Quality People. Building Solutions.

Comfort Systems USA (Arkansas), Inc.
P.O. Box 16620
Little Rock, AR 72231
Phone 501-834-3320
Fax 501-834-5416

Date: 5/2/2024
Return Request: 5/12/2024
Project: Little Rock West High School
Supplier: Airetech
Manufacturer: Aerco
Submittal: Condensing Boilers
Submittal Number: 23 52 16-01
Drawing # and Installation: Mechanical Drawings

ARCHITECT
Lewis Architects Engineers
11225 Huron Lane, Suite 104
Little Rock, AR 72211
501-223-9302

ENGINEER
Lewis Architects Engineers
11225 Huron Lane, Suite 104
Little Rock, AR 72211
501-223-9302

GENERAL CONTRACTOR
Baldwin & Shell
1000 W. Capitol Ave.
Little Rock, AR 72201
501-374-8677

MECHANICAL SUBCONTRACTOR
Comfort Systems USA (Arkansas), Inc.
9924 Landers Rd.
N. Little Rock, AR 72117
501-834-3320

Notes:

chowell@comfortar.com

SUBMITTAL DATA

EQUIPMENT: Aerco Boilers

SPEC SECTION:

TAGS: B-1,2,3

PROJECT: Little Rock West High School

LOCATION: Little Rock, AR

ENGINEER:

CONTRACTOR:

DATE: 4/15/2024

SUBMITTED BY: Nick Moore
nick.moore@airetechcorp.com

100 Oritani Drive • Blauvelt, NY 10913 • Phone 800-526-0288 • Fax 850-580-8090

TRANSMITTAL OF SUBMITTAL DRAWINGS

Supplied by: AERCO International, Inc.
c/o Airetech Corp
Nick Moore

Project: Little Rock West High School

Name: LR West High School Heating Water

The enclosed materials:

☐ **REQUIRE ENGINEER'S APPROVAL**

Your order is being held pending the receipt of your written release and one set of approved drawings. As soon as these are received here in Northvale, we will release the order in accordance with the production schedule shown on the cover page of the submittal. This data should be returned to us through our Representative whose name appears below.

☐ **ARE FOR RECORD ONLY**

Please forward required sets of drawings which are enclosed to your customer, along with letter of transmittal. Retain one for your records.

100 Oritani Drive • Blauvelt, NY 10913 • Phone 800-526-0288 • Fax 850-580-8090

BILL OF MATERIALS

Date: 05/15/2023
Project: Little Rock West High School
Company/Purchaser: Airetech Tulsa
Location: Little Rock, AR
Engineer: Lewis Architects Engineers
Quote Number: SQGH000369_1
Name: LR West High School Heating Water

Proposed Equipment:

Qty (1) Model: BST Controls and Management Systems which will include the following:

Accessories per Model:

Qty	Part#	Description
1	61058	HEADER SENSOR/WELL KIT, PT-1000, DUAL BEAD
1	61060	OUTDOOR AIR TEMPERATURE SENSOR, DUAL BEAD, PT 1000
1	BST	Onboard Boiler Sequencing Technology
1	EDGE	Edge
1	EDGE2	Edge[ii] - (BMK)

Qty (3) Model: BMK2500-NFGCG-US-E0MS Benchmark 2500 Boiler which will include the following:

439 Stainless steel heat exchanger with Single inlet
Fault Mode Diagnostic Panel with Digital Readout
Gas Train is in accordance with CSD-1
Normally Open Fault Relay
Adjustable Automatic Reset High Limit
Manual Reset High Limit with max 210°F Setpoint
15:1 Modulating Air/Fuel Valve
Electric Probe Low Water Cut-Off
Combination Temperature and Pressure Gauge
Insulated Heat Exchanger
Sheet metal finish: Black fine texture powder-coat
Pressure Relief Valve (shipped loose)
Condensate Trap (shipped loose)
2” External Manual Gas Cock (shipped loose)
- Pressure Vessel/Heat Exchanger: 15 Year Non-Prorated From Shipment
- “EDGE[ii]” Control Panel: 3 Years From Shipment
- Other Components: 2 Years From Shipment
- Please Review the Warranty online for additional information.
* If additional warranties are purchased, the extended warranties will either be in addition to or supersede the standard warranty.

Accessories per Model:

Qty	Part#	Description

1	58048-W100	SPARE PARTS KIT, 100 psi
1	EDGE2	Edge[ii] - (BMK)
0	NONE	Ducted Combustion: Yes
1	61060	Outdoor Air Temperature Sensor, Dual Bead, Pt 1000
0	NONE	Instruction Package: INSTRUCTION PACKAGE (O&M)
1	24337-2-5	FIFTEEN YEAR HX WARRANTY
0	NONE	Control Type: Edge
0	NONE	Fuel Type: Natural Gas
0	NONE	Gas Train: FM
0	NONE	Electrical: 460/3/60
0	NONE	Inlet: Single
1	24785-5	AERtrim: BMK2500 AERtrim
1	74793-1	O2 Monitoring: Yes

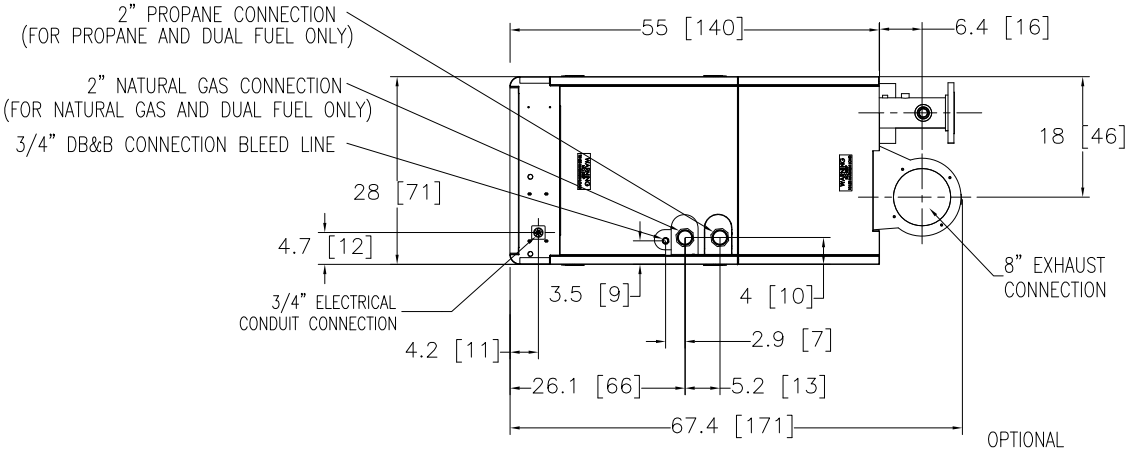
Additional Items:

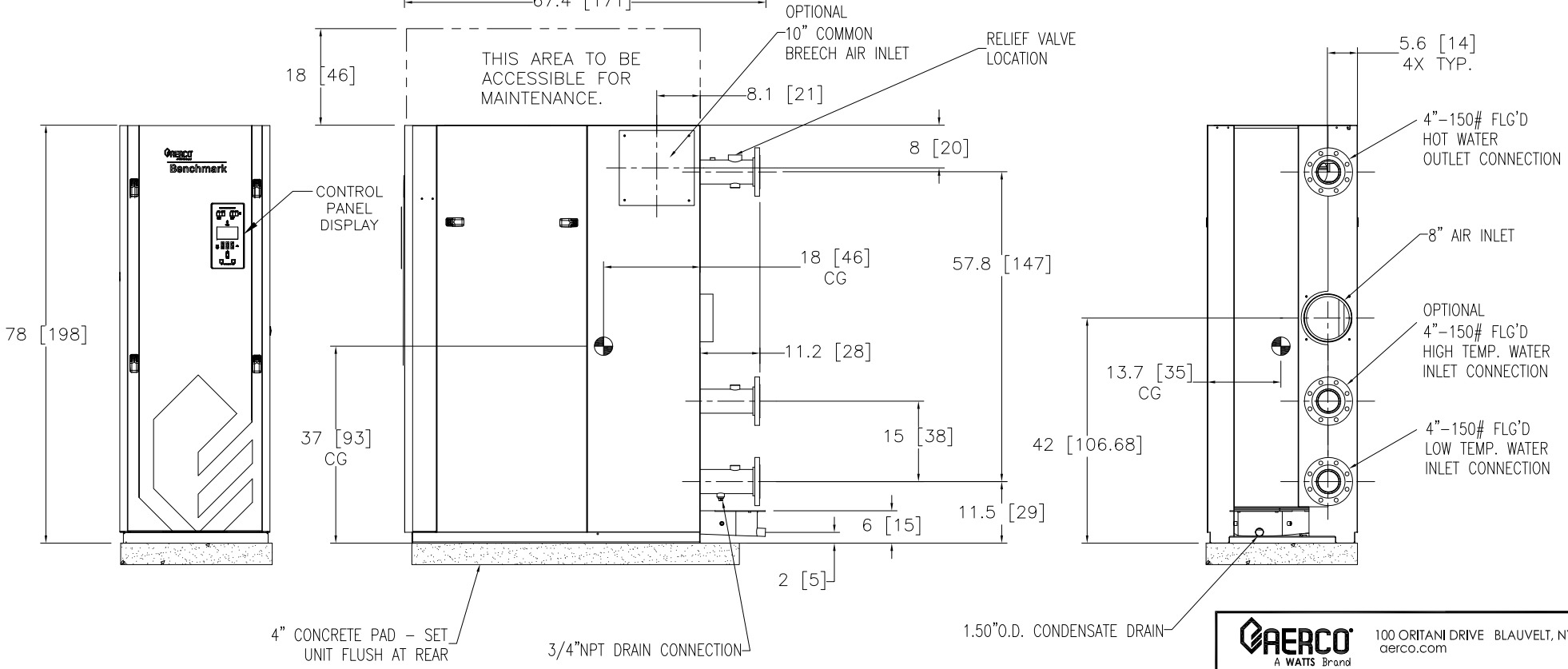
Qty	Part#	Description

MATERIALS OF CONSTRUCTION	
COMBUSTION CHAMBER	SHELL OUTER–1/4" CARBON STEEL,SA–53 GR.B SHELL INNER–1/4"STAINLESS STEEL,SA–240, 439SS HEAD–1/2" CARBON STEEL,SA–516 GR.70 EXPANSION JOINT–1/4" STAINLESS STEEL,SA–240,439SS
HEAT EXCHANGER	UPPER TUBESHEET– 1/4" STAINLESS STEEL,SA–240,439SS LOWER TUBESHEET– 1/4" STAINLESS STEEL,SA–240,439SS TUBES–STAINLESS STEEL,9/16"O.D. X .049 WALL SA–249,439SS SHELL–1/4" CARBON STEEL,SA–53,GR.A OR B

HEAT EXCHANGERS & COMBUSTION CHAMBER DESIGN STANDARDS				
MAX. WORKING PRESS. (PSIG)	MAXIMUM TEMP. (°F)	TEST PRESS. (PSIG)	HT'G SURFACE SQ.FT.	MIN. RELIEF VA. CAPACITY MBH
160	210	240	184	2500
160	210	240	205	3000

ASME B & PV CODE: SECTION IV STAMP H





NOTES:
1) ALL DIMENSIONS SHOWN ARE IN INCHES (CENTIMETERS).
2) RELIEF VALVE, TRIDICATOR & CONDENSATE TRAP ARE INCLUDED SEPARATELY IN SHIPMENT.
3) AERCO RESERVES THE RIGHT TO MODIFY BOILER DIMENSIONS WITHOUT PRIOR NOTICE

AERCO A WATTS Brand
100 ORITANI DRIVE BLAUVELT, NY 10913
aerco.com

BENCHMARK® 2500 & 3000 MBH
NATURAL GAS, PROPANE, DUAL FUEL &
DF–DB&B BOILER DUAL INLET
DIMENSIONAL DRAWING

DWN.BY PR DATE 110712 SCALE ____ SIZE A CHKD. ____ APPD. ____ DWN.BY K.S. DATE 062123	AP–A–915	REV. J

Technical Data Sheet

Benchmark 750-6000 with Edge Controller

High Efficiency Boilers

The AERCO Benchmark® (BMK) Water Boiler is designed for condensing application in any closed loop hydronic system. It delivers unmatched burner modulation to match energy input directly to fluctuating system. No other product packs as much capacity into such a small footprint that fits through a standard door and can be transported in a freight elevator.

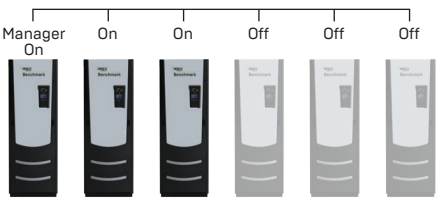
Energy Efficient

To minimize emissions, the BMK Series is fitted with a low NOx burner whose emissions will meet the most stringent NOx and CO requirements. The fully modulating burner also maintains AERCO standards for energy efficiency, longevity, reliability and construction quality.

The BMK Series comes standard with AERCO's designed and patented, Oxygen Level (O_2) monitoring system. This monitoring system, designed to display the O_2 level directly on the unit in real time, can also be remotely monitored via Modbus giving the customer the ability to measure the emissions level and fuel economy of the boiler without traditional combustion calibration devices. This system, combined with AERCO's TComp™ O_2/air temperature compensation (a standard combustion control feature available with BMK boilers for 15+ years) provides precise combustion and maintains O_2 levels throughout the year for best combustion efficiency.

Application and Plant Design

The BMK boilers can be used as an individual unit or in modular arrangements and offers selectable modes of operation. In addition to controlling the boiler according to a constant set point, indoor/outdoor reset schedule or 4-20mA signal, one or more units can be integrated via Modbus communications protocol. For boiler plants ranging from 2-16 boilers, the AERCO Edge® built-in Boiler Sequencing Technology (BST)* can be utilized. The Benchmark can be easily integrated with a facility-wide Energy Management or Building Automation System.



*See BST System technical data sheet for additional system details and capabilities

Features

- Natural gas, propane, or dual fuel
- 20:1 turndown ratio (5%) depending on capacity
- Integrated O_2 monitoring and alert for critical conditions
- 439 stainless steel fire tube heat exchanger
- Capable of variable primary flow Installations
- NOx emissions capable of 9PPM or less @ all firing rates *depending on capacity
- Compact footprint, light weight, freight elevator friendly
- Ducted combustion air capable
- Easy open access for service
- Reliable quiet operation
- Acceptable vent materials AL29-4C, Polypropylene, PVC, cPVC (model dependent)
- Optional gas train with VPS (Value Proving System) for BMK Platinum 4000/5000/6000
- Outdoor solution available

Edge [i]

- Precise temperature vontrol
- On-board Boiler Sequencing Technology (BST)
- Controls options: constant setpoint, indoor/outdoor reset, remote setpoint, 4-20mA signal or ModBus

Specifications

	BMK									
	750	1000	1500	2000	2500	3000	4000	5000N	5000[4]	6000[4]
Boiler Category	ASME Sect.IV									
Gas Connections (NPT)	1”		2”				3”		2 / 3”	
Max. Gas Pressure	14”								2psi/10”[4]	
Min. Gas Pressure [1]	4”								14 / 4”[4]	
Max. Allowed Working Pressure	160 PSIG								80PSIG/150 PSIG Optional	
Electrical Req. 120V/1PH/60Hz [2]	13 FLA		16 FLA		N/A					
Electrical Req. 208V/3PH/60Hz [2]	N/A				10 FLA		23 FLA		19 FLA	
Electrical Req. 460V/3PH/60Hz [2]	N/A				5 FLA		12 FLA		9 FLA	
Electrical Req. 575V/3PH/60Hz [2]	N/A				N/A		N/A		7 FLA	
Water Connect. (Flanged)	3”		4”				6”		6”	
Min. Water Flow (GPM)	12		25				35		75	
Max. Water Flow (GPM)	175		250	350			500		600	
Water Volume Gallons	28	26	44	40	60	55	77		110	
Water Pressure Drop	3.0 PSIG @100 GPM		3.0 PSIG @170 GPM		3.2 PSIG @ 250 GPM		5.0 PSIG @475 GPM		4.0 PSIG @500 GPM	
Turndown Ratio	15:1 (7%)	20:1 (5%)		20:1 (5%)	15:1 (7%)	15:1 (7%)	15:1 (7%)	20:1 (7%)	12:1 (8%)	15:1 (7%)
Vent/Air Intake Connections	6 Inch			8 Inch			12 Inch Vent/10 Inch Air Intake		14 Inch Optional/ 12 Inch Flue Venting	
Vent Materials	AL29-4C Polypro, CPVC, PVC		AL29-4C Polypro							
Type of Gas	Natural Gas, Propane, Dual Fuel									
NOx Emissions <9ppm Capability[4]	✓		✓		<13 ppm		✓		✓	
Temp. Control Range	50ºF to 190ºF									
Ambient Temp. Range	0ºF to 130ºF									
Standard Listings & Approvals	UL, CUL, CSD-1, ASME									
Gas Train Operations	FM Compliant or Factory Installed DBB (IRI)						FM Compliant or Factory Installed DBB (IRI), VPS (Value Proving System)		FM Compliant, VPS (Val-ue Proving System)	
Sound Rating dbA	65	65	70	70	72	72	75		79	
Weight (dry) lbs.	669	700	1406	1500	2,000	2,170	2200		3,000	
Shipping Weight lbs.	862	900	1606	1700	2,200	2,300	2350		3,800	

1. Values are for natural gas FM compliant gas trains only. See Benchmark Gas Components & Supply Design Guide GF-2030 for propane, DBB & dual fuel gas train minimum gas pressure requirements.
2. See Benchmark Electrical Power Guide GF-2060 for Service Disconnect Switch amperage requirements.
3. BMK5000/6000 operating at standard gas pressure (>14” W.C.) can achieve 9 ppm NOx.
4. BMK5000/6000 low gas pressure option is available as a different style number. It operates between 4” and 10” of gas pressure.

