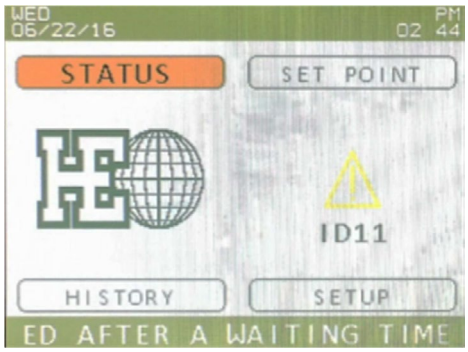
Navigation and set are allowed by the arrow, OK and BACK buttons.

Stand-By Mode:

Operating Mode:

Burner On (flame icon):

SLO Warning:



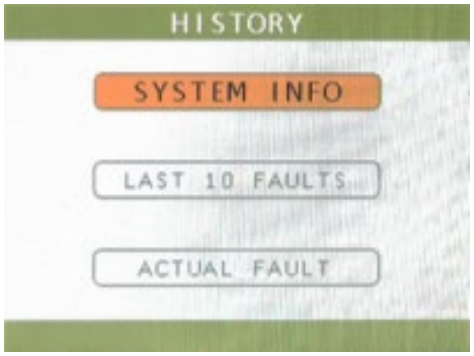
HLO Warning and Pump Icon:

Maintenance - continued

In case of fault indication (SLO or HLO), the main page shows the code of the fault occurred. To see the extended description you have to go into HISTORY menu, where a new item “ACTUAL FAULT” will be displayed. In case a boiler RESET is required (HLO fault), it is possible to activate the RESET procedure entering the ACTIVE FAULT page and selecting the corresponding item.

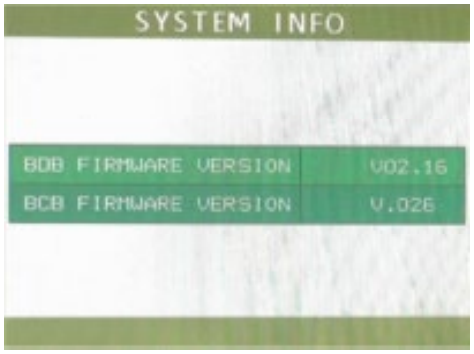
When the outdoor reset function is active, this page shows the calculated set-point value. Going into the SET POINT page, it is possible to change the TW parameter, in order to adjust the calculated value.

Status page when a fault occurs:

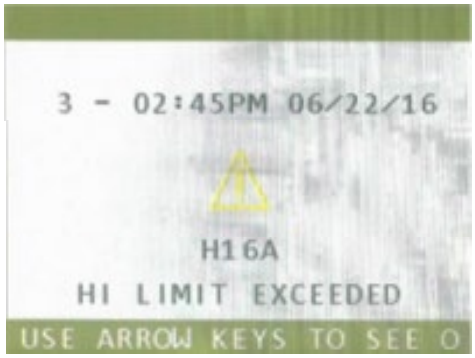


Status page at FACTORY access level:

System Info page:

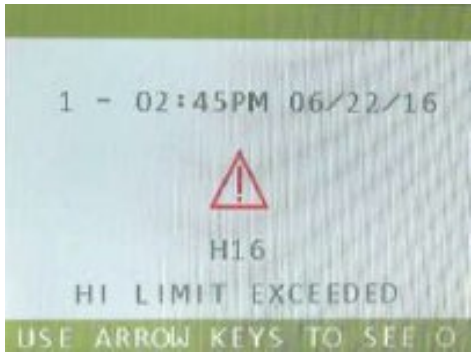


Actual Fault in case of SLO:



Actual Fault in case of HLO:

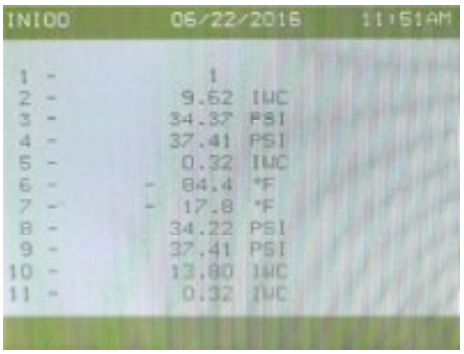
Last 10 Faults page:



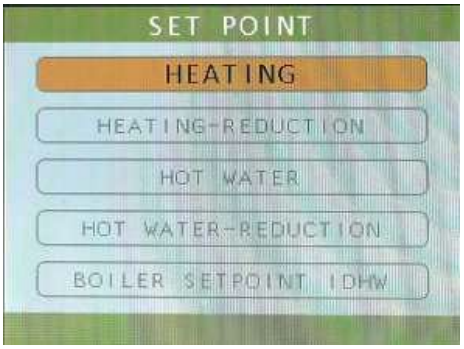
Maintenance - continued

NOTE: the behavior described is referred to the BCB board not working as a cascade module. So, the only possible configuration modes are the following: only central heating, central heating with Indirect hot water, direct hot water. Depending on the active configuration, the corresponding items will be displayed.

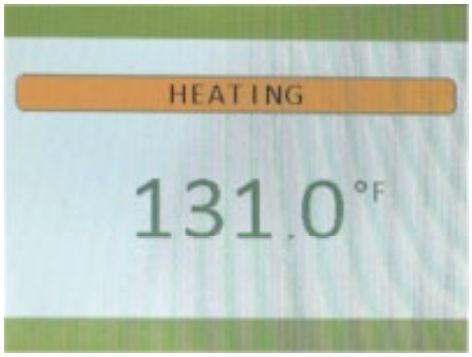
INI Data:



Set-Point page:

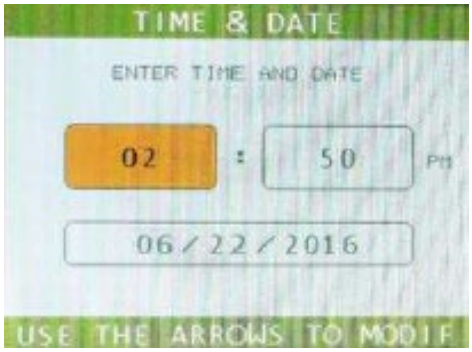


Ch Set-Point value:



Set-Up menu:

Time and Date setting page:



Maintenance - continued

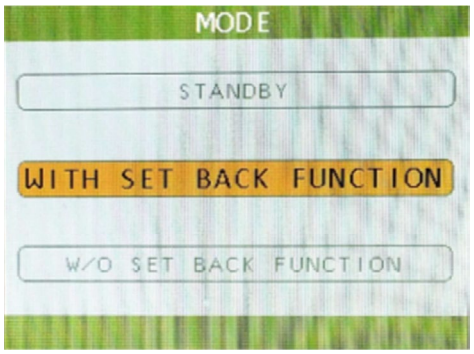
The procedure to access the parameters is as follows: while in STANDBY mode, in SETUP page, or in HISTORY page, press DOWN and BACK keys at the same time for about 5 seconds.

The passwords are as follows:

Level 0= USER (No password needed)

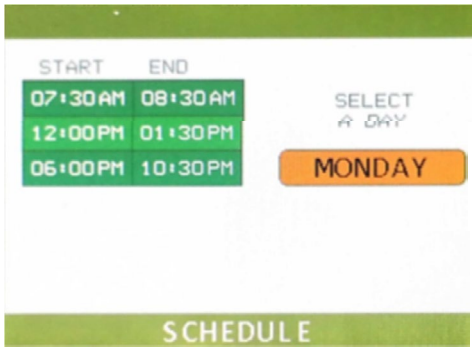
Level 1= INSTALLER → EAZ1LVL

Example of a Multiple Choice Parameter:

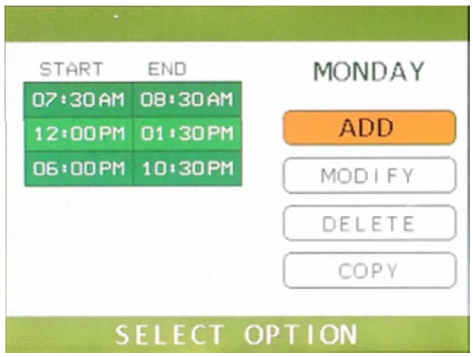


Password Protection page:

Time Schedule page:



View/Edit page:



Coil Anti-Scaling Prevention Feature

The ABH controller contains sophisticated software that enables it to monitor the rate of temperature rise through the heat exchanger. By doing this, it greatly reduces the possibility of heat exchanger failure due to scaling or fouling. A set of parameters are programmed in at the factory, to provide a design temperature rise (ΔT) setting on each size unit that is fixed. The Anti-Scale is based on an increase over the design ΔT through the heat exchanger. This Anti-Scale is determined using the inlet and outlet sensors, even if a tank thermistor is being used. If the Anti-Scale setting is reached, the unit will display H11, shut down and not re-fire until it has cooled. The first 3 times this happens, there will be a reduction of the maximum firing rate. The fault will be accompanied by either an A, B, or C suffix, indicating a maximum firing rate of 80%, 50%, or 30% respectively. The control will go into hard Lockout after the C suffix is achieved, and have to be manually reset. Once the heat exchanger has been acid cleaned, contact the factory for instructions on resetting the unit for full rated BTU input.

Typical causes for repeated H11 indications at start up are air trapped in the heat exchanger (be sure air vent cap is loose) or contaminates lodging in the piping or heat exchanger during installation, both of these causes can generally be cleared by isolating the hot water system and flushing water at full city pressure through the drain valve or relief valve on the heater outlet.

Special Installation Requirements

Installation Requirements—Massachusetts

Requirements for installation – Commonwealth of Massachusetts

For all side wall horizontally vented gas fueled equipment installed in every dwelling, building or structure used in whole or in part for residential purposes, including those owned or operated by the Commonwealth and where the side wall exhaust vent termination is less than seven (7) feet above finished grade in the area of the venting, including but not limited to decks and porches, the following requirements shall be satisfied:

1. INSTALLATION OF CARBON MONOXIDE DETECTORS. At the time of installation of the side wall horizontal vented gas fueled equipment, the installing plumber or gasfitter shall observe that a hard wired carbon monoxide detector with an alarm and battery back-up is installed on the floor level where the gas equipment is to be installed. In addition, the installing plumber or gasfitter shall observe that a battery operated or hard wired carbon monoxide detector with an alarm is installed on each additional level of the dwelling, building or structure served by the side wall horizontal vented gas fueled equipment. It shall be the responsibility of the property owner to secure the services of qualified licensed professionals for the installation of hard wired carbon monoxide detectors.

- In the event that the side wall horizontally vented gas fueled equipment is installed in a crawl space or an attic, the hard wired carbon monoxide detector with alarm and battery back-up may be installed on the next adjacent floor level.
- In the event that the requirements of this subdivision can not be met at the time of completion of installation, the owner shall have a period of thirty (30) days to comply with the above requirements; provided, however, that during said thirty (30) day period, a battery operated carbon monoxide detector with an alarm shall be installed.

2. APPROVED CARBON MONOXIDE DETECTORS. Each carbon monoxide detector as required in accordance with the above provisions shall comply with NFPA 720 and be ANSI/UL 2034 listed and IAS certified.

3. SIGNAGE. A metal or plastic identification plate shall be permanently mounted to the exterior of the building at a minimum height of eight (8) feet above grade directly in line with the exhaust vent terminal for the horizontally vented gas fueled heating appliance or equipment. The sign shall read, in print size no less than one-half (1/2) inch in size, “GAS VENT DIRECTLY BELOW. KEEP CLEAR OF ALL OBSTRUCTIONS”.