Ratings

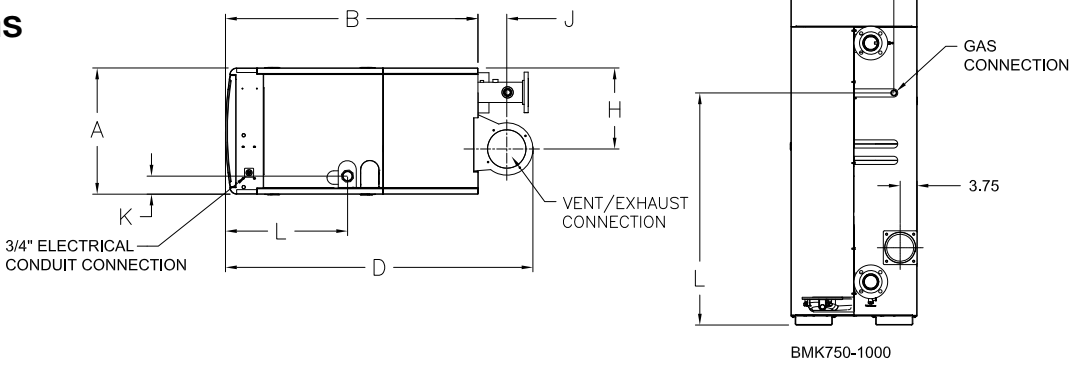
BMK	Min Input MBH	Max Input MBH	Max Output[1] MBH	Efficiency Range	Thermal Efficiency 80° to 180°F
750	50	750	653-720	87%-98%	95.6%
1000	50	1000	870-960	87%-98%	96.8%
1500	75	1500	1305-1440	87%-98%	94.6%
2000	100	2000	1740-1920	87%-98%	94.6%
2500	167	2500	2175-2400	87%-98%	93.5%
3000	200	3000	2610-2880	87%-98%	94.6%
4000	267	4000	3480-3840	87%-98%	94.1%
5000N	250	4990	4341-4790	87%-98%	93.8%
5000	400	5000	4350-4800	87%-98%	94.8%
6000	400	6000	5220-5760	87%-98%	94.5%

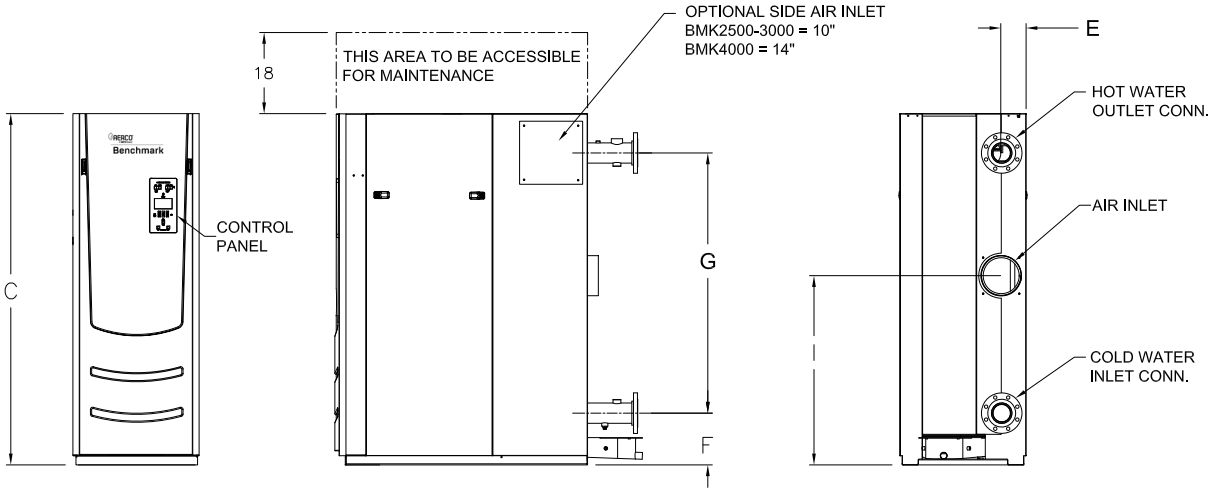
[1]Max output dependent upon application – see efficiency curves

Dimensions

750-4000

Dim: Inches



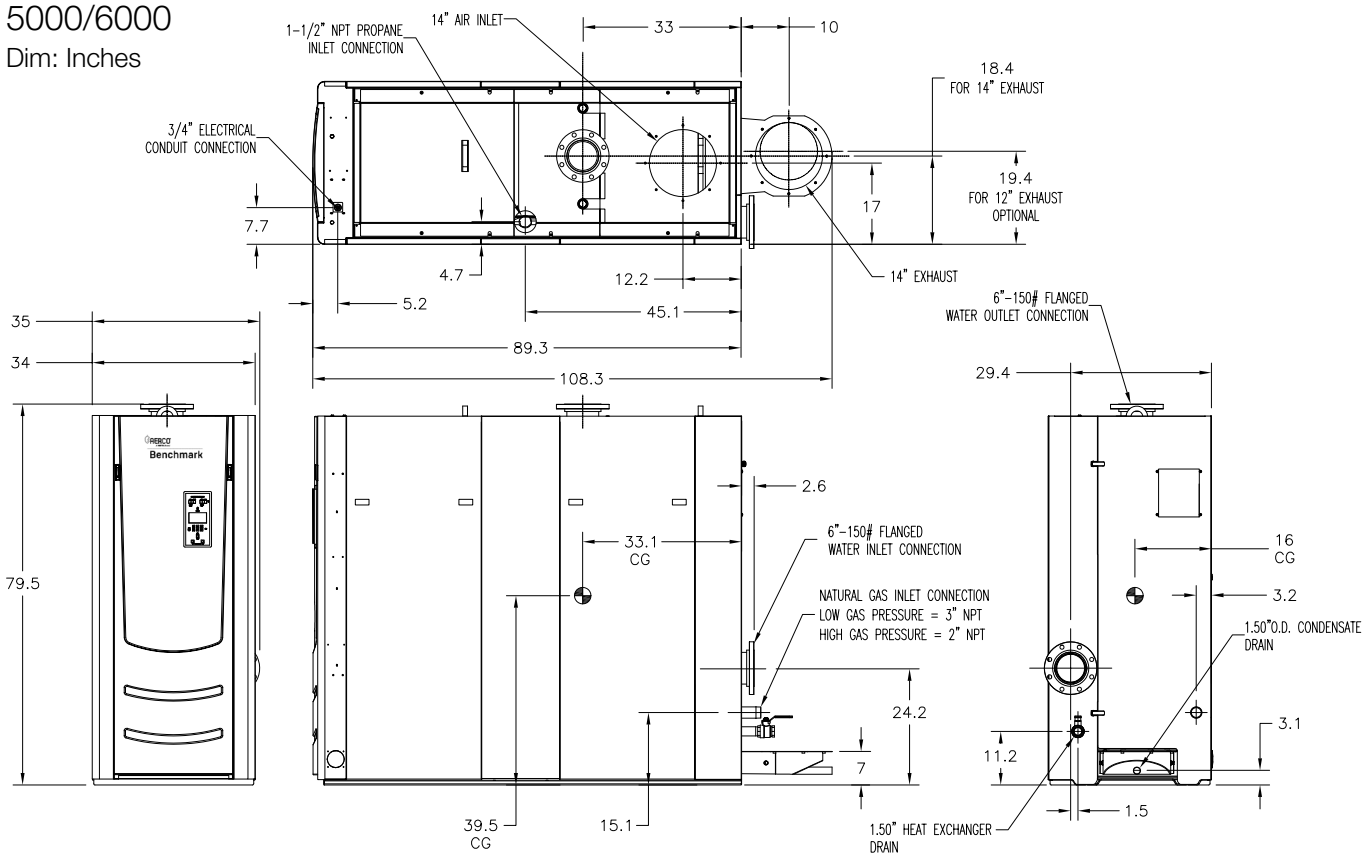


BMK Models	(Width) A	(Depth) B	(Height) C	D	E	F	G	H	I	J	K	L
750	28”	24.5”	78”	34”	10.2”	9.6”	53”	21”	17.1”	4.5’	5.1”	51.5”
1000	28”	25”	78”	34”	10.2”	9.6”	53”	21”	17.1”	4.5”	5.1”	51.5”
1500	28”	43.6”	78”	58.4”	6.6”	11.5”	57.8”	18”	42”	8.9”	4.4”	19.1”
2000	28”	43.6”	78”	58.4”	7”	11.5”	57.8”	18”	42”	8.9”	4.4”	19.1”
2500	28”	56”	78”	68.4”	5.6”	11.5”	57.8”	18”	42”	6.4”	4.4””	27.1”
3000	28”	56”	78”	68.4”	5.6”	11.5”	57.8”	18”	42”	6.4”	4.4””	27.1””
4000	34”	63.5”	78.2”	80.6”	6”	12.4”	56”	21.4”	44.4”	9”	5.5”	28.7”
5000N	34”	63.5”	78.2”	80.6”	6”	12.4”	56”	21.4”	44.4”	9”	5.5”	28.7”

Dimensions

5000/6000

Dim: Inches



BMK Models	(Width) A	(Depth) B	(Height) C
5000	35”	89.3”	79.8”
6000	35”	89.3”	79.8”

AERCO®
A **WATTS** *Brand*

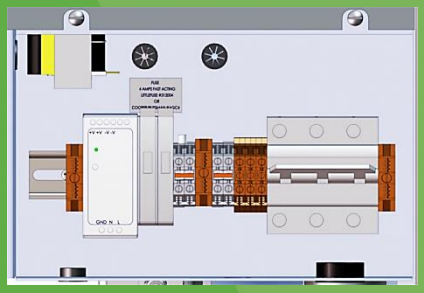
Heating and Hot Water Solutions

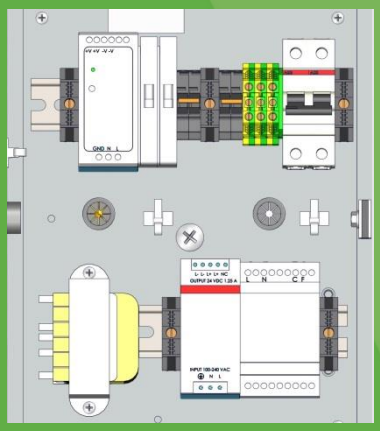
AERCO International, Inc. • 100 Oritani Drive • Blauvelt, NY 10913
USA: T: (845) 580-8000 • Toll Free: (800) 526-0288 • AERCO.com

Electrical Power Design Guide

Benchmark® Boilers

Models 750 through 6000





Other documents for this product include:

OMM-0127 BMK750K-3000K Installation-Startup KOREA
OMM-0128 BMK750K-3000K Operation- Maintenance KOREA
OMM-0136 BMK750-6000 Platinum-Edge Installation-Startup
OMM-0137 BMK750-6000 Platinum-Edge Operation-Service
OMM-0138 BMK750-6000 Platinum-Edge Reference Manual

TAG-0019 Benchmark Boiler Application Guide
TAG-0022 Benchmark Vent & Combustion Air Guide
TAG-0047 Benchmark Gas Guide

TAG-0048_Q • 5/16/2023

Heating and Hot Water Solutions
AERCO International, Inc. • 100 Oritani Drive • Blauvelt, NY 10913
USA: T: (845) 580-8000 • Toll Free: (800) 526-0288 • AERCO.com
Technical Support • (800) 526-0288 • Mon-Fri, 8 am - 5 pm EST

1. GENERAL

Benchmark (BMK) Gas Fired Boilers are fully factory wired packaged units which require simple external power wiring as part of the installation (Figure 1). This technical guide is intended to help designers provide electrical power wiring (line voltage) to Benchmark units. Control wiring details are provided in other publications, depending upon unit application. This document is intended only as a guide and therefore cannot include all possible alternatives or unit applications. In order to comply with all codes and authorities having jurisdiction, designers and installers must plan the electrical wiring carefully and execute the installation completely. Emergency shutoffs, fusible fire switches, break glass stations, and other electrical requirements should be considered and installed whenever necessary.

2. BOILER ELECTRICAL REQUIREMENTS

Benchmark boilers are available with the following power options:

BMK Model	Voltage	Phase	Amperage
BMK750 – 1000 Domestic	120 V	1Ø / 60 Hz	15
BMK750 – 1000 International	220 V	1Ø / 50-60 Hz	20
BMK1500 – 2000 Domestic	120 V	1Ø / 60 Hz	20
BMK1500 – 2000 International	220 V	1Ø / 50-60 Hz	20
BMK2500 - 3000 Domestic	208 V	3Ø / 60 Hz	20
	480 V	3Ø / 60 Hz	15
BMK2500 - 3000 International	380-415 V	3Ø / 50-60 Hz	15
BMK4000 – 5000N Domestic	208 V	3Ø / 60 Hz	40
	480 V	3Ø / 60 Hz	20
BMK4000 – 5000N International	380-415 V	3Ø / 50-60 Hz	20
BMK5000 - 6000 Domestic	208 V	3Ø / 60 Hz	30
	480 V	3Ø / 60 Hz	20
BMK5000 - 6000 Canada	575 V	3Ø / 60 Hz	20
BMK5000 - 6000 International	380-415 V	3Ø / 50-60 Hz	20

Voltages lower than those specified in the table above will result in increased wear and premature failure of the blower motor. Wire size and type should be made per the National Electrical Code based on length and load.

For all Benchmark models, the power box for field wiring connections is located in the upper right corner behind the unit front panel. All copper wire must be connected to the power box.

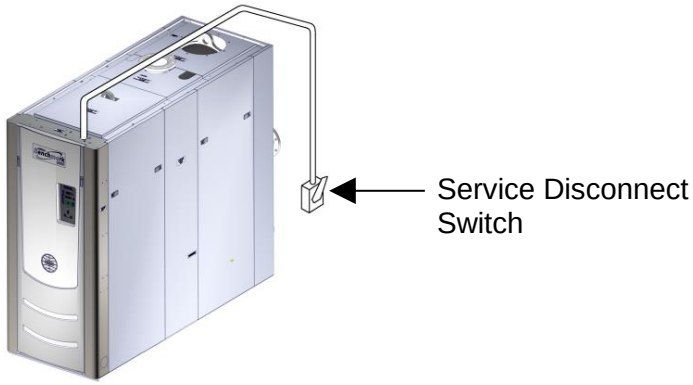


Figure 1: Service Disconnect Switch Typical Location

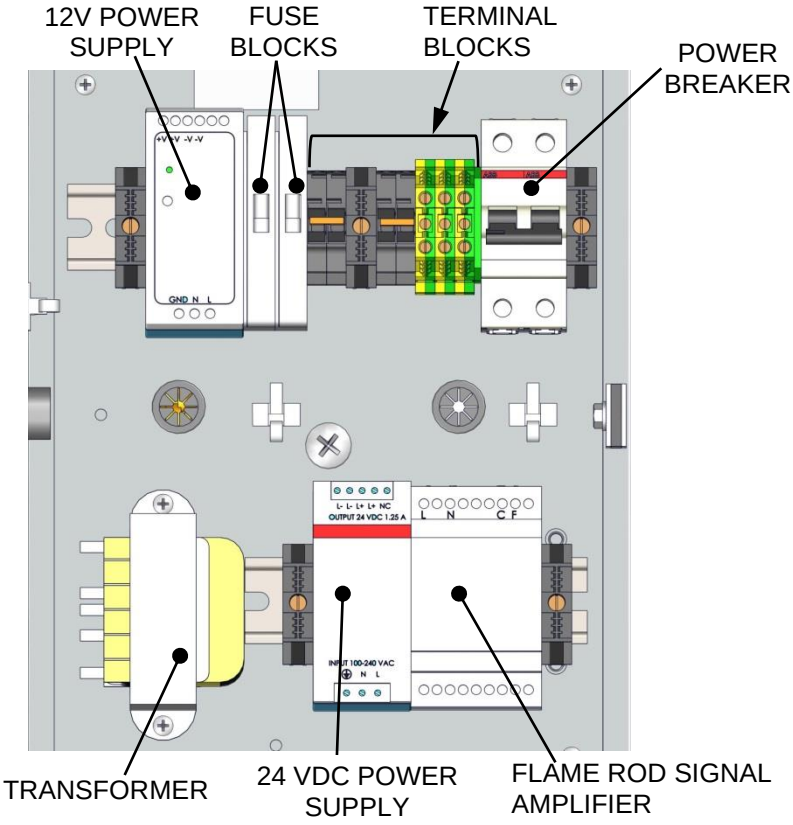


Figure 2a: Power Box Components, BMK750 & 1000 – DOMESTIC

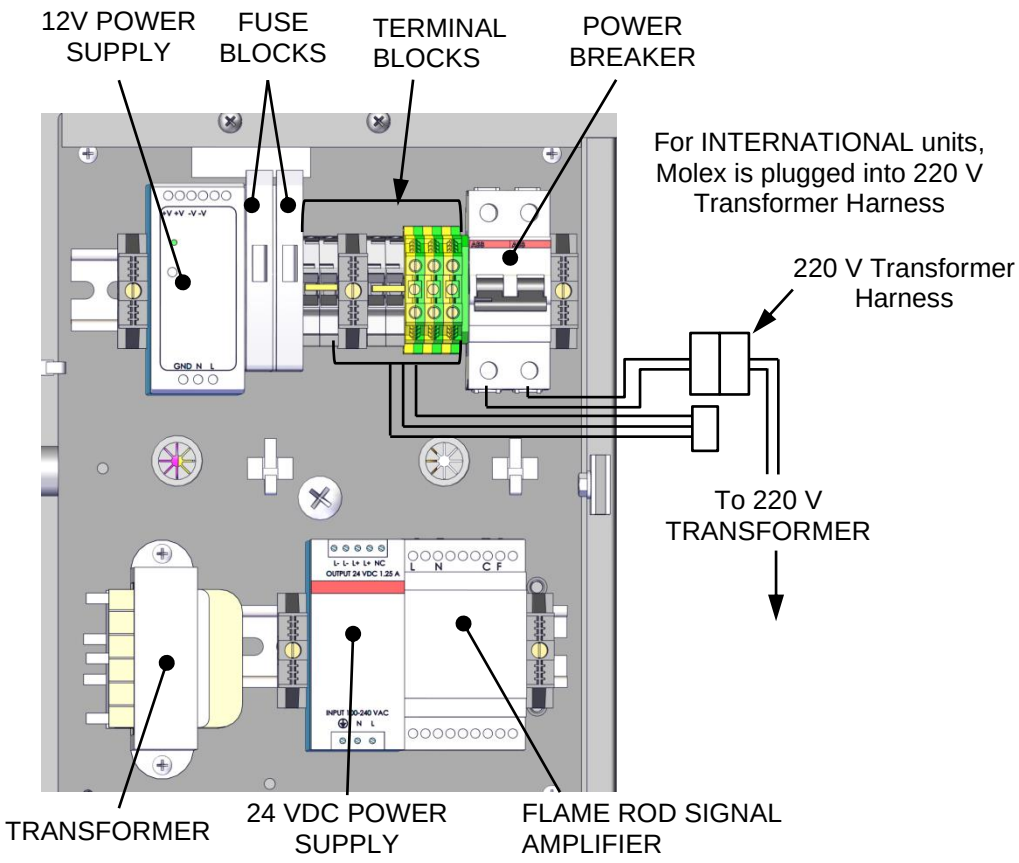


Figure 2a: Power Box Components, BMK750 & 1000 – INTERNATIONAL

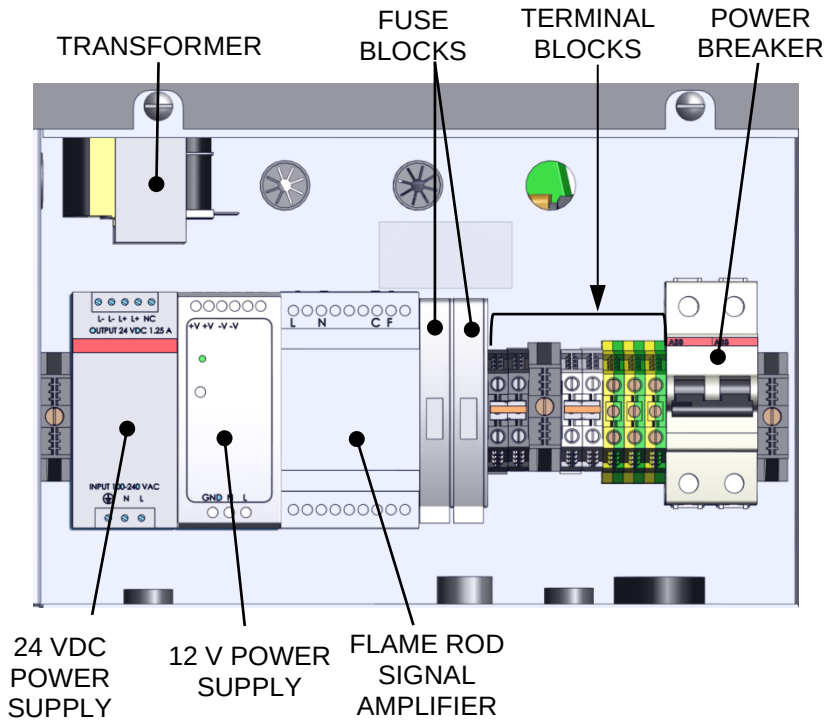


Figure 3a: Power Box Components, BMK1500 – 2000 – DOMESTIC

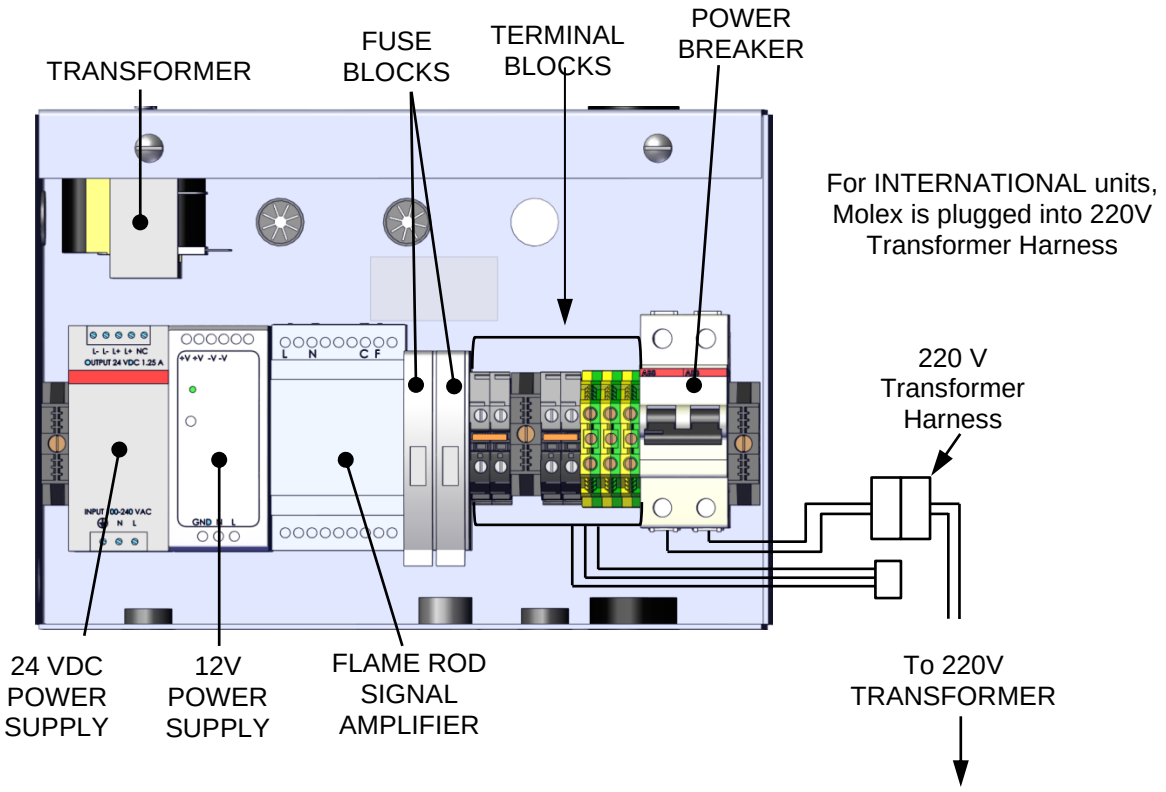


Figure 3b: Power Box Components, BMK1500 – 2000 – INTERNATIONAL

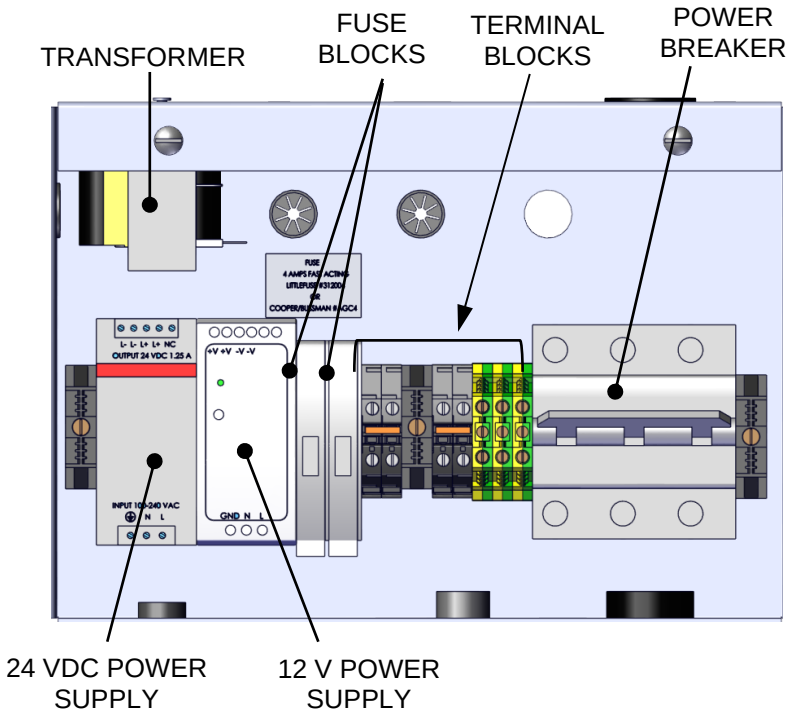


Figure 4a: Power Box Components, BMK2500 – 6000 – DOMESTIC

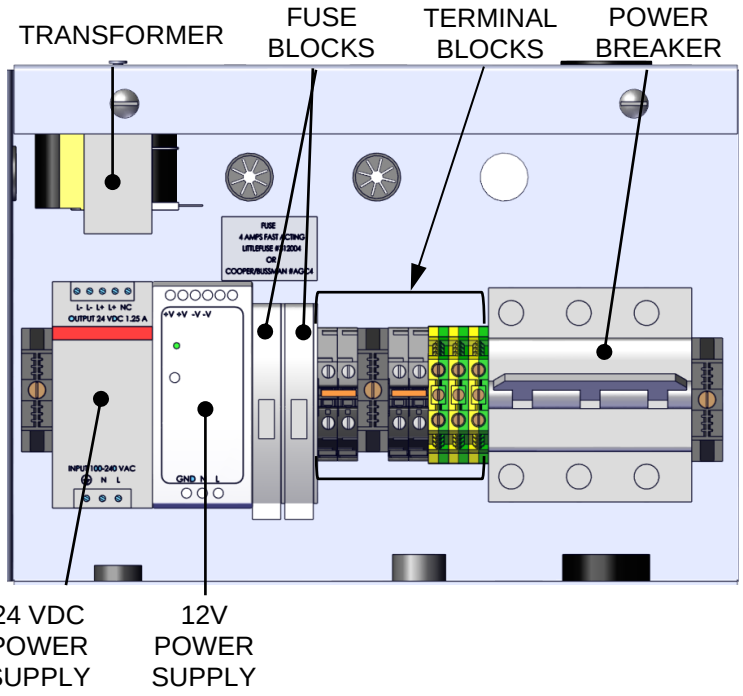


Figure 4b: Power Box Components, BMK2500 – 6000 – INTERNATIONAL

3. PROVISIONS FOR SERVICE

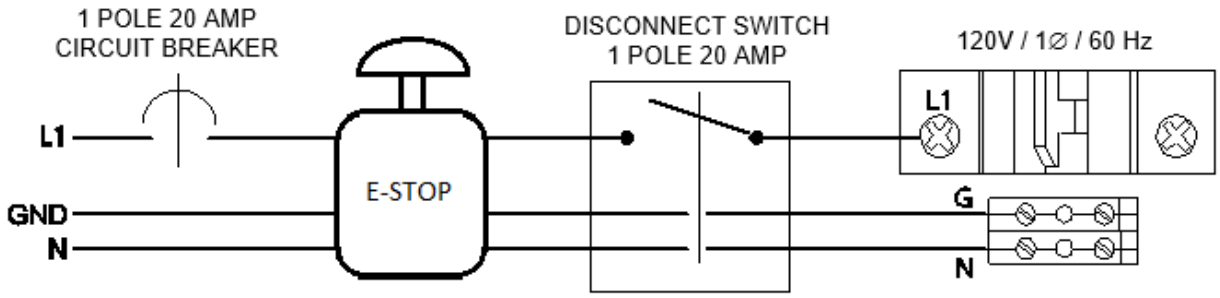
Designers must provide emergency shutoffs and other devices to satisfy electrical codes. It is also recommended to provide an electrical shutoff disconnect switch of suitable load carrying characteristics near each BMK boiler. No electrical boxes or field components should be mounted to the surface of the boiler or where they would interfere with the removal of the side or top panels for maintenance. The service disconnect switch should be mounted near the unit, as illustrated in Diagram 1. Wiring conduit, EMT, or other wiring paths should not be secured to the unit but supported externally. Electricians should be instructed as to where the wiring conduit should be located, such as away from the relief valve discharge, drains, etc. All electrical conduit and hardware should be installed so that it does not interfere with the removal of any covers, inhibit service or maintenance, or prevent access between the unit and walls or another unit.

4. BOILER WIRING

A dedicated protected circuit, sized for the amperage values below, should be provided to the boiler. No other electrical devices should be permanently wired on the same circuit.

An emergency switch (electrical shutoff) must be wired in series with power to the unit. Connecting an emergency shutoff switch (E-stop) to the main power terminals of the boiler is the safest way to disable and un-power the unit. Use of the remote interlock, located on the I/O board, is not recommended since it does ***not*** cutoff power within the unit, it only disables it. Under no circumstance should the remote interlock of the BST Manager unit be used as an emergency switch for the plant.

Multiple Unit Wiring: When multiple units are installed within the same mechanical spaces, electrical code requirements call for a single electrical shutoff for emergency use. It is the responsibility of the electrical designer to comply with local codes and regulations affecting an individual installation.



The following table lists the input power requirements for all Benchmark boilers, including the diagram number of each model's corresponding schematic diagram:

	DOMESTIC UNITS				INTERNATIONAL UNITS			
BMK Model	**Diag.**	**Voltage/Phase/Frequency**	**Amps**	**Wires**	**Diag.**	**Voltage/Phase/Frequency**	**Amps**	**Wires**
750 – 1000	1a	120V / 1∅ / 60 Hz@	15 A	3	1b	220V / 1∅ / 50- 60 Hz	20 A	3
1500 – 2000			20 A					
2500/3000	2	208V / 3∅ / 60 Hz	20 A	5				
	3a	480V / 3∅ / 60 Hz	15 A	4	3b	380-415V / 3∅ / 50- 60 Hz	15 A	4
4000/5000N	7	208 V / 3∅ / 60 Hz	40 A	4				
	6a	480V / 3∅ / 60 Hz	20 A	4	6b	380-415V / 3∅ / 50- 60 Hz	20 A	4
5000/6000	4	208V / 3∅ / 60 Hz	30 A	4				
	5a	480V or 575V / 3∅ / 60 Hz	20 A	4	5b	380-415V / 3∅ / 50-60 Hz	20 A	4

For applicable wiring connections, refer to the schematic diagrams below.

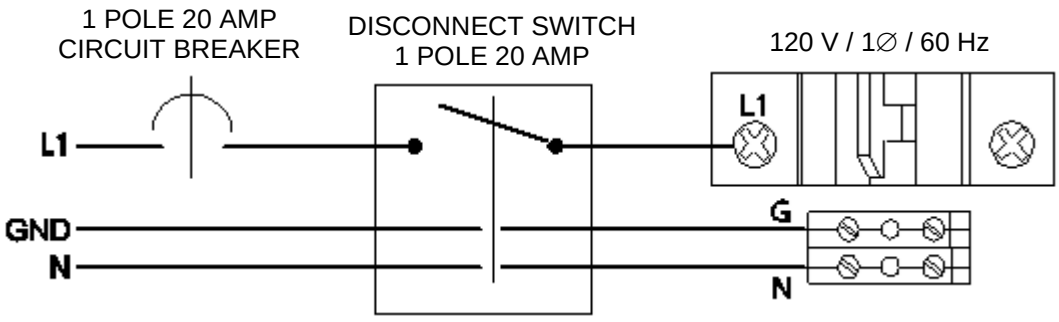


Diagram 1a - BMK750 – 2000: 120 V / 1∅ / 60 Hz Wiring Schematic – 3 Wire – DOMESTIC

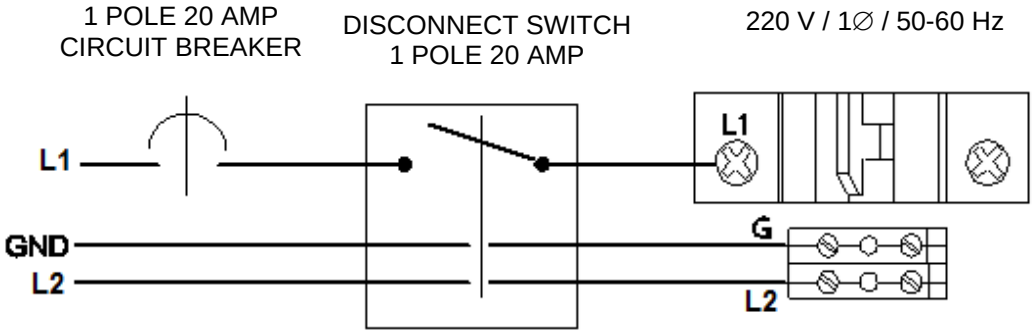


Diagram 1b - BMK750 – 2000: 220 V / 1∅ / 50-60 Hz Wiring Schematic – 3 Wire – INTERNATIONAL

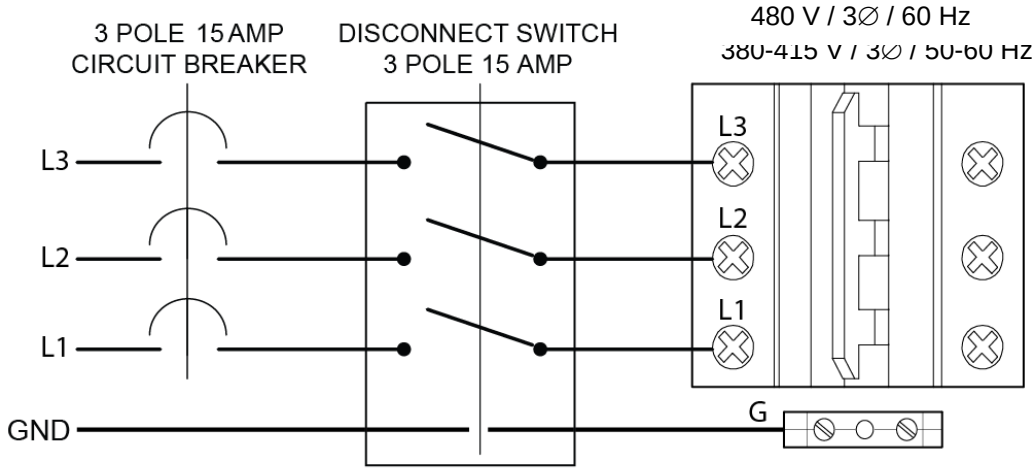


Diagram 2 - BMK2500-5000N: 380-415 V / 3∅ / 50-60 Hz Wiring Schematic- 4 Wire – INTERNATIONAL

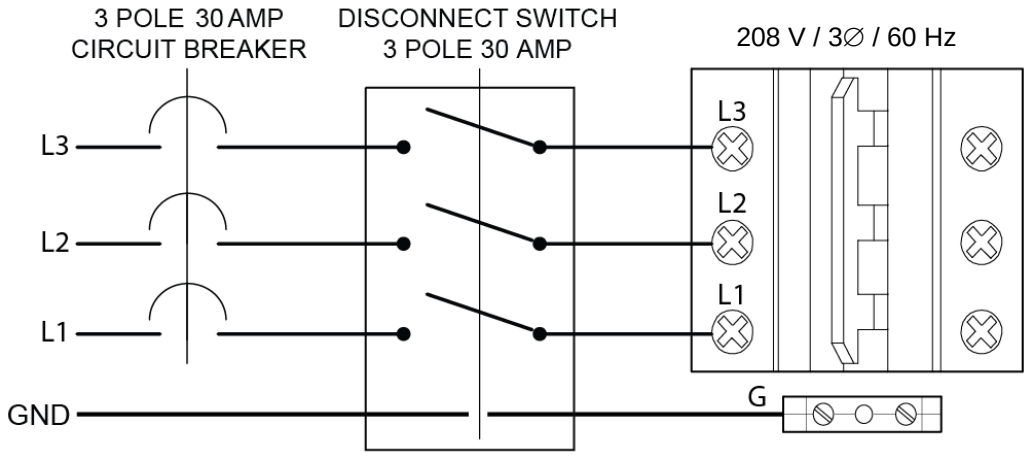


Diagram 3: BMK5000/6000: 208 V / 3∅ / 60 Hz Wiring Schematic- 4 Wire – DOMESTIC

480 V / 3∅ / 60Hv ***or***
575 V / 3∅ / 60 Hz

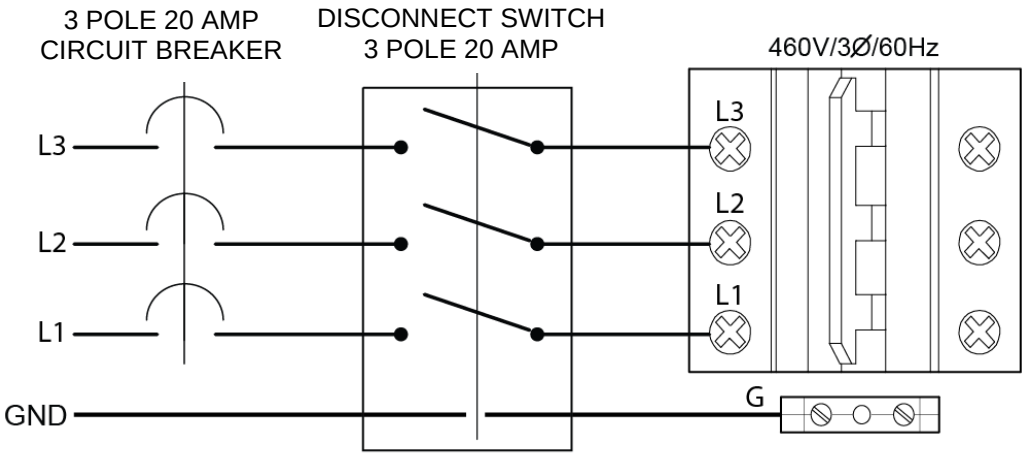


Diagram 4a: BMK5000/6000: 480 V or 575 V / 3∅ / 60 Hz Wiring Schematic- 4 Wire – DOMESTIC