4. INSPECTION. The state or local gas inspector of the side wall horizontally vented gas fueled equipment shall not approve the installation unless, upon inspection, the inspector observes carbon monoxide detectors and signage installed in accordance with the provisions of 248 CMR 5.08(2)(a)1 through 4.

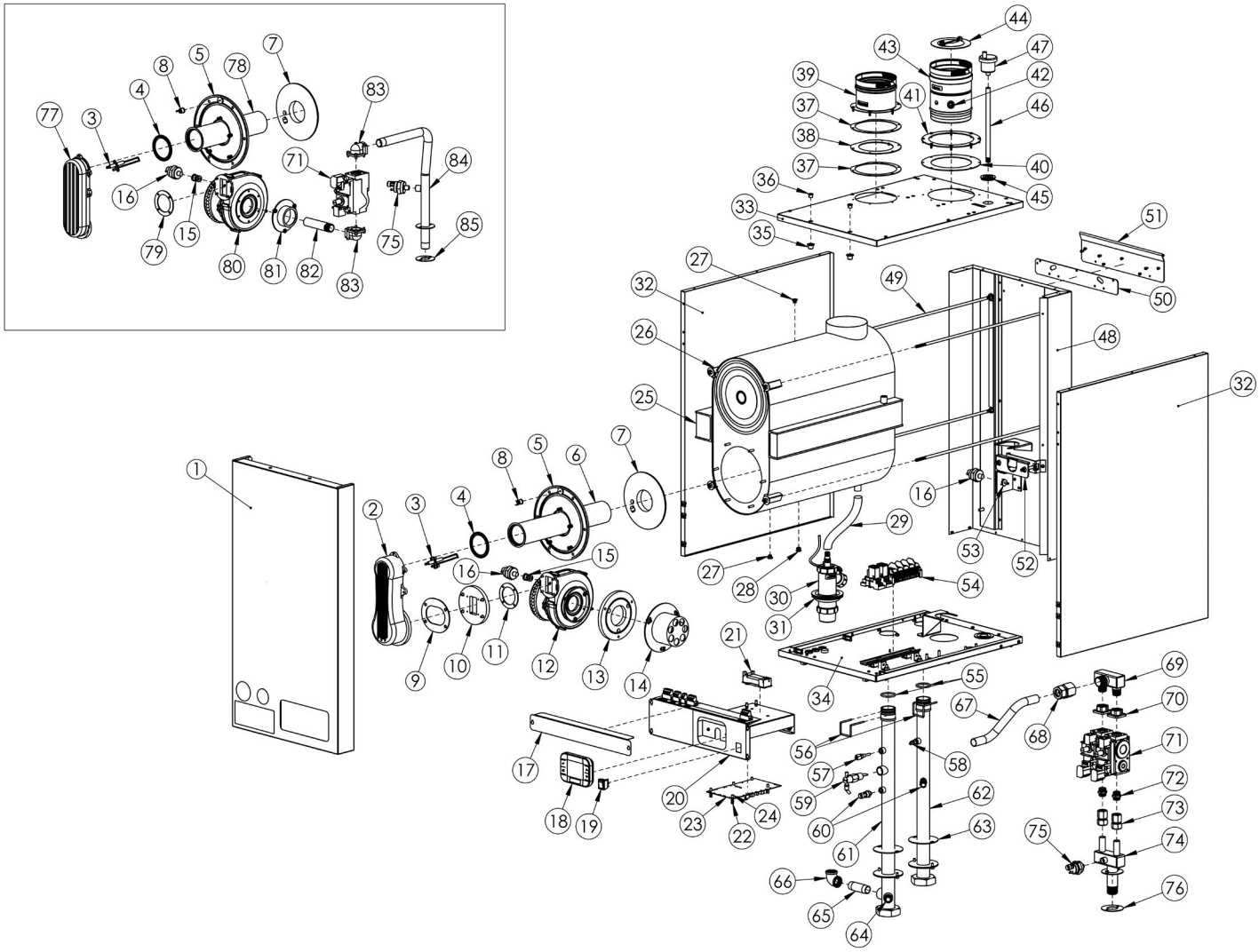
- EXEMPTIONS: The following equipment is exempt from 248 CMR 5.08(2)(a)1 through 4:
  - The equipment listed in Chapter 10 entitled “Equipment Not Required To Be Vented” in the most current edition of NFPA 54 as adopted by the Board; and
  - Product Approved side wall horizontally vented gas fueled equipment installed in a room or structure separate from the dwelling, building or structure used in whole or in part for residential purposes.

Installation Requirements—High Altitudes

5. This appliance is equipped with an automatic combustion characteristic adjustment system, provided the installed elevation above sea level is entered into the operating control when the elevation is greater than 2,000 feet and less than or equal to 19,000 feet. To enter the operating elevation:

- From the setup menu, enter the password for the installer level or higher. Enter the parameters menu, then the altitude parameter set. Enter the appropriate elevation for the installation.
- The adjusted altitude entered is internally converted to an offset on top of the maximum fan speed.
- **By adjusting the combustion characteristics as described above, there is no de-rate required at altitudes up to 19,000 feet. For elevations in excess of 19,000 feet or gas BTU content levels below 950 BTU/cubic foot, consult the Armstrong Hot Water, Inc. for adjustments and de-rating information.**