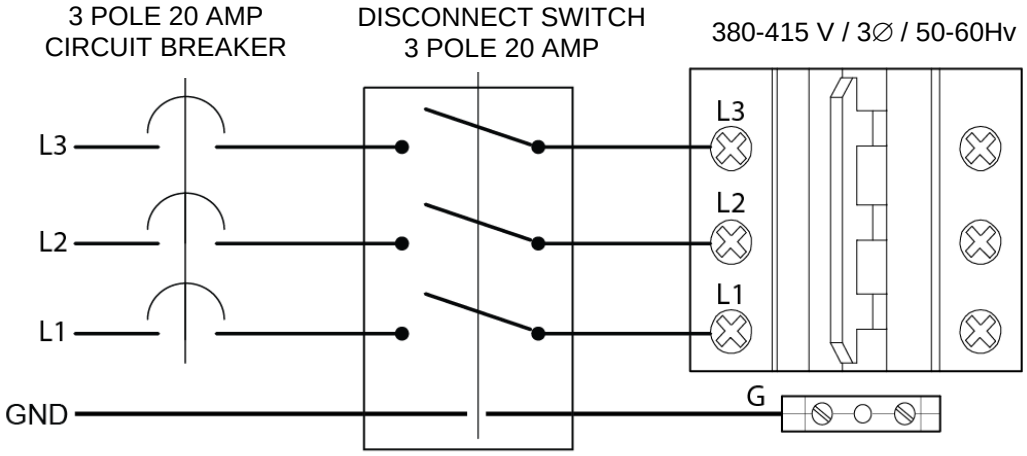


Diagram 4b: BMK5000/6000: 380-415 V / 3∅ / 50-60 Hz Wiring Schematic- 4 Wire – INTERNATIONAL

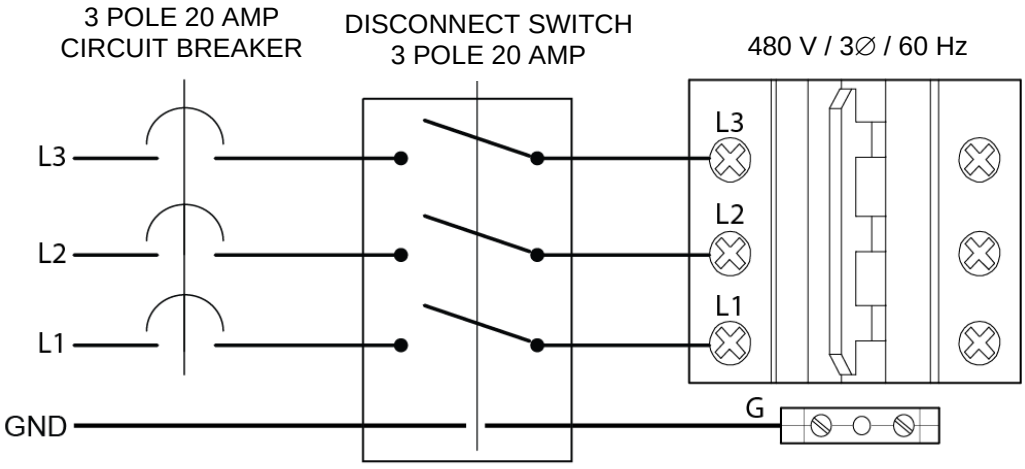


Diagram 5a - BMK4000-5000N: 480 V / 3∅ / 60 Hz Wiring Schematic- 4 Wire – DOMESTIC

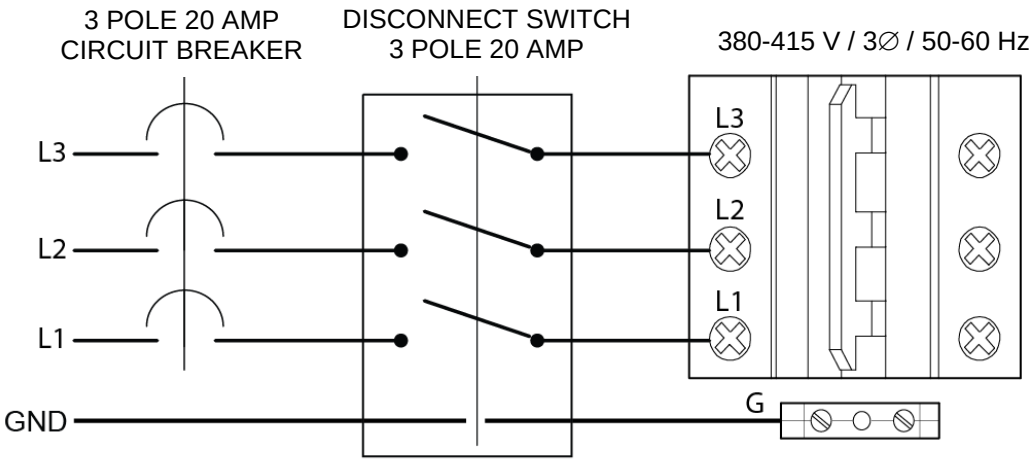


Diagram 5b- BMK4000-5000N: 380-415 V / 3∅ / 50-60 Hz Wiring Schematic- 4 Wire – INTERNATIONAL

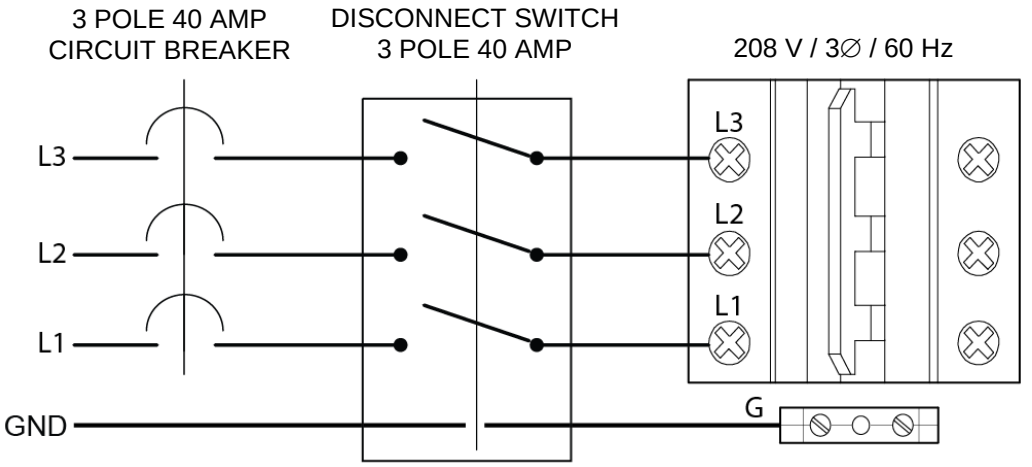


Diagram 6: BMK2500-5000N: 208 V / 3∅ / 60 Hz Wiring Schematic- 4 Wire – DOMESTIC

Change Log:

Date	Description	Changed by
6/9/2020	**Rev O:** Added BMK5000N information where applicable.	Linley Thobourne, Chris Blair
5/16/2023	**Rev P:** Added diagram and description of E-Stop power shutoff switch to Section 4. Added 208 V row to BMK 4000/5000N – Domestic, changed amperage from 15 to 20 in Sections 2 and 4. Added new wiring schematic diagrams 6a, 6b and 7 for the BMK4000 & 5000N.	Chris Blair
5/16/2023	**Rev Q:** Removed reference to Platinum; updated formatting	dwbarron

Gas Supply Design Guide

Benchmark® Boilers

Models 750 through 6000

Other documents for this product include:

OMM-0127 BMK750K-3000K Installation-Startup KOREA
OMM-0128 BMK750K-3000K Operation- Maintenance KOREA
OMM-0136 BMK750-6000 Edge [II] Installation-Startup
OMM-0137 BMK750-6000 Edge [II] Operation-Service
OMM-0138 BMK750-6000 Edge [II] Reference Manual
OMM-0144 BMK750-6000-Edge [I] Installation-Startup
OMM-0145 BMK750-6000-Edge [I] Operation-Service
OMM-0146 BMK750-6000-Edge [I] Reference Manual

TAG-0019 Benchmark Boiler Application Design Guide
TAG-0022 Benchmark Vent & Combustion Air Design Guide
TAG-0048 Benchmark Electrical Power Design Guide

TAG-0047_S • 11/14/2020

Heating and Hot Water Solutions
AERCO International, Inc. • 100 Oritani Drive • Blauvelt, NY 10913
USA: T: (845) 580-8000 • Toll Free: (800) 526-0288 • AERCO.com
Technical Support • (800) 526-0288 • Mon-Fri, 8 am - 5 pm EST

1. SAFETY PRECAUTIONS

AERCO Benchmark Low NOx gas fired boilers are modulating input devices that require an adequate volume of natural gas at constant pressure for proper operation. The gas requirements specified in this document must be satisfied to ensure efficient combustion. Designers and installers must adhere to the AERCO specifications and those of the local authorities having jurisdiction. A thorough understanding and knowledge of these guidelines is required for the successful design and installation of Benchmark Low NOx series boilers.

1.1 Gas Train Components

AERCO Benchmark gas-fired boilers are equipped with standard UL approved/FM compliant gas trains. These gas trains are factory tested and fired, with a minimum number of modular components. The gas train components have been designed to operate at high combustion efficiencies by closely controlling both the volume and air/fuel mixture to the burner. The major internal gas train components are:

- **SAFETY SHUT OFF VALVE (SSOV) With BUILT-IN SUPPLY GAS REGULATOR** - An electro-hydraulic gas valve, containing a proof of closure switch, is utilized to stop fuel from flowing into the gas train of the boiler. This is a 100% tight shutoff device with a visible window indicator showing valve position. Reliable, and a standard industry component, this valve is factory piped with a low gas pressure switch on the inlet side of the valve which monitors the manifold pressure for minimum supply conditions. There is also a high gas pressure switch installed on the outlet side of the gas valve, which shuts down the boiler if gas manifold pressures exceed maximum conditions.

  For minimum and maximum gas pressures, see Table 1, below.

- **AIR/FUEL VALVE** - The air/fuel valve controls the volume and mixture of air and fuel in perfect proportion throughout the entire modulation range of the boiler. The valve utilizes one common shaft to simultaneously vary the gas port area and air volume. The gas portion of the valve is a slide port type valve with linear proportion-to-position characteristics. The air side uses a butterfly type valve for adjusting the air volume. The driver of the valve shaft is a precision stepping motor which provides continuous positioning from full input to minimum fire. The air/fuel valve also contains two proof-of-position switches.

- **CAST ALUMINUM BLOWER ASSEMBLY** - A cast aluminum pre-mix blower ensures the precise mixing of air and fuel prior to entering the burner thereby providing controlled combustion.

- **LOW NOx BURNER** – The burner provides the actual point of air/fuel contact and combustion into the cylindrical combustion/heat exchanger. Fabricated from metal fiber mesh covering a stainless-steel body, the burner is stable throughout the entire input range of the boiler. The spark igniter and flame detector for the combustion supervision system are part of this assembly. The burner is easily removable from the boiler.

- **VALVE PROVING SYSTEM (VPS)** – An external device designed to replace the Double Block and Bleed (DBB) option. VPS is optional and available only on Benchmark 4000, 5000N, 5000 and 6000 standard and with Edge Controller. VPS tests the valves in the gas train by pumping fuel into the space between the two valves for a set period of time and measures the resulting pressure increase. If the pressure does not increase by at least 7.0 W.C. in the time allotted, perhaps because either value is leaking, VPS prevents the boiler from firing. This system has the advantage over a DBB systems in that if a valve is leaking, it does not need to vent any gas to the atmosphere, thus eliminating the need for a bleed line.

2. GAS PRESSURE REQUIREMENTS

AERCO Benchmark Low NOx series boilers require a stable natural gas and propane input pressure. A low supply gas pressure switch in each gas train prevents the boiler from operating without sufficient pressure. The allowable gas inlet pressure range when firing at maximum input for standard gas trains, such as FM is shown in Table 1. **For custom gas trains, such as DBB and dual fuel, see Section 3: Custom gas Trains.**

TABLE 1**: Allowable Gas Inlet Pressure for Standard Gas Trains**

Model	NATURAL GAS		PROPANE	
	Minimum	Maximum	Minimum	Maximum
BMK750	4.0" W.C. (1.00 kPa)	14.0" W.C. (3.49 kPa)	7.0" W.C. (1.74 kPa)	14.0" W.C. (3.49 kPa)
BMK1000	4.0" W.C. (1.00 kPa)	14.0" W.C. (3.49 kPa)	11.0" W.C. (2.74 kPa)	16.0" W.C. (3.99 kPa)
BMK1500/2000	4.0" W.C. (1.00 kPa)	14.0" W.C. (3.49 kPa)	4.0" W.C. (1.00 kPa)	14.0" W.C. (3.49 kPa)
BMK2500/3000	4.0" W.C. (1.00 kPa)	14.0" W.C. (3.49 kPa)	4.0" W.C. (1.00 kPa)	14.0" W.C. (3.49 kPa)
BMK4000/5000N	4.0" W.C. (1.00 kPa)	14.0" W.C. (3.49 kPa)	6.0" W.C. (1.49 kPa)	14.0" W.C. (3.49 kPa)
BMK5000/6000 (regular pressure models)	14.0" W.C. * (3.49 kPa)	2.0 psig (13.8 kPa)	10.5" W.C. (2.62 kPa)	2.0 psig (13.8 kPa)
BMK5000/6000 LGP ** (Low Gas Pressure model)	4.0" W.C. (1.00 kPa)	10.0" W.C. (2.49 kPa)		

NOTES:

* The regular pressure BMK5000 and 6000 may operate with inlet pressures *less* than 14 inches W.C. (13.8 kPa) but will derate by approximately 265,000 BTU/hr. (77.7 kw) per inch (25.4 mm) under 14-inch W.C. (13.8 kPa). The ***absolute minimum gas pressure*** while in operation is **11 inches W.C. (0.3974 psig).**

** For BMK5000 & 6000 applications, if site natural gas pressure (measured when the unit is in operation/firing) is greater than 10" and less than 14", use the LGP models and use a gas pressure regulator to bring down the supply pressure to 10" or less.

Gas pressure must be measured when the unit is in operation (firing). Measure the gas pressure with a manometer at the NPT ball valve provided at the SSOV inlet. In a multiple boiler installation, gas pressure must initially be set for single boiler operation, and then the remaining boilers must be staged on at full fire, to insure gas pressures never falls below the supply gas pressure when the single unit was firing.

All Benchmark models have a low supply gas pressure switch in the gas train to prevent operation if incoming gas pressure is insufficient.

2.1 Manual Shutoff Valves

An external manual shutoff valve must be installed at each Benchmark boiler, as shown in Figure 1a – 1d, below. This valve is supplied with the boiler.

2.2 Pressure Regulators

The lock-up type pressure regulator(s) must be sized as follows:

TABLE 2: Lock-Up Regulator Sizing

Boiler Size (MBH)	Required Volume	
	CFH	(m^3/HR)
750	750 – 850	(21.2 – 24.1)
1000	1000 – 1200	(28.3 – 34.0)
1500	1500 – 1750	(42.5 – 49.6)
2000	2000 – 2300	(56.6 – 65.1)
2500	2500 – 2850	(70.8 – 80.7)
3000	3000 – 3400	(85.0 – 96.3)
4000	4000 – 4500	(113.3 – 127.5)
5000, 5000N	5000 – 5450	(141.6 – 154.3)
6000	6000 – 6500	(169.9 – 184.1)

An external lock-up type regulator ***MUST*** be installed downstream of the isolation valve at all installations where gas supply pressure will *exceed* 14.0**" W.C. (3.49 kPa)**.

External gas regulators are self-contained with tapped diaphragm vent ports allowing the diaphragm to change its position as required. These vents typically require piping to the outside. For details, see Section 8: *Venting of Gas Supply Regulators*, below. The SSOV/Regulator in the gas train is factory piped and does not require any vent piping.

CAUTION!

AERCO BOILERS MUST BE ISOLATED FROM THE SYSTEM WHEN LEAK TESTING.

Drip legs are typically required at the gas supply of each boiler to prevent any dirt, weld slag, or debris from entering the boiler gas train inlet pipe. When multiple boilers are installed, some utilities and local codes require a full-size drip leg on the main gas supply line in addition to the drip leg at each unit. The bottom of the gas drip leg(s) should be removable without disassembling any gas piping. The weight of the gas pipe must not be supported from the bottom of the drip leg. The drip leg(s) must not be used to support any or part of the gas piping.

On all Benchmark models it is strongly recommended that the pressure regulator be installed a minimum distance of **10 pipe diameters** between the pressure regulator and the nearest *downstream* fittings (an elbow or the unit itself), and a minimum of **5 pipe diameters** between the pressure regulator and any *upstream* fitting, such as elbow or shutoff valve, as shown in Figure 1a, below. **This recommendation applies to all gas trains on all Benchmark models.**

NOTE: It is the responsibility of the customer to source and purchase the appropriate gas regulator as described above. However, AERCO offers for sale an appropriate regulator, which may be ordered at the time of unit purchase or separately. Contact your AERCO sales representative for more information.

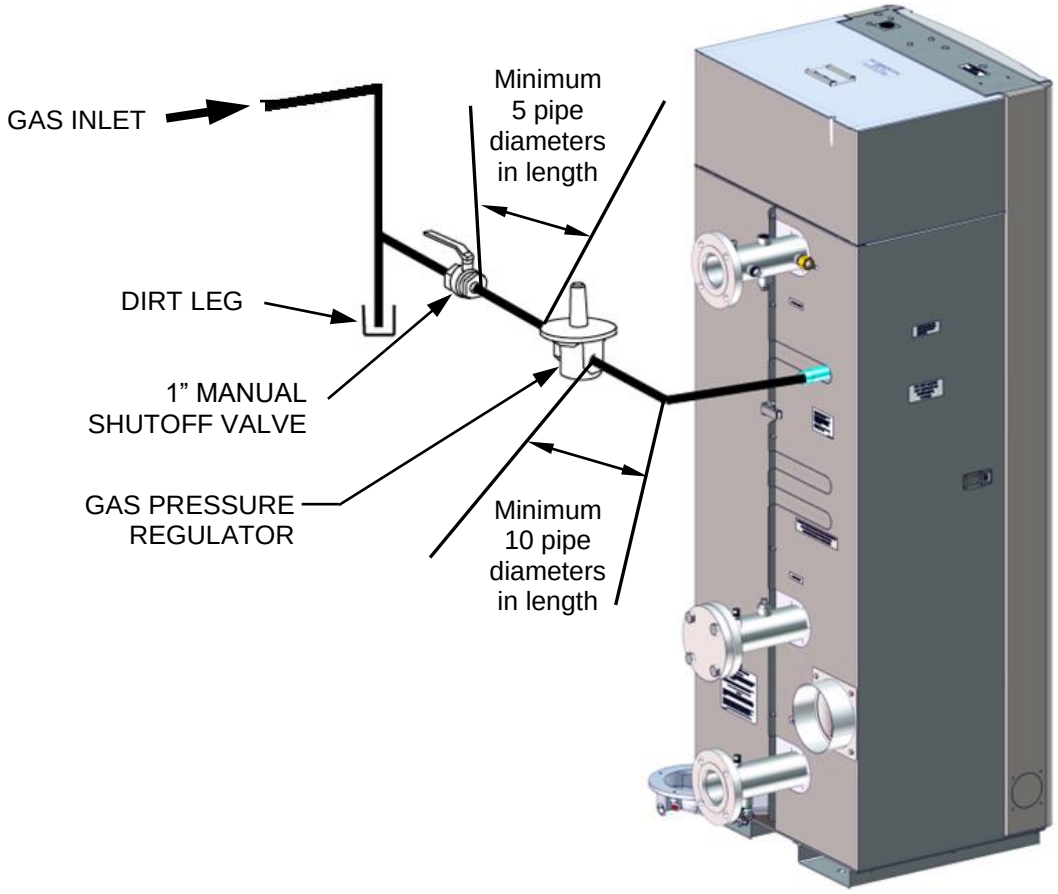


Figure 1a: BMK750/1000 Gas Regulator and Manual Shut-Off Valve

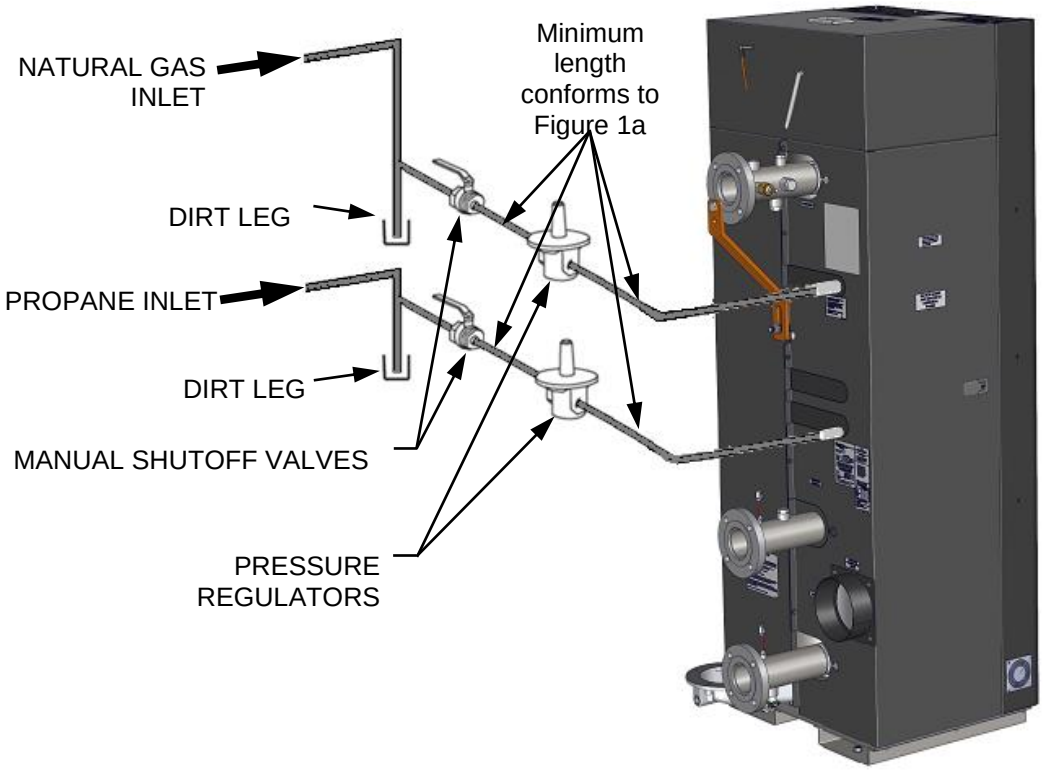


Figure 1b: BMK750/1000 Gas Regulator and Manual Shut-Off Valve – Dual Fuel

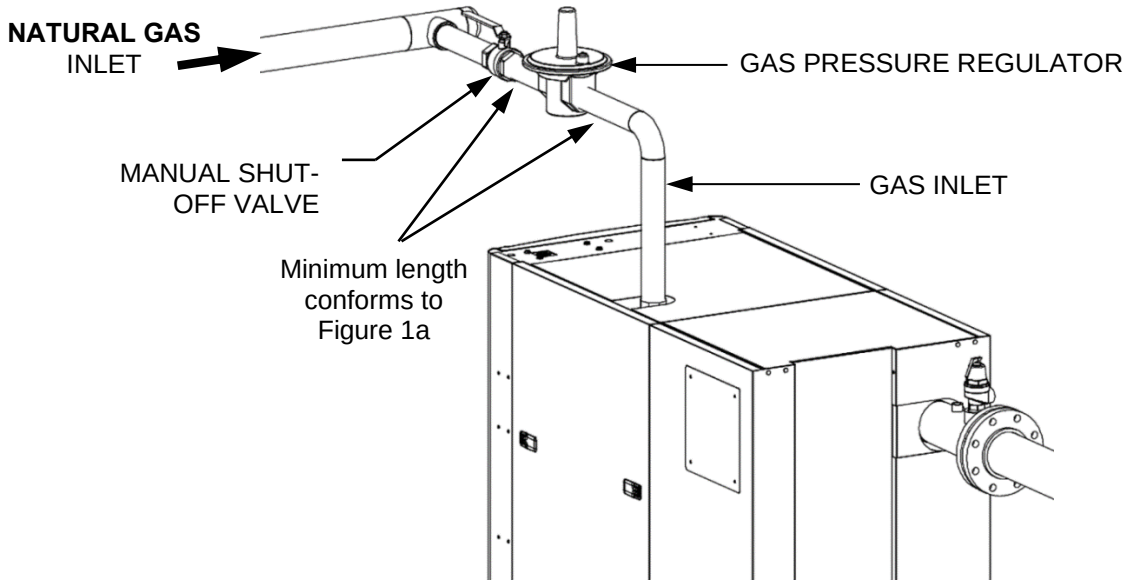


Figure 1c: BMK1500-5000N Gas Regulator and Manual Shut-Off Valve

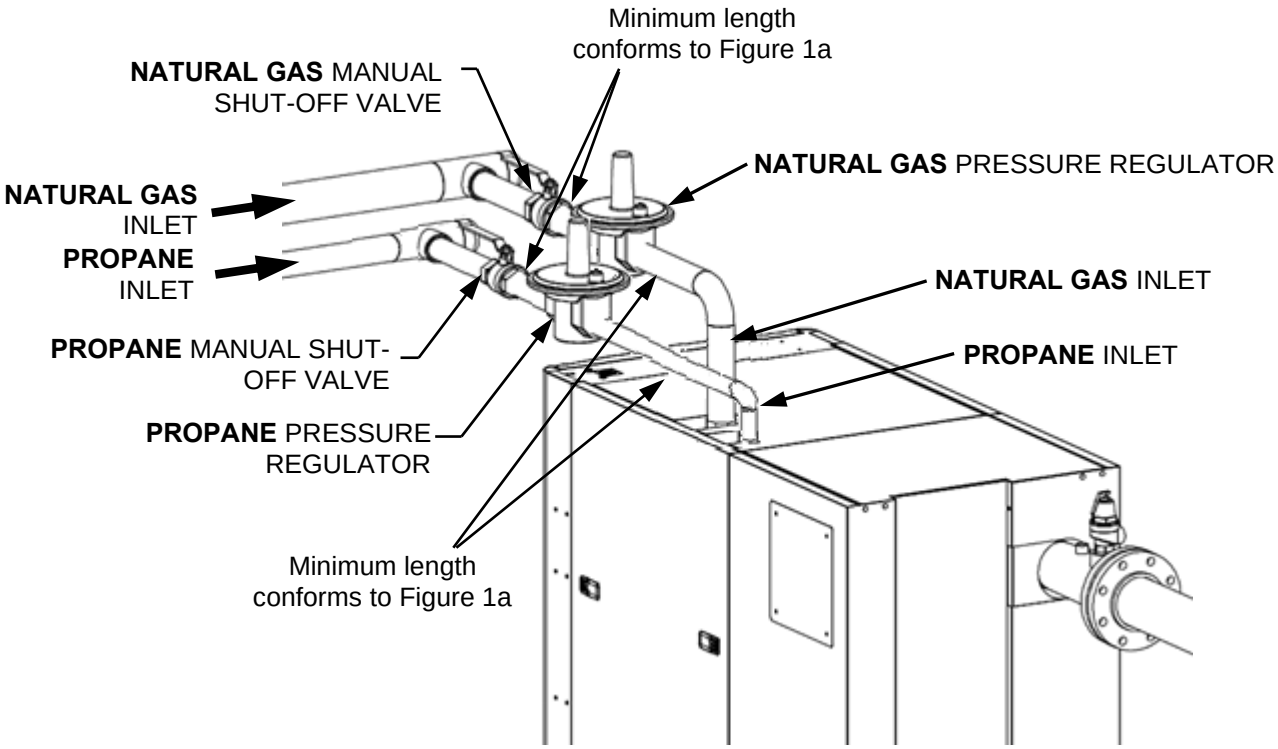


Figure 1d: BMK1500-5000N Gas Regulator and Manual Shut-Off Valve – Dual Fuel

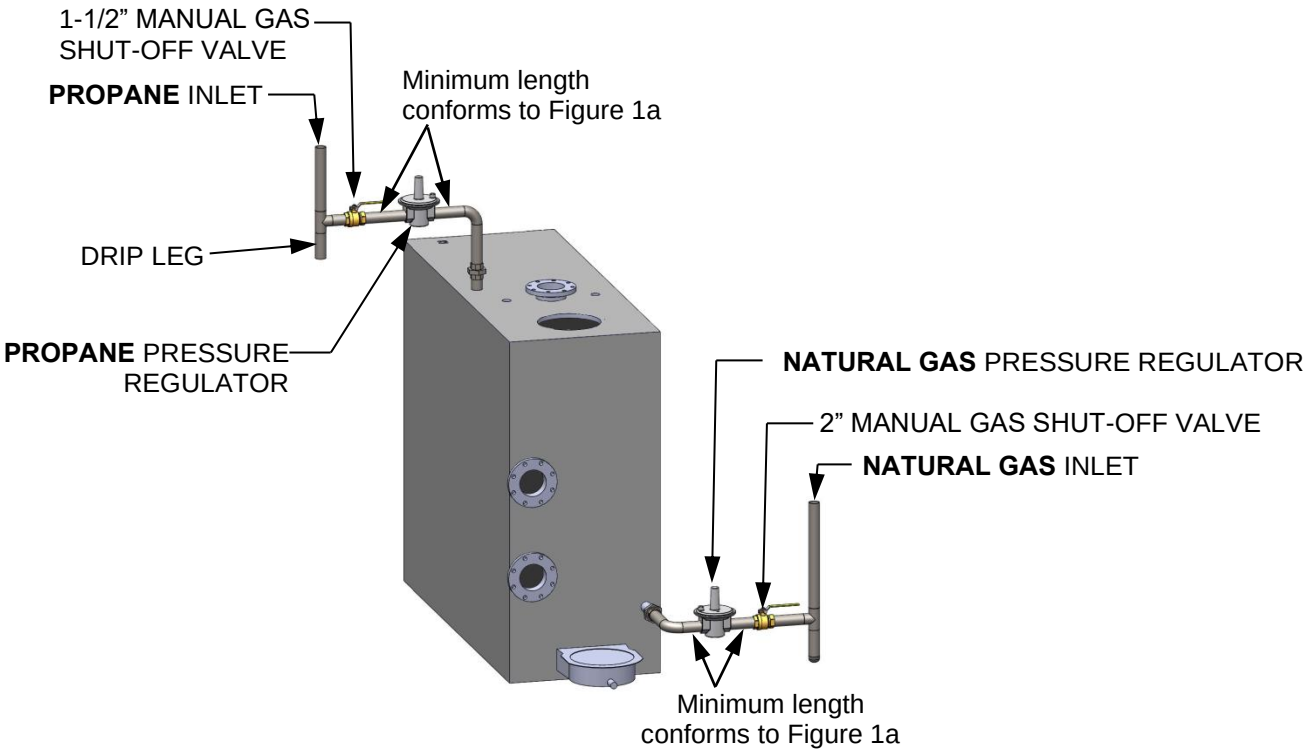


Figure 1e: BMK5000/6000 Manual Gas Shut-Off Valve Location – Dual Fuel

2.3 Massachusetts Installations Only

For Massachusetts installations, a mandatory external gas supply regulator must be positioned as shown in Figure 1a – 1e. The gas supply regulator must be properly vented to outdoors. Consult the local gas utility for detailed requirements concerning venting of the supply gas regulator.

2.4 Multiple Unit Installations

The following points apply to sites that have multiple Benchmark units installed:

Benchmark 750 to 5000N units:

- If inlet pressures are above **7” W.C. (1.74 kPa)** a gas pressure regulator may be ***highly recommended***, based on site conditions. Consult your local AERCO representative or the factory.
- If inlet pressures are above **14” W.C. (3.49 kPa)** a gas pressure regulator is ***mandatory***.

Benchmark 5000 & 6000 units:

- If inlet pressures are above **1 psi (6.89 kPa)**, a gas pressure regulator may be ***highly recommended***, based on site conditions. Consult your local AERCO representative or the factory.
- If inlet pressures are above **2 psi (13.79 kPa)**, a gas pressure regulator is ***mandatory***.
- For BMK5000 & 6000 applications, if site natural gas pressure (measured when the unit is in operation/firing) is greater than 10" and less than 14", use the LGP models and use a gas pressure regulator to bring down the supply pressure to 10" or less.

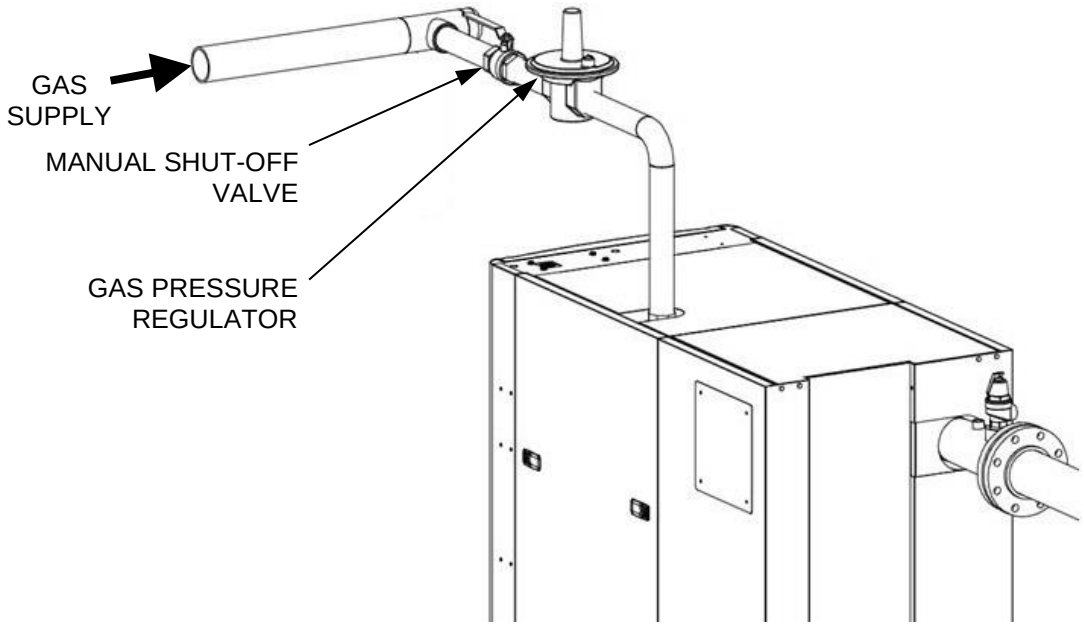


Figure 2: Multiple Boiler Gas Pipe Connections Guidelines (BMK2500 Shown)

The following are AERCO's recommendations for installation of gas pressure regulator, unless superseded by state and local codes and the regulator manufacturer's specifications:

- Horizontal installation of gas pressure regulators is recommended unless stated otherwise by the regulator manufacturer. Consult the manufacturer for additional recommendations and installation options.
- For Benchmark 750 & 1000 units, when installed horizontally the required distance between the gas pressure regulator and the nearest pipe fitting, elbow or valve is **20 inches (51 cm)**.
- For Benchmark 1500 through 6000 units, when installed horizontally, the required distance between the gas pressure regulator and the nearest pipe fitting, elbow or valve is **5 to 10 pipe diameters**, as shown in Figure 2, above.
- When pipe size reduction is required, use only bell reducers.

3. CUSTOM GAS TRAINS

Some utilities, insurance carriers, and industrial customers have special requirement gas components on high input devices that are beyond what is normally supplied with AERCO boilers. Secondary shutoffs, high- or low-pressure operators, and external regulators are typical of the requirements of gas utilities. It is mandatory that a designer or installer comply with these requirements. AERCO assumes no liability when these requirements are not satisfied for any location or installation. Contact your local gas utility for their specific requirements before installing AERCO equipment. Special gas trains with a **Double Block and Bleed** (**DBB**) configuration (formerly **IRI**) and the **Valve Proving System** (**VPS**) are available from AERCO.

Table 3 lists the minimum gas inlet pressure requirements for custom **Natural Gas** (**N.G.**) and **Propane** (**LPG**) gas trains:

TABLE 3: Minimum Gas Inlet Pressure Requirements for Custom Gas Trains

Model	Fuel	DBB	Dual Fuel	Dual Fuel-DBB	VPS
BMK750	N.G.	4.5” W.C. (1.12 kPa)	7.0” W.C.	N/A	N/A
	LPG	N/A	7.0” W.C.	N/A	N/A
BMK1000	N.G.	4.5” W.C. (1.12 kPa)	7.0” W.C.	N/A	N/A
	LPG	N/A	7.0” W.C.	N/A	N/A
BMK1500	N.G.	4.5” W.C. (1.12 kPa)	6.0” W.C. (1.49 kPa)		N/A
	LPG	N/A	4.0” W.C. (1.0 kPa)		N/A
BMK2000	N.G.	4.5” W.C. (1.12 kPa)	8.5” W.C. (2.12 kPa)		N/A
	LPG	N/A	4.0” W.C. (1.0 kPa)		N/A
BMK2500	N.G.	4.5” W.C. (1.12 kPa)	8.5” W.C. (2.12 kPa)		N/A
	LPG	N/A	4.0” W.C. (1.0 kPa)		N/A
BMK3000	N.G.	4.5” W.C. (1.12 kPa)	8.0” W.C. (1.99 kPa)		N/A
	LPG	N/A	4.0” W.C. (1.0 kPa)		N/A
BMK4000/5000N	N.G.	4.0” W.C. (1.0 kPa)	6.0” W.C. (1.49 kPa)		4” W.C. (1.00 kPa)
	LPG	N/A	6.0” W.C. (1.49 kPa)		N/A
BMK5000/6000	N.G.	N/A	14” W.C. (3.49 kPa)	N/A	14” W.C. (3.49 kPa)
	LPG	N/A	10.5” W.C. (2.62 kPa)	N/A	10.5” W.C. (2.62 kPa)
BMK5000/6000	N.G.	4” W.C. (1.00 kPa)	N/A		4” W.C. (1.00 kPa)
Low Gas Pressure	LPG	N/A			

4. GAS PIPING

All gas piping and components must comply with NFPA local codes, and utility requirements minimum. Only gas approved fittings, valves, or pipe should be utilized.