Parts Breakdown



Parts Breakdown - continued

Table X.X ABH Parts Breakdown		
Item#	**Part Description**	**Part Number**
1	PANEL FRONT DOOR ABH299-399HOT ASSY W/BEVEL WIN	D116957
	DOOR ASSY ABH599HOT FLAT WINDOW	D109348
2	BURNER INL HW599 AIR/GAS	D105610
3	PILOT SPARK ELECTRODE ASSEMBLY 79-599 KNURLED	PLT 94318 A
4	GASKET 3-5/16 OD EPDM 60 DURO TUBE/BURNER	D104184
5	BURNER DOOR HW79-599	D105611
6	BURNER PIPE HW599 70MM X 395MM	D105609
7	INSULATION BURNER DOOR W/ SPARES MONO/DUO HAM	D105632
8	SWITCH TEMP LIMIT BURNER DOOR	D106936
9	GASKET BLO HW599	D104185
10	FLANGE FAN ADPT AMETEK 7.6 TO EBM RG175	D105630
11	GASKET 3.27 OD EPDM 70A HW179 GAS/AIR INL PIP	D106935
12	BLOWER 7.6 240VAC HGH OUTPUT ENHANCED FAN	D109384
13	FLANGE FAN ADPT INL 140-100MM DIA AMETEK 7.6	D105631
14	COVER VENTURI BURNER AIR/GAS MXG HW599	D105629
15	COUPLING RDCR 1/4X1/8 NPT 150 SS CF8	D106932
16	TRANSDUCER PRESS 1/4 MNPT 0-1/2 PSI	D104963
	SWITCH DIF PRESS M20 CONN CNDS HW79-599 (NOT SHOWN)	D113636
17	BRACKET PROTECTION HW299-599 CS TB G30 BOILER CTRL	D107939
18	DISPLAY BOILER BRD	D107557
19	SWITCH RKR ON/OFF 20A 250V DPST	D108302
20	PANEL DWR HW299-599	D107543
21	TRANSFORMER IGNIT	D104904
22	STANDOFF HEX #4-40 X 3/4 SS 18-8	D104901
23	BOARD CTRL BOILER 2 DRIVERS	D108471
24	SPACER RD #4 X 1/4 NYL	D104899
25	EXCHANGER HEAT HW599 ASME W/ FAST CONN	D105679
26	BRACKET HOLD DOWN HEAT EXCHANGER SS T304 HW299-599	D106928
27	PLUG HEX 1/8 BSPP SS CF8 HW79-199SIT M5 HI-LMT	D121450
28	PLUG HEX 1/4 BSPP SS CF8 HW299-599 M5 HI-LMT	D121451
29	DRAIN HOSE LOWER ASSY HW299-399	CDK 94201
	HOSE 1 OD POLY CROSS LINKED	D107853
30	ABH HW299-599 CNDS TRAP DRN	D104204
31	GROMMET 2-1/2 NEOPRENE 3-1/2 HOLE	D104277
32	PANEL SIDE HW299-399 LEFT	D117663
	PANEL SIDE HW299-399 RIGHT	D117661
	PANEL SIDE 599 LEFT	D109597
	PANEL SIDE 599 RIGHT	D109598
33	PANEL TOP HW299-399 CS A1008 TB	D110567
	TOP PANEL ASSY HW299-399	D118981
	HW599 ABH TOP PANEL	D107647
	HW599 PANEL TOP ASSY	D110440

Parts Breakdown - continued

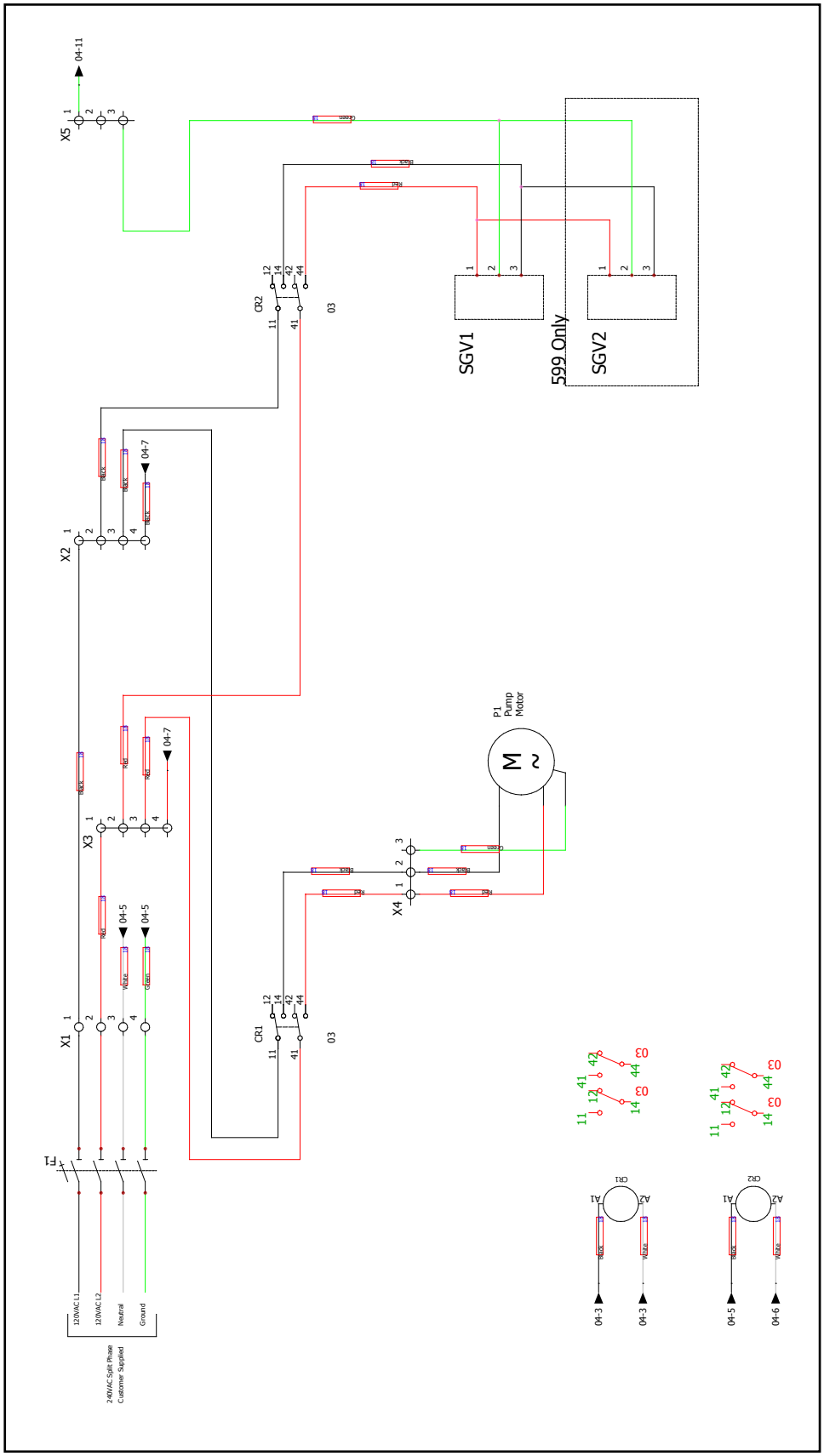
Table X.X ABH Parts Breakdown - continued		
Item#	**Part Description**	**Part Number**
34	PANEL BTM 20GA CS 1010-1020 HW299-399 POWDER COAT	D113884
	PANEL SHEET METAL BOTTOM ASSEMBLY 299-399	JKB 94102 B
	PANEL BTM 18GA CS A1008 TB HW599HOT PWDR COAT	D108482
	PANEL BTM ASSY HW599HOT	D109370
35	CAP PROTECTION 0.48 ID PVC BLACK	D108572
36	GROMMET SNAP IN 1/2 OD X 3/8 ID NYLON WHITE L	D108574
37	GASKET 5.9 OD W/ CUT 299/599 AIR INLET	D104186
38	DISK RDCR 3.2 ID X 4-1/2 DUCT FLG SS A268 AIR INL HW299-399	D113156
	COLLAR DUCT 4 SS A268	D109372
39	DUCT FLG 4-1/2 SS A268 AIR INL HW299-399	D113155
	COLLAR DUCT 5 SS A268 W/ HOSE CLAMP	D109371
40	GASKET 8.067 OD SILICON FLUE GAS HW299-399	D113103
	GASKET 7-1/2 OD SILICON FLUE GAS HW599	D104188
41	FLANGE 8.07 OD CS GALV FLUE GAS HW299-399 SPCL COAT PROC	D114072
	FLANGE FLUE 5.887 ID CS TB G90 HW599	D109123
42	THERMISTOR 1/4 MBSPP X 55 MM 10 KOHM NEGATIVE	D104921
43	FLUE GAS OUTLET ASSEMBLY HW299-399	VNT 94101 A
	FLUE GAS OUTLET ASSEMBLY HW599	VNT 94102 A
44	ABH299-399 DUO VLV NON-RTN	D113615
	ABH 599 DUO VLV NON-RTN	D104923
45	GROMMET 1.875 OD SILICONE AIR VENT TUBE BLACK	D104189
46	ROD TBE 0.54 X 9.73 SS MT304 HW299-599 AIR VENT	D108337
47	VENT AIR 1/8 NPT AUTOMATIC BRS	D104903
48	PANEL REAR ABH299-399HOT	D114534
	HW599 ABH REAR PANEL HC	D108296
49	ROD TBE 8MM X 12.812 SS T303 M8-1.25 X 1.625	D114161
	ROD TBE 8MM X 17 SS T303 M8-1.25 X 1.625	D110848
	ROD TBE M8X1.25 24.25 SS T303 HW599 HEAT EX HOLD DOWN	D108299
50	BRACKET HGR CS A1011 CS TB HW79-599 SPCR	D103748
51	BRACKET HGR CS A1011 CS TB HW79-599	D103747
52	BRACKET CS TB G30 GAS VAL FRONT HW599	D107926
53	ADAPTER NYLON 1/4 FNPT X 3/16 BARB	D104964
54	ABH PWR RELAY HOT CONTROLS	D108684
55	O-RING 26MM X 3.5MM RBR	D114528
	O-RING 1.63 OD RBR HW399	D113610
	O-RING 40MM X 4MM EPDM 60 DUROMETER	D104578
56	CLIP FORK SS T304 HW299 ARM	D113886
	CLIP FORK SS T304 HW399 ARM	D113885
	CLIP FORK SS HW599 ARM	D108335
57	THERMISTOR 1/8 NPT X 25 MM 10 KOHM NEGATIVE TEMP COEFFICIENT DUPLEX	D104920
58	THERMISTOR 1/8 NPT X 25 MM 10 KOHM NEGATIVE T	D104919