Standard industry practice for gas piping is Schedule 40 iron pipe and fittings. All high and low gas pressure piping systems must comply with local utility and building codes.

Assembled piping must be clean of all debris, pipe chips and foreign material to prevent any from entering the boiler's gas train. Piping must be tested as prescribed in NFPA 54. Equipment must be isolated before testing any piping system over the allowable pressure. *DO NOT EXCEED 14.0" W.C. (3.49 kPa) on* the inlet side of the Benchmark boiler at any time for BMK750 through BMK3000 Models. For BMK5000 & 6000 boilers, DO NOT EXCEED 2.0 P.S.I. (13.795 kPa) on the inlet side of the boiler at any time.

The diameter of the gas inlet pipes is as follows:

Inlet Pipe Diameter				
BMKModel	**Single Fuel**		**Dual Fuel**	
	Natural Gas	**Propane**	**Natural Gas**	**Propane**
750-1000	1 Inch	1 Inch	1 Inch	3/4 Inch
1500-2000	2 Inch	1 Inch	2 Inch	1 Inch
2500-3000	2 Inch	2 Inch	2 Inch	2 Inch
4000-5000N	3 Inch	1.5 Inch	3 Inch	1.5 Inch
5000-6000	2 Inch	1.5 Inch	2 Inch	1.5 Inch
5000-6000 Low Gas Pressure	3 Inch	N/A	N/A	N/A

5. GAS SUPPLY MAIN SIZING

Gas pipe sizing, for either a single or multiple boiler installation, must be sized for a **maximum pressure drop of 0.3" W.C. (75 Pa) from the source to the final boiler**. The maximum gas flow rate required is the sum of the maximum inputs of each unit divided by the heat of combustion of the fuel supplied at the location, (approximately 1,030 BTU per cubic foot [38.35 megajoule/cubic meter] for natural gas or 2,520 BTU per cubic foot [93.83 megajoule/cubic meter] for propane gas). The fuel supplier or utility should be consulted to confirm that sufficient volume and normal pressure is provided to the building at the discharge side of the gas meter or supply pipe. For existing installations with gas equipment, gas pressure must be measured with a manometer to be certain sufficient pressure is available. Before sizing gas piping, a survey of all connected gas devices must be made. Gas piping supplying more than one gas device must be able to handle the total connected input within the allowable gas pressure drop. The allowable minimum and maximum gas pressure for each device must be considered. Whenever the minimum and maximum gas pressures vary between devices, gas pressure regulators at each unit must be installed to allow regulation at any individual unit. Gas pressure must never exceed the maximum allowable rating of any connected device.

The total length of gas piping as well as fitting pressure drop must be considered when sizing the gas piping. Total equivalent length must be calculated from the meter or source location to the last boiler connected on the header. The values in the Gas Piping Tables 4, 5 and 6 (in Section 7: *Gas Piping Tables*, below), which contain data extracted from NFPA 54, must be used as *a minimum guideline*. Gas pipe size must be selected on the total *equivalent* length from the appropriate pressure table. The gas volume for CFH (m^3/hr.) flow will be the input divided by the calorific value of the fuel to be supplied.

6. GAS HEADER SIZING

Main supply gas pipe sizing must be developed for the total plant. Boiler gas manifold piping must be sized based on the volume requirements and lengths between boilers and the fuel main. Header sizes can be either full size or stepped in size as units are connected. A typical gas piping header diagram for a 4-module Benchmark Boiler Plant is illustrated in Figure 3.

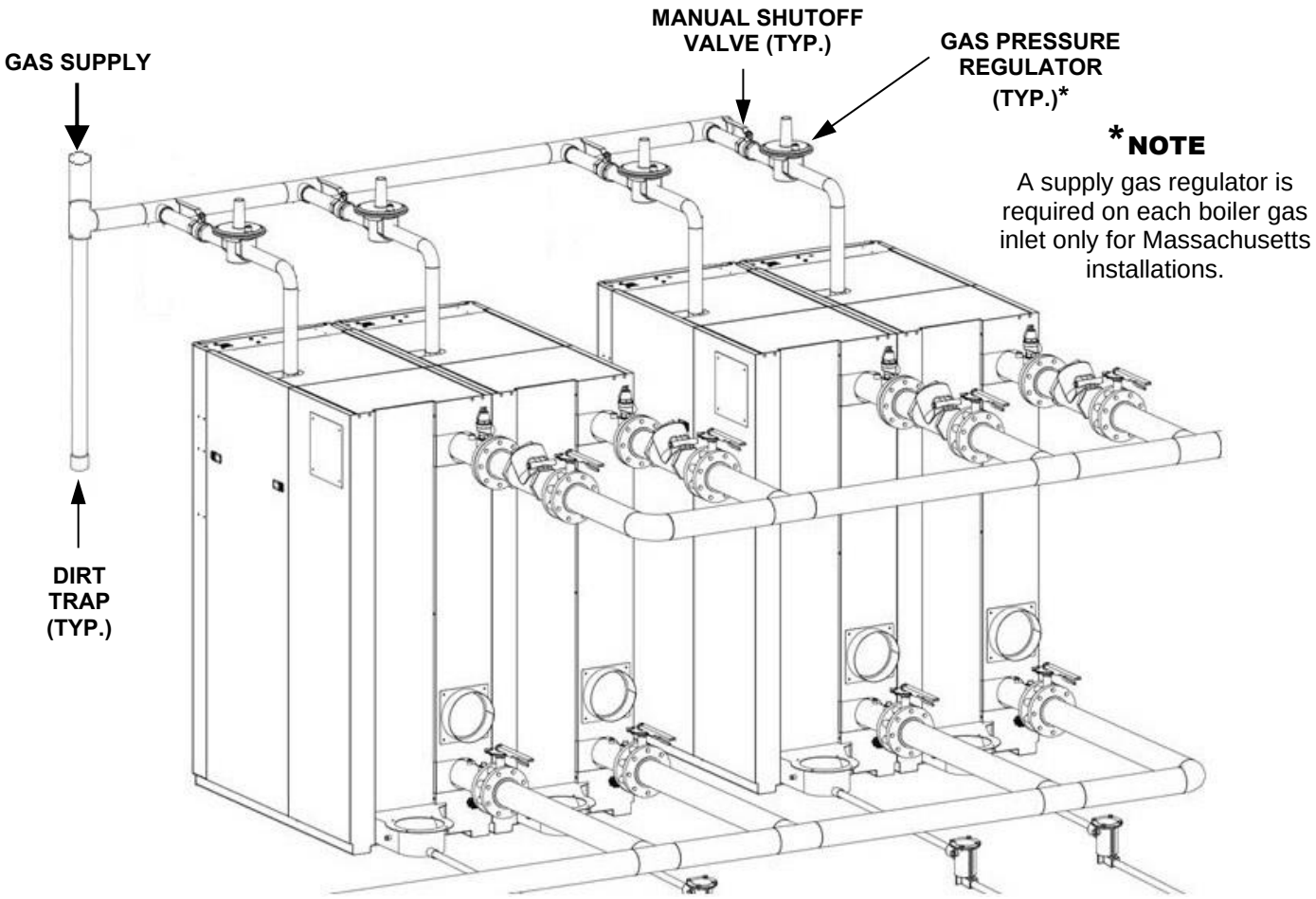


Figure 3: Typical Multiple Boiler Manifold Construction

* Based on Table 4 on the following pages for natural gas, 0.6 specific gravity, 1,000 CFH (28 m^3/hr.) / unit, actual header sizes will vary with length of pipe run and fittings employed. For propane gas (1.6 specific gravity, 2,520 BTU/FT^3) header sizing, consult NFPA 54.

If supply gas pressure exceeds **14.0" W.C. (3.49 kPa)**, a single lock-up regulator in the header, or individual lock-up regulators in each unit must be used to bring the gas pressure down to **14.0" W.C. (3.49 kPa)**. The header should be located above or behind boiler. Gas piping should not be installed directly over top or front of any part of boiler. Sufficient clearances for maintenance are required.

7. GAS PIPING TABLES

The data in the following pipe and vent sizing tables have been extracted from the National Fire Protection Association Article 54 (NFPA 54).

TABLE 4: Maximum Capacity of Pipe for 0.5 PSI or Less (Imperial Units)

In Cubic Feet of Gas per Hour
For a Pressure Drop of 0.3-inch Water Column

Nominal Iron Pipe Size in Inches	Internal Diameter in Inches	Total Equivalent Length of Pipe (Feet)												
		10	20	30	40	50	60	70	80	90	125	150	175	200
2.00	2.067	3,050	2,100	1,650	1,450	1,270	1,150	1,050	990	930	780	710	650	610
2.50	2.469	4,800	3,300	2,700	2,300	2,000	1,850	1,700	1,600	1,500	1,250	1,130	1,050	980
3.00	3.068	8,500	5,900	4,700	4,100	3,600	3,250	3,000	2,800	2,600	2,200	2,000	1,850	1,700
4.00	4.026	17,500	12,000	9,700	8,300	7,400	6,800	6,200	5,800	5,400	4,500	4,100	3,800	3,500

TABLE 4: Maximum Capacity of Pipe for 3.45 kPa or Less (Metric Units)

In Cubic Meters of Gas per Hour (m^3/hr.)
For a Pressure Drop of 75 Pa

Nominal Iron Pipe Size in mm	Internal Diam. in mm	Total Equivalent Length of Pipe (Meters)												
		3.05	6.1	9.14	12.19	15.24	18.28	21.33	24.38	27.43	38.1	45.72	53.34	60.96
50.80	**52.50**	86.37	59.47	46.72	41.06	35.96	32.56	29.73	28.03	26.33	22.09	20.10	18.41	17.27
63.50	**62.71**	135.92	93.45	76.46	65.13	56.63	52.39	48.14	45.31	42.48	35.40	32.00	29.73	27.75
76.20	**77.93**	240.69	167.07	133.09	116.10	101.94	92.03	84.95	79.29	73.62	62.30	56.63	52.39	48.14
101.60	**102.26**	495.54	339.80	274.67	235.03	209.54	192.55	175.56	164.24	152.91	127.43	116.10	107.60	99.11

TABLE 5: Pipe Sizing Table for 1 Pound Pressure (Imperial Units)									
Capacity of Pipes of Different Diameters and Lengths In Cubic Feet per Hour with a 10% Pressure Drop and a Gas of 0.6 Specific Gravity									
Pipe Size of Schedule 40 Standard Pipe in Inches	**Internal Diameter in Inches**	**Total Equivalent Length of Pipe (Feet)**							
		50	**100**	**150**	**200**	**250**	**300**	**400**	**500**
2.00	2.067	4245	2918	2343	2005	1777	1610	1378	1222
2.50	2.469	6766	4651	3735	3196	2833	2567	2197	1947
3.00	3.068	11962	8221	6602	5650	5008	4538	3884	3442
3.50	3.548	17514	12037	9666	8273	7332	6644	5686	5039
4.00	4.026	24398	16769	13466	11525	10214	9255	7921	7020
5.00	5.047	44140	30337	24362	20851	18479	16744	14330	12701
6.00	6.065	71473	49123	39447	33762	29923	27112	23204	20566
8.00	7.981	146849	100929	81049	69368	61479	55705	47676	42254

TABLE 5: Pipe Sizing Table for for 6.89 kPa Pressure: (Metric Units)									
Capacity of Pipes of Different Diameters and Lengths In Cubic Meters per Hour with a 10% Pressure Drop and a Gas of 0.6 Specific Gravity									
Pipe Size of Schedule 40 Standard Pipe in mm	**Internal Diam. in mm**	**Total Equivalent Length of Pipe (Meters)**							
		15.24	**30.48**	**45.72**	**60.96**	**76.2**	**91.44**	**121.92**	**152.4**
50.80	**52.50**	120.21	82.63	66.35	56.78	50.32	45.59	39.02	34.60
63.50	**62.71**	191.59	131.70	105.76	90.50	80.22	72.69	62.21	55.13
76.20	**77.93**	338.73	232.79	186.95	159.99	141.81	128.50	109.98	97.47
88.90	**90.12**	495.94	340.85	273.71	234.27	207.62	188.14	161.01	142.69
101.60	**102.26**	690.88	474.85	381.32	326.35	289.23	262.07	224.30	198.79
127.00	**128.19**	1249.91	859.05	689.86	590.44	523.27	474.14	405.78	359.65
152.40	**154.05**	2023.90	1391.02	1117.02	956.04	847.33	767.73	657.07	582.37
203.20	**202.72**	4158.32	2858.01	2295.06	1964.29	1740.90	1577.40	1350.04	1196.51

TABLE 6: Pipe Sizing Table for an Initial Pressure of 2.0 PSI (Imperial Units)									
Capacity of Pipes of Different Diameters and Lengths In Cubic Feet per Hour with a 10% Pressure Drop and a Gas of 0.6 Specific Gravity									
Pipe Size of Schedule 40 Standard Pipe in Inches	**Internal Diameter in Inches**	**Total Equivalent Length of Pipe (Feet)**							
		50	**100**	**150**	**200**	**250**	**300**	**400**	**500**
2.00	2.067	6589	4528	3636	3112	2758	2499	2139	1896
2.50	2.469	10501	7217	5796	4961	4396	3983	3409	3022
3.00	3.068	18564	12759	10246	8769	7772	7042	6027	5342
3.50	3.548	27181	18681	15002	12840	11379	10311	8825	7821
4.00	4.026	37865	26025	20899	17887	15853	14364	12293	10895
5.00	5.047	68504	47082	37809	32359	28680	25986	22240	19711
6.00	6.065	110924	76237	61221	52397	46439	42077	36012	31917

TABLE 6: Pipe Sizing Table for an Initial Pressure of 13.79 kPa: (Metric Units)									
Capacity of Pipes of Different Diameters and Lengths In Cubic Feet per Hour with a 10% Pressure Drop and a Gas of 0.6 Specific Gravity									
Pipe Size of Schedule 40 Standard Pipe in mm	**Internal Diameter in mm**	**Total Equivalent Length of Pipe (Meters)**							
		15.24	**30.48**	**45.72**	**60.96**	**76.2**	**91.44**	**121.92**	**152.4**
50.80	**52.50**	186.58	128.22	102.96	88.12	78.10	70.76	60.57	53.69
63.50	**62.71**	297.36	204.36	164.13	140.48	124.48	112.79	96.53	85.57
76.20	**77.93**	525.68	361.30	290.14	248.31	220.08	199.41	170.67	151.27
88.90	**90.12**	769.68	528.99	424.81	363.59	322.22	291.98	249.90	221.47
101.60	**102.26**	1072.22	736.95	591.80	506.51	448.91	406.75	348.10	308.51
127.00	**128.19**	1939.83	1333.22	1070.64	916.31	812.13	735.85	629.77	558.16
152.40	**154.05**	3141.03	2158.80	1733.60	1483.73	1315.01	1191.49	1019.75	903.79

TABLE 7: Pipe Sizing Table for an Initial Pressure of 5.0 PSI (Imperial Units)									
Capacity of Pipes of Different Diameters and Lengths In Cubic Feet per Hour with a 10% Pressure Drop and a Gas of 0.6 Specific Gravity									
Pipe Size of Schedule 40 Standard Pipe in Inches	**Internal Diameter in Inches**	**Total Equivalent Length of Pipe (Feet)**							
		15.24	**30.48**	**45.72**	**60.96**	**76.2**	**91.44**	**121.92**	**152.4**
2.00	2.067	11786	8101	6505	5567	4934	4471	3827	3391
2.50	2.469	18785	12911	10368	8874	7865	7126	6099	5405
3.00	3.068	33209	22824	18329	15687	13903	12597	10782	9556
3.50	3.548	48623	33418	26836	22968	20365	18444	15786	13991
4.00	4.026	67736	46555	37385	31997	28358	25694	21991	19490
5.00	5.047	122544	84224	67635	57887	51304	46485	39785	35261
6.00	6.065	198427	136378	109516	93732	83073	75270	64421	57095

TABLE 7: Pipe Sizing Table for an Initial Pressure of 34.47 kPa: (Metric Units)									
Capacity of Pipes of Different Diameters and Lengths In Cubic Feet per Hour with a 10% Pressure Drop and a Gas of 0.6 Specific Gravity									
Pipe Size of Schedule 40 Standard Pipe in mm	**Internal Diameter in mm**	**Total Equivalent Length of Pipe (Meters)**							
		15.24	**30.48**	**45.72**	**60.96**	**76.2**	**91.44**	**121.92**	**152.4**
50.80	**52.50**	333.74	229.40	184.20	157.64	139.72	126.61	108.37	96.02
63.50	**62.71**	531.93	365.60	293.59	251.29	222.71	201.79	172.71	153.05
76.20	**77.93**	940.38	646.31	519.02	444.21	393.69	356.71	305.31	270.60
88.90	**90.12**	1376.86	946.30	759.92	650.38	576.68	522.28	447.01	396.18
101.60	**102.26**	1918.08	1318.30	1058.63	906.06	803.01	727.58	622.72	551.90
127.00	**128.19**	3470.08	2384.97	1915.22	1639.19	1452.78	1316.32	1126.59	998.49
152.40	**154.05**	5618.86	3861.82	3101.16	2654.21	2352.38	2131.42	1824.21	1616.76

8. VENTING OF GAS SUPPLY REGULATORS

AERCO's general guidelines for venting of gas regulators are listed below. AERCO requires that these guidelines be followed to ensure the most reliable and proper operation of AERCO gas fired equipment. It is also required that you consult local codes and the gas regulator manufacturer for additional details. Always follow the most stringent guidelines available, including those listed below.

- When venting a gas supply regulator, the vent pipe must be no smaller than the regulator vent size.
- In a multiple unit installation, each regulator must have a separate vent line.
- Vent lines must not be manifolded together or with any other equipment at the site that also requires atmospheric vents.
- When sizing the vent, pipe diameters must be increased by one pipe diameter every 20 equivalent feet of pipe.

Each 90° elbow is equivalent to approximately:

⇒ 2.5 feet (0.76 m) for nominal pipe sizes of up to 3/4" (19 mm)

⇒ 4.5 feet (1.37 m) for nominal pipe sizes of up to 1-1/2" (38 mm)

⇒ 10.5 feet (3.2 m) for nominal pipe sizes of up to 4" (101 mm)

Each 45° elbow is equivalent to approximately:

⇒ 1 foot (0.3 m) for nominal pipe sizes of up to 3/4" (19 mm)

⇒ 2 feet (0.61 m) for nominal pipe sizes of up to 1-1/2" (38 mm)

⇒ 5 feet (1.52 m) for nominal pipe sizes of up to 4" (101 mm)

Change Log:

Date	Description	Changed by
9/30/2020	**Rev Q:** Added BMK4000 and BMK5000N Dual Fuel values to Minimum Inlet Pressure table, Section 3. Added a Note to Table 1 concerning BMK 5000/6000 LGP models. Revised gas pressure regulator recommendations for sites with pressure above **7" W.C.** (BMK 750-5000N) or above 1 psi (BMK 5000/6000), added a bullet point for BMK 5000/6000 units, Section 2.4.	Chris Blair
11/14/2020	**Rev R:** Updated to support Benchmark 750/1000 Dual Fuel models, Sections 2.2, 3 and 4. Revised figures in Section 2.2 to clarify minimum pipe lengths in gas inlet piping for all models. Revised/clarified Note ** under Table 1 (page 3) concerning when use of BMK 5000/6000 LGP model is recommended, and repeated recommendation in bullet in Section 2.4.	Chris Blair
5/16/2023	**Rev S:** Removed reference to Platinum; updated formatting	DWBarron

AERCO
A WATTS Brand

Venting & Combustion Air Design Guide

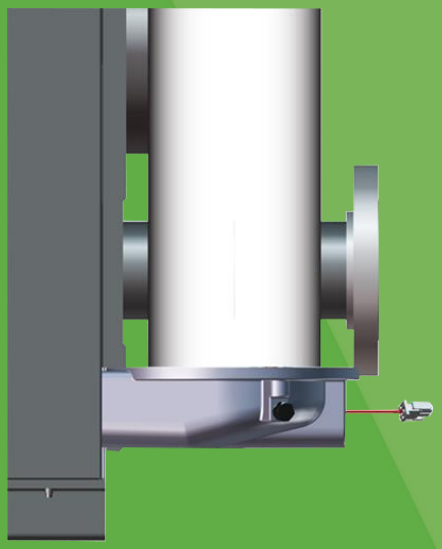
Benchmark® Boilers

Models 750 through 6000

Other documents for this product include:

OMM-0127 BMK750K-3000K Installation-Startup KOREA
OMM-0128 BMK750K-3000K Operation- Maintenance KOREA
OMM-0136 BMK750-6000 Edge Installation-Startup
OMM-0137 BMK750-6000 Edge Operation-Service
OMM-0138 BMK750-6000 Edge Reference Manual
OMM-0144 BMK750-6000 Edge [I] Installation-Startup
OMM-0145 BMK750-6000 Edge [I] Operation-Service
OMM-0146 BMK750-6000 Edge [I] Reference Manual

TAG-0019 Benchmark Boiler Application Guide
TAG-0022 Benchmark Vent & Combustion Air Guide
TAG-0048 Benchmark Electrical Power Guide



GAS-FIRED c UL us LISTED

AHRI CERTIFIED™ www.ahridirectory. Commercial Boilers AHRI Standard BTS-2000

ASME H

Heating and Hot Water Solutions
AERCO International, Inc. • 100 Oritani Drive • Blauvelt, NY 10913
USA: T: (845) 580-8000 • Toll Free: (800) 526-0288 • AERCO.com
Technical Support • (800) 526-0288 • Mon-Fri, 8 am - 5 pm EST

TAG-0022_AI • 4/5/2023

TABLE OF CONTENTS

1. GENERAL

The AERCO Benchmark gas-fired boiler is a high efficiency, forced draft, hydronic-heating unit with unique venting capabilities. All Benchmark venting options (which include horizontal and vertical discharges, individual vent, and manifolded vent breeching), typically exceed the capabilities of competing combustion equipment. These and other features enable Benchmark boilers to provide extremely high thermal efficiencies and optimum temperature control under widely varying conditions. It is therefore critical that the flue gas vent and combustion air system be designed to maintain these objectives.

Benchmark's high efficiency is achieved through air/fuel modulation and the release of energy from the moisture condensing in the combustion products. Because condensation can occur in the exhaust vent system, means must be provided to remove the moisture accumulation. Each Benchmark model is fitted with a condensate removal trap, as indicated in Figures 1a – 1e, which illustrate the air inlet, vent connections and condensate removal connections for the BMK750 (0.75 MMBTU), BMK1000 (1.0 MMBTU), BMK1500 (1.5 MMBTU), BMK2000 (2.0 MMBTU), BMK2500 (2.5 MMBTU), BMK3000 (3.0 MMBTU), BMK4000 (4.0 MMBTU), BMK5000N (4.99 MMBTU), BMK5000 (5.0 MMBTU) and BMK6000 (6.0 MMBTU) models.
The design guidelines in this guide provide broad latitude while meeting the objectives of safety, longevity and optimum performance.

2. APPROVED VENT MATERIALS

The Benchmark boiler is a Category II and IV or Type BH appliance, which require special attention to exhaust venting and combustion air details. The exhaust vent MUST be UL listed for use with Category II and IV appliances. The following materials are allowed:

- The BMK750 and BMK1000 boilers can use PVC, CPVC or Category II or IV UL1738 or Type BH under ULCS636 listed Polypropylene and Stainless-Steel vent materials.
- The BMK750, 1000, 1500, 2000, 2500, 3000, 4000, 5000N, 5000 and 6000 boilers can use Category II or IV under UL1738 or Type BH under ULCS636 listed Polypropylene and Stainless-Steel vent materials.
- AERCO recommends the use of Stainless Steel and Polypropylene as the preferred venting material for all Benchmark boilers.
- Where codes allow, PVC and CPVC may be used with BMK750 and 1000 models only.
- Stainless Steel venting thickness should conform to the following thickness requirements:

Diameter	3" to 8"	9" to 16"	18" to 24"	26" to 30"
Material Thickness in Inches (mm)	0.015 (0.38)	0.020 (0.51)	0.024 (0.61)	0.034 (0.86)

It is the responsibility of the design engineer and installing contractor to ensure all vent system designs and installations follow industry best practices, including proper pitch, support, and drainage to prevent failure. While UL is the industry standard guideline for venting, it is highly recommended that exhaust vent passing through confined or enclosed building spaces be made of AL29-4C as the most corrosion resistant vent material currently available.

If needed, a PVC Vent Adapter is provided in the Spares Kit included with each BMK750 through 1000 boiler. Proper clearances to combustibles must be maintained per UL and the vent manufacturer requirements. The UL, National Fuel Gas Code (ANSI Z223.1/ NFPA54)[1] and CSA B149.1-10 guidelines are often the basis for state and local codes. AERCO's recommendations follow the guidelines of these agencies, unless more stringent codes govern the installation site. The venting and combustion air systems must meet all applicable code requirements.

All Canada installations must comply with CSA B149.1 installation code.

3. CODE REQUIRED VENT TERMINATIONS

The guidelines provided in this bulletin should be followed to comply with AERCO, UL, NFPA 54 (National Fuel Gas Code, ANSI Z223.1) and in Canada: CSA B149.1-10 recommendations and regulations.

Vent terminations must be at least **4 feet (1.22 m)** below, **1 foot (0.30 m)** above or **4 feet (1.22 m)** removed horizontally from any window, door or gravity air inlet of a building. Such terminations must extend beyond the outside face of the wall by at least **6 inches (15.2 cm)**.

The bottom of the vent termination must be at least **12 inches (30.5 cm)** above both finished grade and any maximum snow accumulation level to avoid blocking the vent or air intake. The vent termination must be least **3 feet (0.91 m)** above any forced-air building inlet within **10 feet (3.05 m)**. Design must prevent flue gases from recirculating through the boiler air intake.

Vents must not terminate over public walkways or areas where condensate or vapor could create a nuisance or be detrimental to the operation of regulators, meters or related equipment.

Discharges must not be in high wind areas or corners, or be located directly behind vegetation. Discharges in these locations may cause the flue pressures to fluctuate and result in flame instability. Generally, designs should minimize wind effects.

Wall and roof penetrations must follow all applicable codes and the vent manufacturer's instructions. Vents must never be installed at less than required clearances to combustible materials, as enumerated in UL, NFPA, CSA B149.1-10 or local codes "Double-wall" or 'Thimble" assemblies are required when vents penetrate combustible walls or roofs.

Vertical discharges must extend at least **3 feet (0.9 M)** above the roof through properly flashed penetrations, and at least **2 feet (0.61 m)** above any object within a **10 foot (3.05 m)** horizontal distance.

Large-mesh screens can be applied to the vent termination to protect against the entry of foreign objects, but the “free area” should be at least 50% larger than the required flue cross-sectional area preceding the vent termination. It is recommended that a T termination be used if a screen is desired. Do not use mesh screens on velocity cones.

If the vent system is to be connected to an existing stack, the stack must be UL listed for Category II and IV appliances (capable of **280 °F (138 °C)**, positive pressure and condensing flue gas operation). Masonry stacks must be lined, and the vent penetration must terminate flush with, and be sealed to, this liner. Vents may enter the stack through the bottom or side. All side connections must enter at a 45-degree connection in the direction of flow and must enter at different elevations, with the smallest vent connection at the highest elevation. Benchmark vents must not be connected to another manufacturer’s equipment.

The exhaust vent must be pitched upward toward the termination by a minimum of **¼ inch per foot (21 mm per m)** of length. Condensate must flow back to the Benchmark unit freely, without accumulating in the vent.

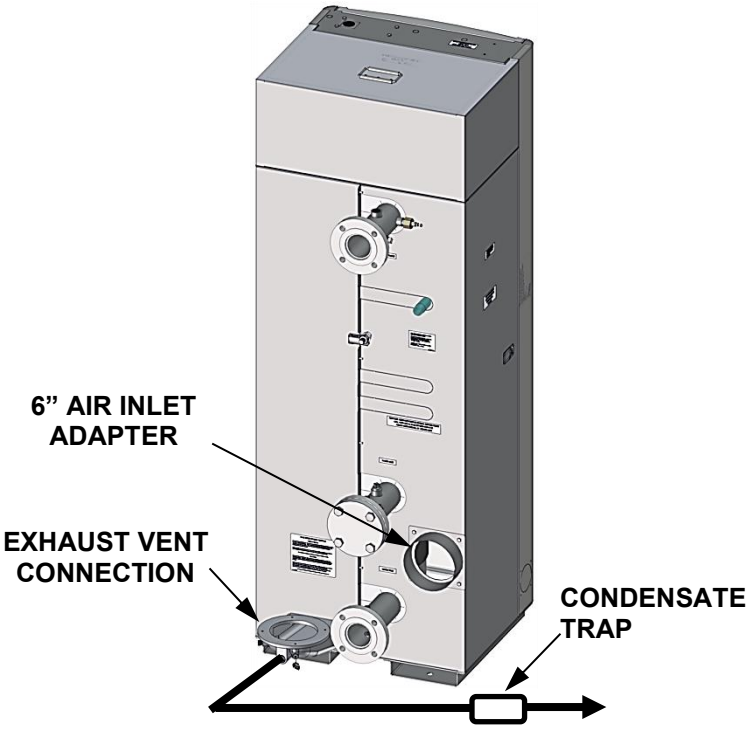


Figure 1a: BMK750/1000

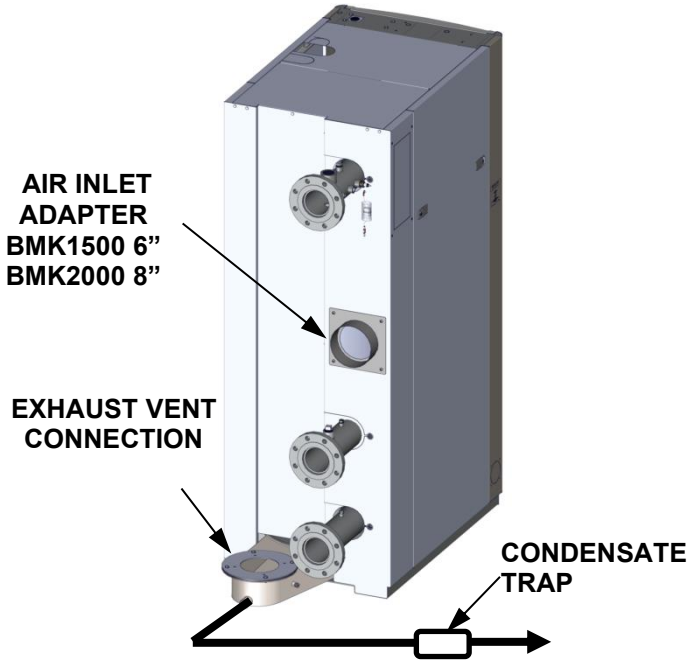


Figure 1b: BMK1500/2000

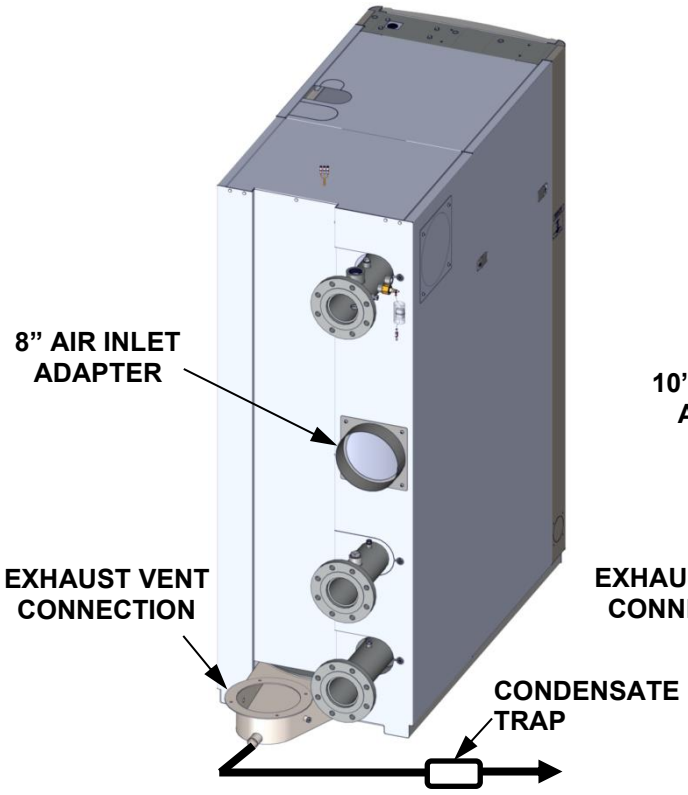


Figure 1c: BMK2500/3000

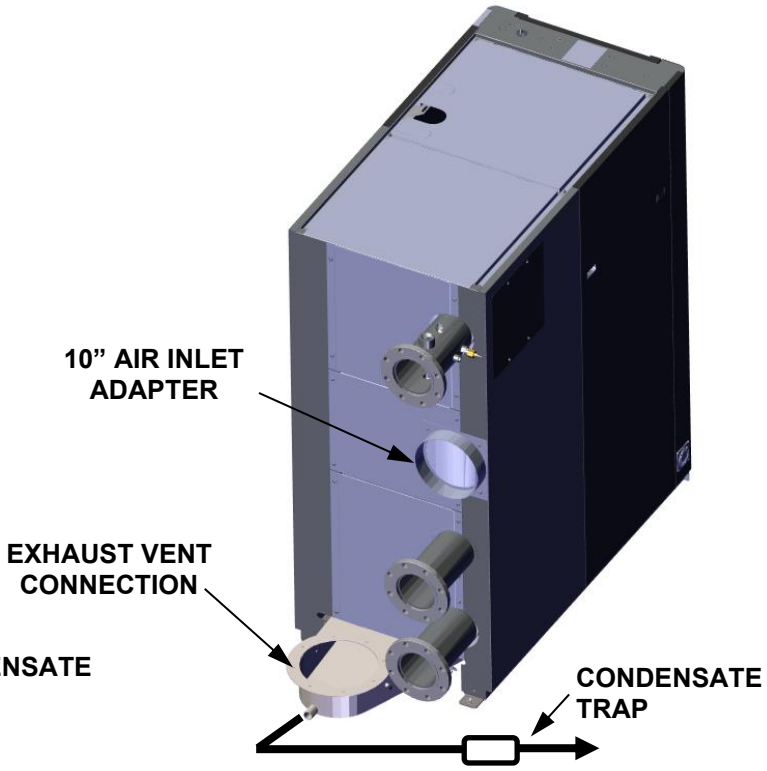


Figure 1d: BMK4000/5000N

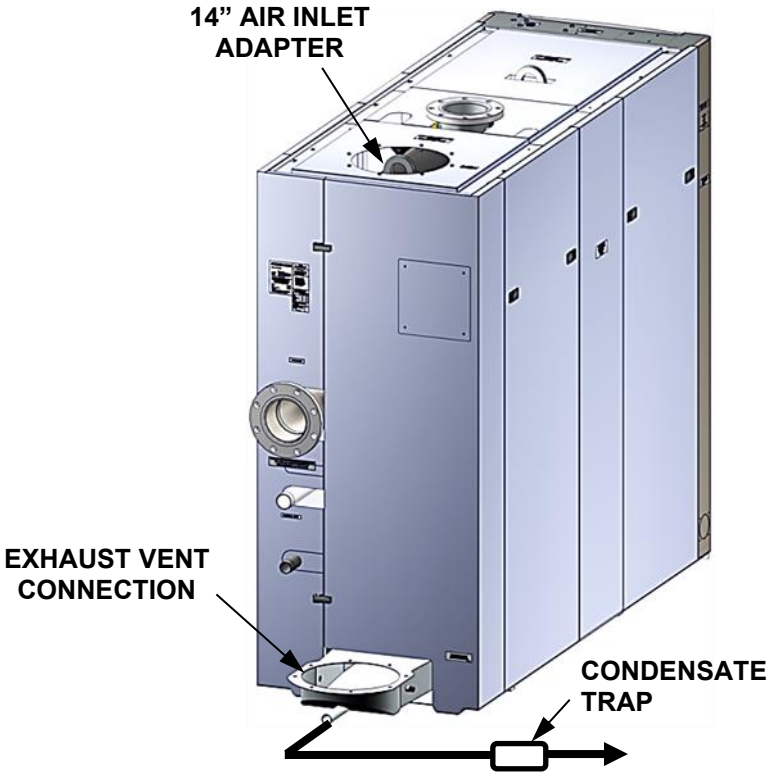


Figure 1e: BMK5000/6000

The following Vent Adapters are available from AERCO. All non-PVC adapters must be purchased along with the rest of the venting.

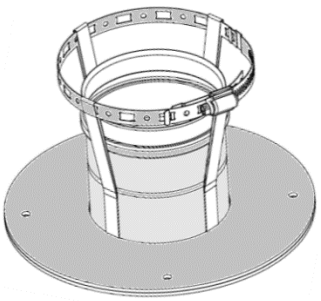
BMK750 & 1000

6” (152 mm) (PVC) Kit # 24286

BMK750-1500

6” (152 mm) PolyPro Adapter P/N 39006-2, for Duravent venting system only.

For other manufacturers, consult the manufacturer.



BMK2000 - 3000

8” (203 mm) PolyPro Adapter P/N 39006-4, for Duravent venting system only.

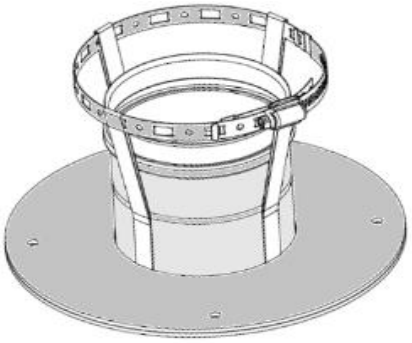


Figure 1e: **Exhaust Vent Adapters**

4. COMBUSTION AIR SUPPLY

The Benchmark boilers require the following combustion air volumes when operating at full capacity.