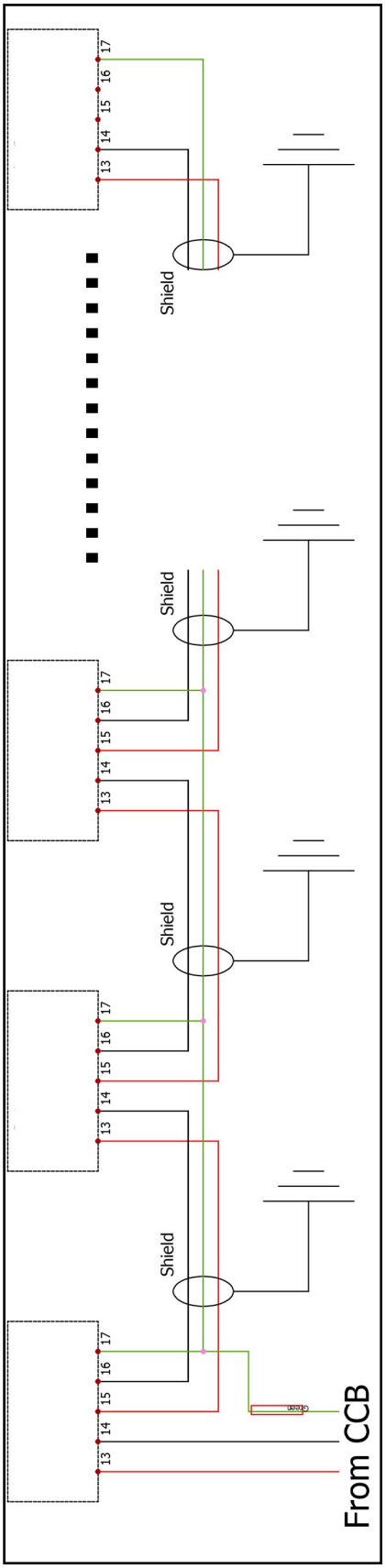
Parts Breakdown - continued

Table X.X ABH Parts Breakdown - continued		
Item#	**Part Description**	**Part Number**
59	SWITCH FLOW 1/2 MNPT 1.09 V-10 FLAT PADDLE ABH399-599SIT (HW599.3 ONLY)	D114073
60	TRANSDUCER PRESS 1/8 MNPT 0-150 PSIG (HW599.2 QTY=2X, HW599.3 QTY=1X)	D104961
61	ARM OUT ABH599	D104575
62	ARM INLET HW599 HC	D104574
63	GASKET 3/4 OD EPDM 70A DURO SQ HOLES FAST CONNECT ARM 399/599	D104191
64	PLUG PIPE 1/2 NPT BRS SQ HD SCH40 LF	D30035
65	NIPPLE TBE 3/4 NPT X 3 BRS SCH40	D10861
66	ELBOW 90 3/4 NPT CU UNS C87850 LF	D11029
67	TUBE ABH GAS HW599 OUTLET REV. D	D111660
68	ADAPTER 1 CMPXFNPT BRS HW599	D104272
69	MANIFOLD GAS OUT HW599	D105000
70	KIT FLG 3/4	D104922
71	VALVE GAS 1/2 BSPT HW79/599	D108737
72	NIPPLE HEX 1/2 MNPTXNPSL X 1 BRS	D104271
73	ADAPTER RDCR 3/4 CMP X 1/2 FNPT BRS HW599 GAS	D104275
74	MANIFOLD GAS INL HW599	D105002
75	TRANSDUCER PRESS 1/4 MNPT +/-1 PSI	D104962
76	GASKET 2.8 OD EPDM 60 DURO ABH 559 GAS MAN	D104190
77	BURNER INL HW79-399 AIR/GAS	D112959
78	BURNER PIPE HW299 70MM X 210MM	D113711
	BURNER PIPE HW399 70MM X 296MM	D113050
79	GASKET 3.27 OD EPDM 70A HW179 GAS/AIR INL PIP	D106935
80	BLOWER 7.6 240VAC STD OUTPUT ENHANCED FAN NAU	D105628
81	COVER VENTURI BURNER AIR/GAS MXG HW299	D113733
	COVER VENTURI BURNER AIR/GAS MXG HW399	D113051
82	NIPPLE TOE 3/4 BPST X 4.467 SCH40 CS A53 TF HW299-399 GAS OUT CTD ZINC AND CLEAR 299/399 GAS OUTLET TUBE	D114865
83	KIT FLG 3/4 NPT ELBOW	D114078
84	PIPE GAS INL HW399HOT	D116288
85	GASKET 2.4 OD EPDM 60 DURO INL GAS MAN	D113692
85	GASKET 2.4 OD EPDM 60 DURO INL GAS MAN	D113692

Appendix - Additional Electrical Drawings

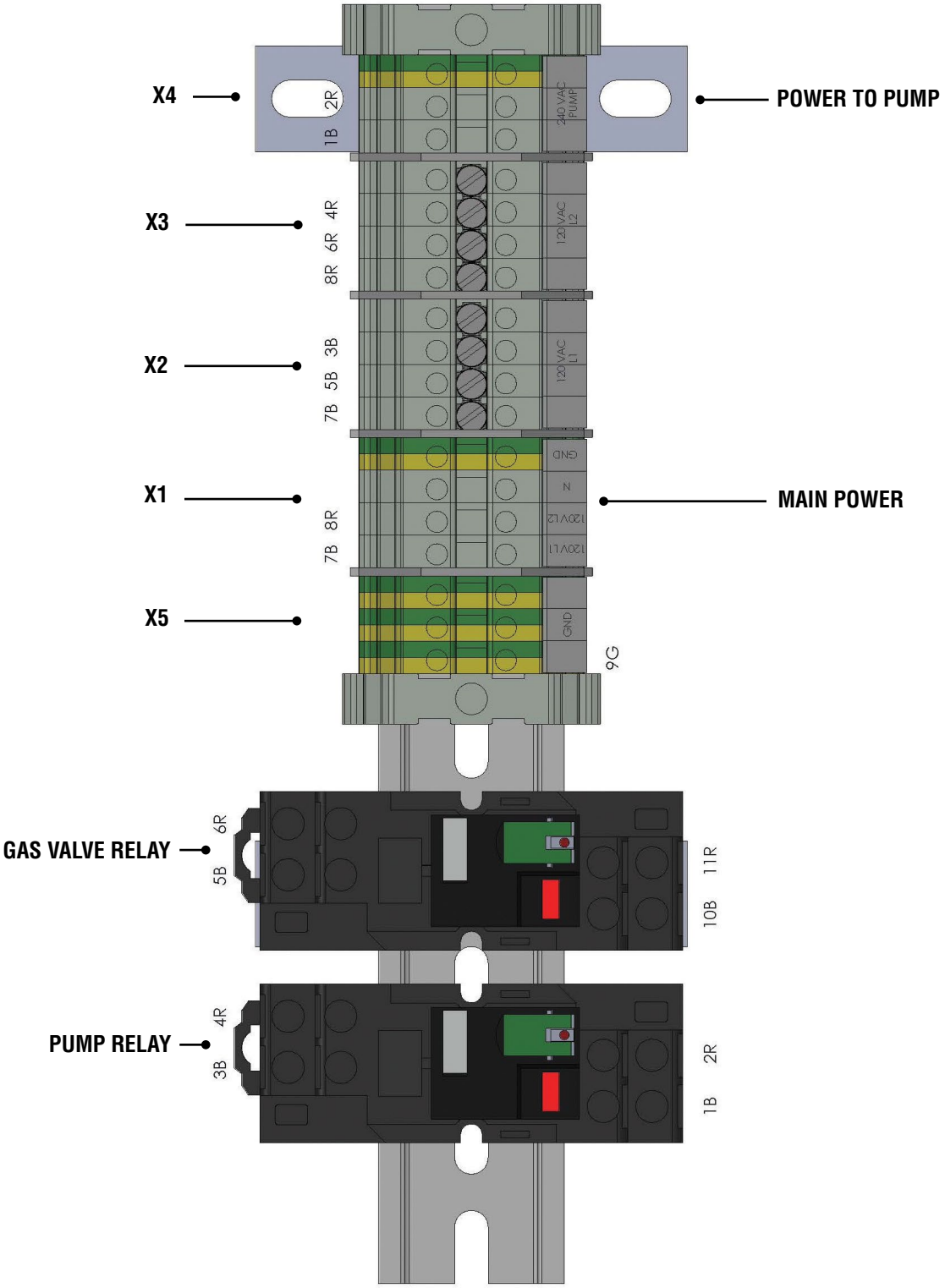
Main Power & Relay Assembly and Cascade Wiring for ABH





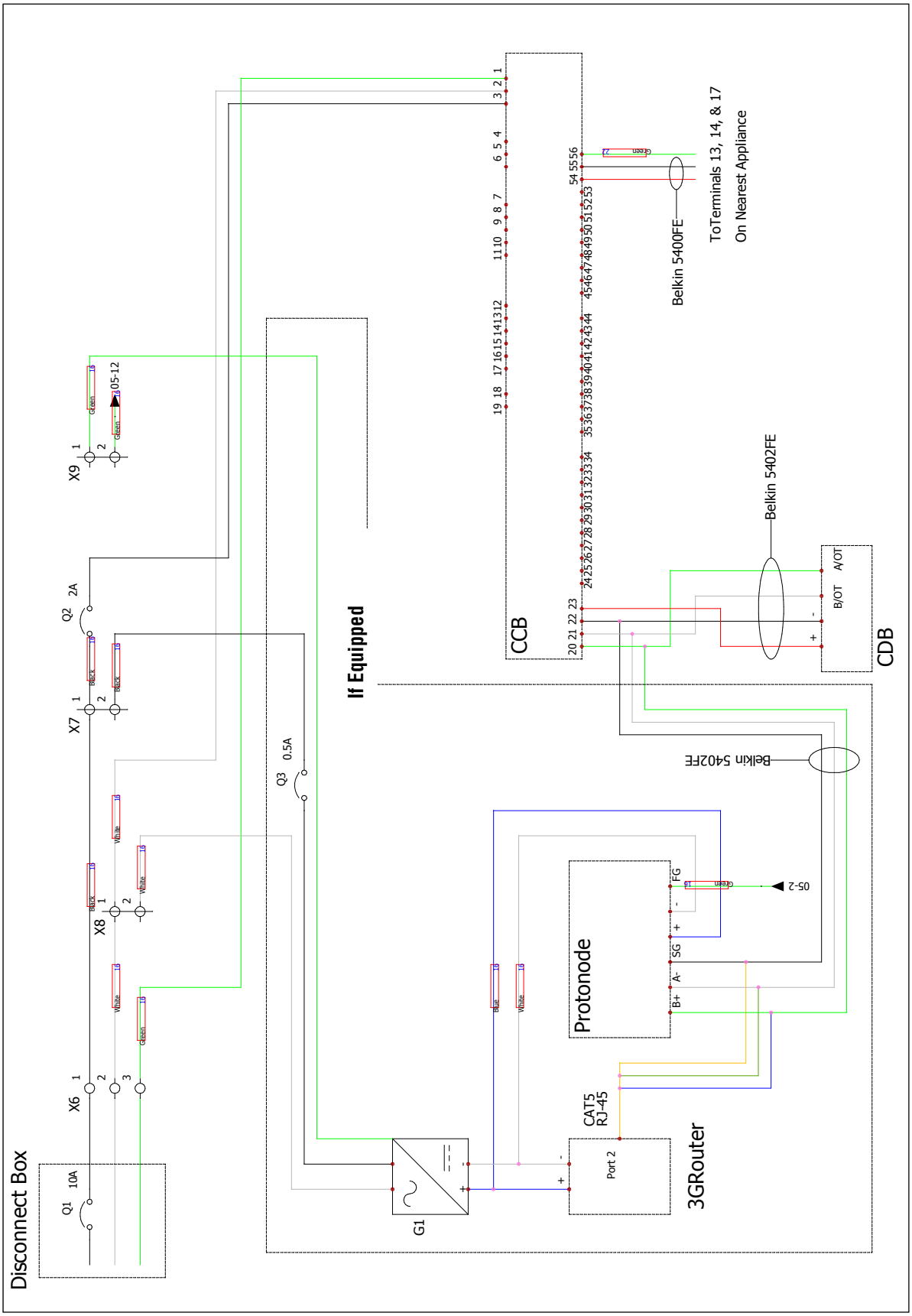
Appendix - Additional Electrical Drawings - continued

Main Power & Relay Assembly



Appendix - Additional Electrical Drawings - continued

Cascade Box with 3G Router



Notes

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Limited Warranty and Remedy

Armstrong International, Inc. or the Armstrong division that sold the product ("Armstrong") warrants to the original user of products supplied by it and used in the manner for which they are intended that the products shall be free from defects in material and workmanship for the for applicable Warranty Period (set forth below under "Warranty Periods"). This Limited Warranty shall be subject to all of the terms and conditions herein, including those listed in the Exclusions Section below. Except as may be expressly provided in a written agreement between Armstrong and the user, which is signed by both parties, Armstrong **DOES NOT MAKE ANY OTHER REPRESENTATIONS OR WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR ANY IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE.** The warranties provided herein are for the benefit of the original purchaser of Armstrong products and may not be assigned.

The sole and exclusive remedy with respect to the above limited warranty or with respect to any other claim relating to the products supplied by Armstrong, however caused, and whether such claim is based upon warranty, contract, negligence, strict liability, or any other basis or theory, is limited to Armstrong's repair or replacement of the product, or, at Armstrong's discretion, refund of the purchase price. **IN NO EVENT SHALL ARMSTRONG BE LIABLE FOR SPECIAL, DIRECT, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO, LOSS OF USE OR PROFITS OR INTERRUPTION OF BUSINESS.**

EXCLUSIONS

Without limiting the generality of the foregoing, Armstrong does not warrant or cover:

1. Any labor charges incurred by any person in connection with the examination, removal, repair or replacement/re-installation of parts claimed by the purchaser or user to be defective.
2. Any shipping or delivery charges incurred in returning or replacing products or components under this warranty.
3. Any failed components of the product or system not manufactured by Armstrong. For any such claims, users shall revert to the respective manufacturer's warranty. Armstrong shall provide reasonable assistance to users seeking warranty coverage from such component manufacturers.
4. Products repaired or altered without prior written approval of Armstrong so as to adversely affect their performance or reliability.
5. Any damage, defects or malfunctions resulting from improper installation or maintenance, misuse, abuse, accident, neglect, freezing and the like.
6. Any damage or failure resulting from scale buildup or corrosion due to high chloride or other contaminates on the inside of, or in contact with the product.
7. Any damage or failure resulting from exposure of the product or any of its components to contaminated air, including, but not limited to, chlorine, chloride, chlorinated hydrocarbons or with halogens, sheetrock particles, dryer lint, dirt or dust.
8. Any damage or failure resulting from improper installation or failure to maintain and operate the product in accordance with the printed instructions that accompany the unit.
9. Components of the product that are not defective, but must be replaced during the warranty period as a result of reasonable wear and tear. Armstrong's determination of whether any issue is caused by defect or reasonable wear and tear shall be final and conclusive.
10. Malfunctions resulting from, or repairs necessitated by, uses of the product for purposes other than that for which it was designed, or resulting from flood, fire, wind, lightning or other accidental damage.

WARRANTY PERIODS

All warranty periods herein run from (a) the date of installation, or (b) six months from shipment from the Armstrong factory, whichever is earlier (the "Warranty Start Date"). All repairs or replacement parts carry the balance of the original factory warranty. Extra charges may apply if new government or industry codes require new specifications at the time of the repair or replacement.

ABH Boiler —15 year limited warranty period. Armstrong will repair or replace units defective in workmanship or materials during the first 15 months from the Warranty Start Date. During months 16 through the seventh anniversary, Armstrong will repair or replace a unit having failed due a leaking heat exchanger due to defects in workmanship or materials. From the seventh anniversary of the Warranty Start Date to the fifteenth anniversary, Armstrong will repair or replace a unit having failed due a leaking heat exchanger due to defects in workmanship or materials at a cost to purchaser equal to the following percentages of the manufacturer's list price for a complete boiler in effect at the date of replacement.

Year of Claim:	**8–10**	**11–13**	**14–15**
% to be paid by purchaser:	35%	45%	55%

This warranty only extends to ABH boilers used in a closed loop heating applications that have been properly installed in accordance with Armstrong's installation instructions. Use of the ABH boiler as a potable water heating application voids this warranty and coverage shall be as represented in the 10 year ABH water heater warranty.

ABH Water Heater—10 year limited warranty period. Armstrong will repair or replace units defective in workmanship or materials during the first 15 months from the Warranty Start Date. During months 16 through the fifth anniversary, Armstrong will repair or replace a unit having failed due a leaking heat exchanger due to defects in workmanship or materials. From the fifth anniversary of the Warranty Start Date to the tenth anniversary, Armstrong will repair or replace a unit having failed due a leaking heat exchanger due to defects in workmanship or materials at a cost to purchaser equal to the following percentages of the manufacturer's list price for a complete water heater of like capacity and model in effect at the date of replacement.

Year of Claim:	**6–7**	**8–9**	**10**
% to be paid by purchaser:	35%	45%	55%

Indirect Water Heater—This limited lifetime warranty covers the stainless steel tank, stainless steel heat exchanger, and component parts for leakage or other malfunction caused by defects in material or workmanship. In addition to the general exclusions above, this warranty excludes excessive use, and does not apply in non-residential use. If this product is used other than for single family housing, the unit will carry a 10 year warranty on tank and one year on parts . In such cases (where the 10 year warranty applies), during the sixth through the tenth anniversary of the Warranty Start Date, replacements will be at a cost to the purchaser equal to the following percentages of the manufacturer's list price for a complete indirect water heater of like capacity and model in effect at the date of replacement.

Year of Claim:	**6–7**	**8–9**	**10**
% to be paid by purchaser:	35%	45%	55%

Safety Warning: Water heaters are heat producing appliances. To avoid injury from an overheated outer jacket, care should be taken to avoid unnecessary human contact with the jacket and then only with proper precautions, including protective gear. No materials should be stored against the jacket. Under no circumstance should flammable materials such as gasoline or paint thinners be used or stored in the vicinity of the heater or where fumes could reach the heater.

PROCEDURES FOR WARRANTY SERVICES REQUESTS

At the time a claim is filed, the purchaser must present a copy of the original sales receipt or the invoice number on which the appliance was purchased from Armstrong. If, at the time of a request for service the purchaser can not provide a copy of the of the original sales receipt or the warranty card registration, the warranty period for the product shall the be deemed to have commenced thirty (30) days after the date of manufacture (based on the product serial number) and NOT the date of installation. All alleged defective or malfunctioning parts must be returned to Armstrong via trade channels or directly to Armstrong; on receipt Armstrong will, if all warranty conditions are satisfied, provide replacement parts or repairs. Claims must be submitted in writing (a) within 30 days of the last day of the applicable warranty period, or (b) within 30 days of manifestation of the the condition or occurrence giving rise to the claim, whichever is earlier.

Designs, materials, weights and performance ratings are approximate and subject to change without notice.
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