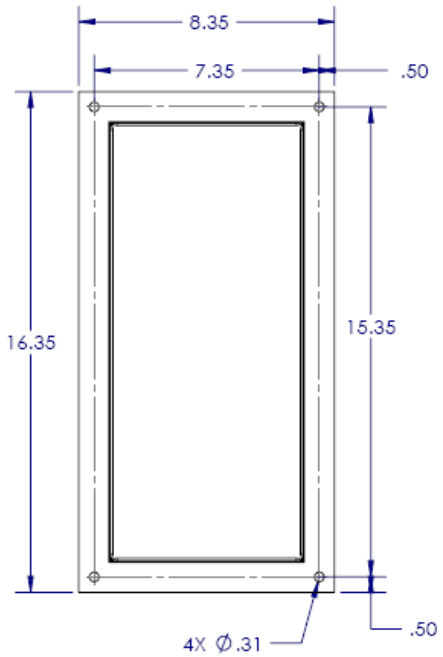
UNIT	VOLUME at 60°F (15.6°C)	Air Inlet Adapter Size
BMK750	165 SCFM (4.67 m^3/min)	6 inch
BMK1000	200 SCFM (5.66 m^3/min)	6 inch
BMK1500	325 SCFM (9.20 m^3/min)	6 inch
BMK2000	500 SCFM (14.16 L/min)	8 inch
BMK2500	600 SCFM (16.99 m^3/min)	8 inch
BMK3000	700 SCFM (19.82 m^3/min)	8 inch
BMK4000	1167 SCFM (33.05 m^3/min)	10 inch
BMK5000N	1167 SCFM (33.05 m^3/min)	10 inch
BMK5000	1167 SCFM (33.05 m^3/min)	14 inch
BMK6000	1400 SCFM (39.64 m^3/min)	14 inch

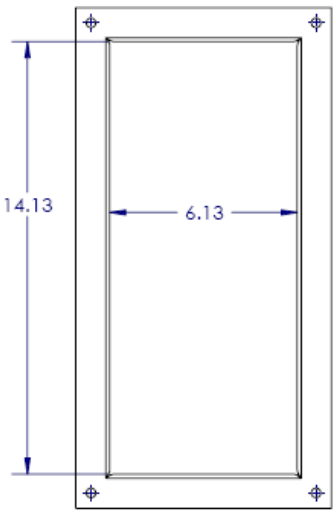
These flows MUST be accommodated. Air supply is a direct requirement of NFPA, CSA B149.1-10 (Canada) and local codes that should be consulted for correct design implementation.

Combustion air typically enters Benchmark boilers though the air inlet on the rear of the unit. Benchmark 2500 and 3000 units have the option of installing a side air inlet adapter kit. Two kits are available, including installation instructions, for Benchmark 2500 and 3000 units only:

1. **58080-1** – 8” Side Air Inlet Adapter Kit
2. **58080-2** – 10” Side Air Inlet Adapter Kit; requires enlarging opening in side panel to fit

The mechanical room must <u>not</u> be under negative pressure, even when the combustion air is direct ducted. If necessary, ventilate the room to prevent negative pressure from occurring.





4.1 Combustion Air Quality

In equipment rooms containing other air-consuming equipment — including air compressors and other combustion equipment — the combustion air supply system must be designed to accommodate all such equipment when all are operating simultaneously at maximum capacity.

WARNING!

Combustion air must provide positive pressure in the enclosure and be free of contaminants.

Combustion air intakes must be located in areas that will not induce excessive (>**0.10" W.C. (25 Pa)**) intake air pressure fluctuations. Designs should consider equipment blowers and exhausts when using room air for combustion.

Air intakes must be located to prevent infiltration of chlorine, chlorides, halogens or any other chemicals that are detrimental to the operation of combustion equipment. Common sources of these chemicals are swimming pools, degreasing compounds, water softener salts, plastic processing and refrigerants. This will ensure equipment longevity and maintain warranty validation.

WARNING!

If the equipment room is in the vicinity of any these types of chemicals, it must be supplied with clean combustion air. The equipment room must also have a slightly positive room air pressure, provided by a powered combustion air supply louver or duct.

Air intakes must not be in the proximity of garages, industrial and medical hood venting, loading docks or refrigerant vent lines. Boilers must not be installed in the proximity of activities that generate dust if that dust can enter the boiler intake. Boilers must be located to prevent moisture and precipitation from entering combustion air inlets.

When a boiler is used, temporarily, to provide heat during ongoing building construction or renovation, accumulated drywall dust, sawdust and similar particles can:

- Accumulate in the unit's combustion air intake and block combustion air flow
- Accumulate over the burner surface and restrict flow of air/fuel mixture

In these situations, AERCO requires that a disposable air intake filter be installed, temporarily, above the boiler combustion air inlet. Air filters may be required year-round in instances in which dust or debris can enter the combustion air tube. Consult the boiler Operations and Maintenance Manual for details.

Combustion air temperatures as low as **-30 °F (-34.4 °C)** can be used without affecting the integrity of the equipment; however, the combustion settings may require adjustment to compensate for site conditions.

4.2 Combustion Air From *Within* The Building

Where combustion air will originate from within the building, air must be provided to the equipment room from two permanent openings to an interior room (or rooms). Openings connecting indoor spaces must be sized and located in accordance with the following:

- Each opening must have a minimum free area of **1 inch^2 per 1,000 BTU/hr. (2,200 mm^2/kW)** of total input rating of all appliances in the space, but not less than **100 inch^2 (0.06 m^2)**.
- One opening must commence within **12 inches (300 mm)** of the top of the enclosure, and one opening must commence within **12 inches (300 mm)** of the bottom. (See Figure 2).
- For Canadian installations, refer and adhere to the latest publication of CAN/CSA B149.1.

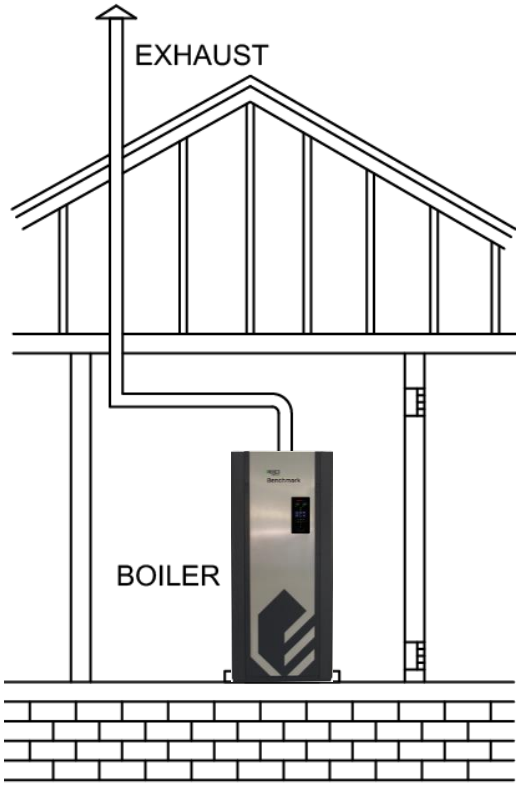


Figure 2: All Combustion Air from Adjacent Indoor Spaces through Indoor Combustion Air Openings

4.3 Combustion Air From *Outside* The Building

Outdoor combustion air must be provided through opening(s) to the outdoors in accordance with the methods described below. The minimum dimension of air openings must not be less than **3 inches (76 mm)**. The required size of the openings for combustion air must be based upon the net free area of each opening. When the free area through a louver, grille, or screen is known, it must be used to calculate the opening size required to provide the free area specified. For additional details, consult NFPA 54, or in Canada, CSA B149.1-10, paragraphs 8.4.1 and 8.4.3.

4.4 Two-Permanent-Openings Method (Usa Only)

Two permanent openings must be provided; one commencing within **12 inches (304 mm)** of the top of the enclosure and one commencing within **12 inches (304 mm)** of the bottom. The openings must communicate directly — or by ducts — with the outdoors, or spaces that freely communicate with the outdoors, as shown on the following pages:

1. When communicating directly with the outdoors, or when communicating to the outdoors through vertical ducts, each opening must have a minimum free area of **1 inch^2 per 4,000 BTU/hr. (550 mm^2/kW)** of total input rating of all appliances in the space (see Figures 3 and 4).

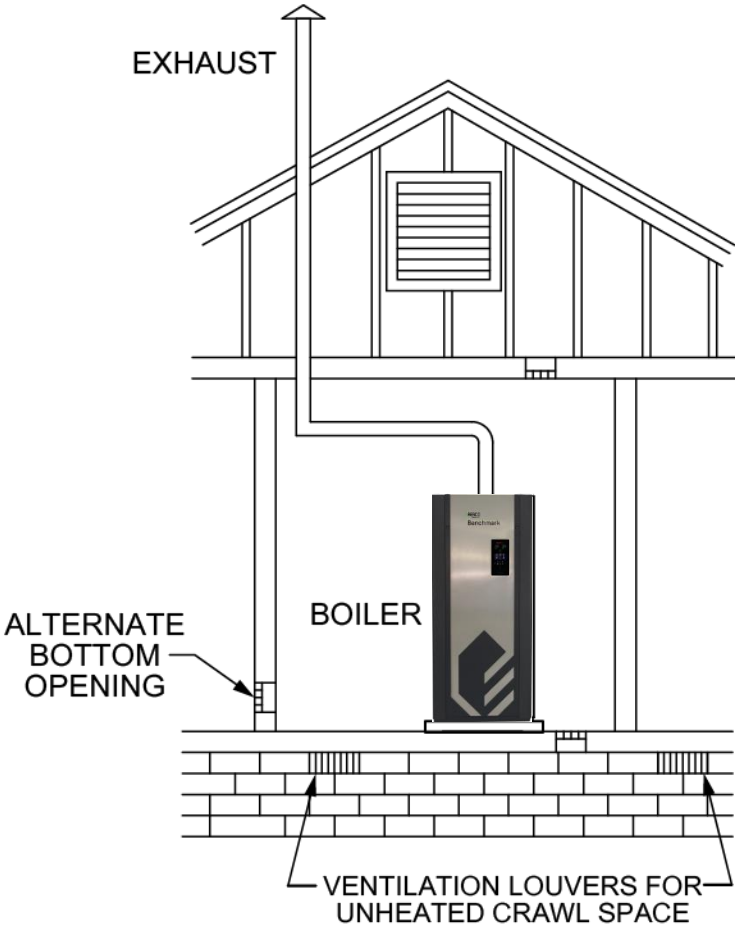


Figure 3: All Combustion Air from Outdoors - Inlet Air from Ventilated Crawl Space and Outlet Air to Ventilated Attic

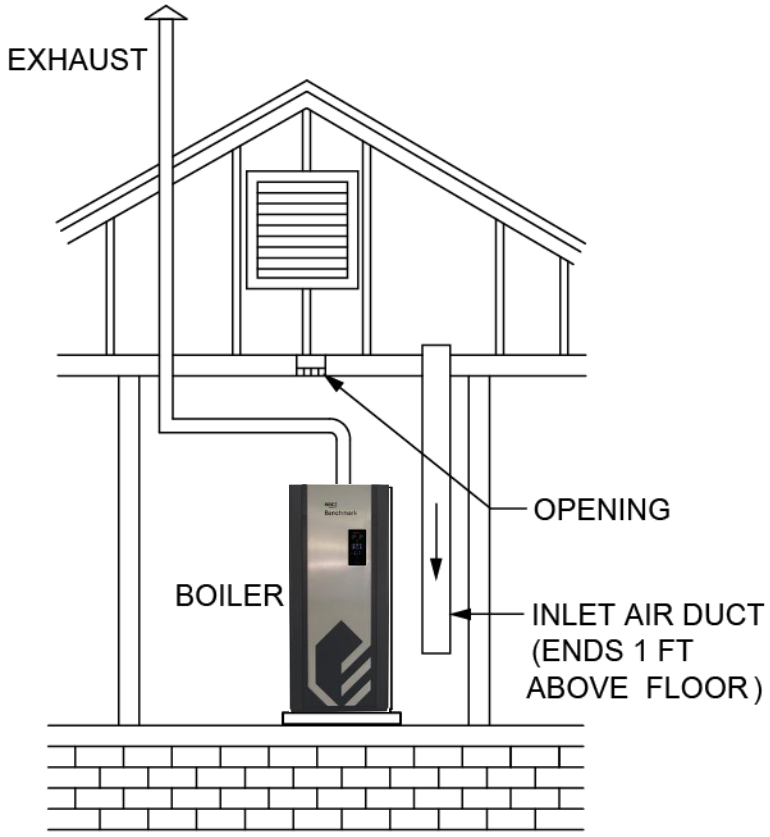


Figure 4: All Combustion Air from Outdoors - Through Ventilated Attic

2. When communicating with the outdoors through horizontal ducts, each opening must have a minimum free area of **1 inch^2 per 2,000 BTU/hr. (1100 mm^2/kW)** of total input rating of all appliances in the space (see Figure 5).

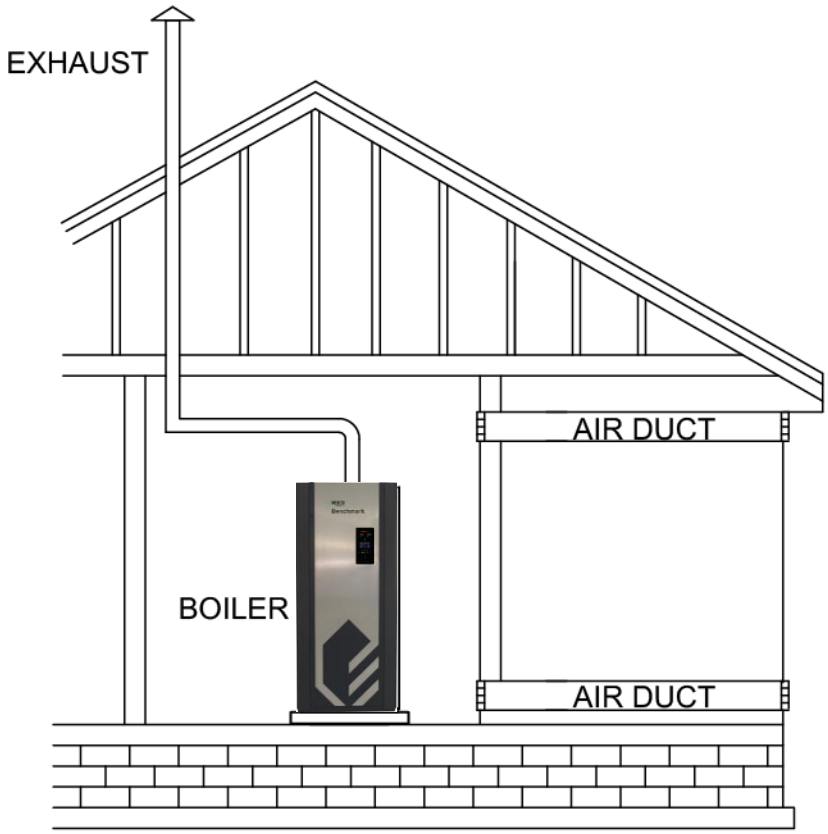


Figure 5: All Combustion Air from Outdoors Through Horizontal Ducts

NOTE: For Canadian installations, refer and adhere to the latest publication of CAN/CSA B149.1.

4.5 One Permanent Opening Method

One permanent opening must be provided, commencing within **12 inches (300 mm)** of the top of the enclosure. The appliance must have clearances of at least **1 inch (25 mm)** from the sides and back of the appliance, and a clearance of 6 inches (150 mm) from the front. The opening must communicate with the outdoors directly or through a vertical or horizontal duct to the outdoors or spaces that freely communicate with the outdoors (as shown in Figure 6) and must have a minimum free area as follows:

- **1 inch^2 per 3,000 BTU/hr. (700 mm^2/kW)** of the total input rating of all appliances located in the space.

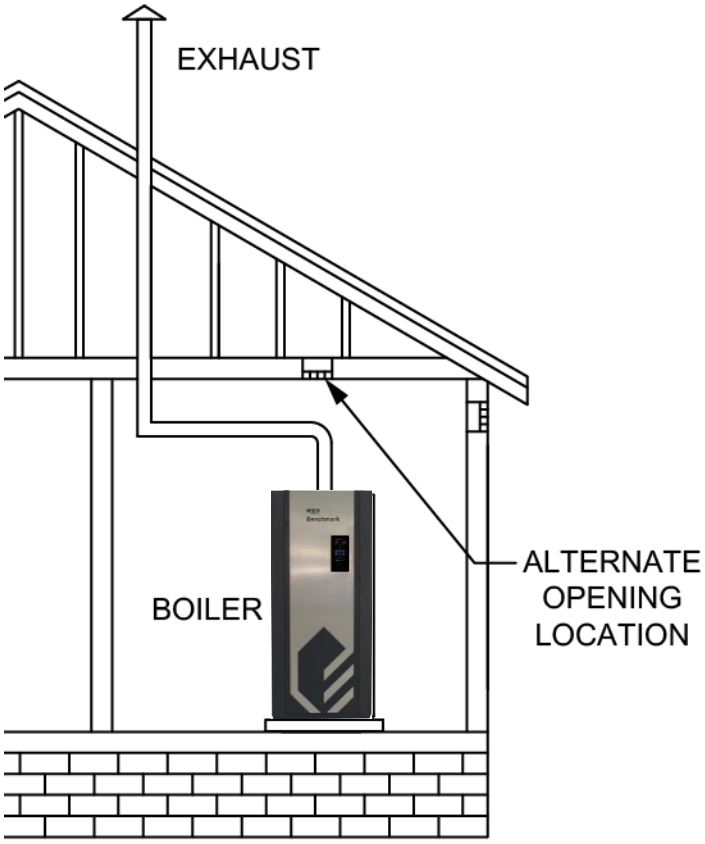


Figure 6: All Combustion Air from Outdoors Through Single Combustion Air Opening

NOTE: For Canadian installations, refer and adhere to the latest publication of CAN/CSA B149.1.

4.6 Opening A Louver Through The Benchmark Boiler

A louver can be opened using the auxiliary relay contacts of the Benchmark boiler. These contacts are provided by a single pole double throw (SPDT) relay that is energized when there is a demand for heat and is de-energized after that demand is satisfied. The relay contacts are rated for 120 VAC at 5 amps, resistive.

NOTE: Do NOT power louver directly using the Auxiliary Relay. An external relay (not supplied) must be employed for this purpose. The boiler power cannot support external accessories.

If the louver features a proof-of-open switch, it must be connected to the boiler's delayed interlock. The delayed interlock must be closed for the unit to fire. If the louver requires time to open, a time-delay must be programmed to hold the start sequence of the boiler long enough for the proof-of-open switch to make (Parameter: **Aux Start On Delay** — programmable from 0 to 120 seconds). If the proof-of-open switch does not prove within the programmed time frame, the boiler will shut down.

For wiring connections and further details regarding the auxiliary relay, delayed interlock and the **Aux Start On Delay** parameter, refer to the Benchmark boiler's Operations and Maintenance manual.

If an AERCO Control System (ACS) is being used to manage a multiple boiler installation, the louver must be opened using the System Start Relay of the ACS. Refer to the ACS Operations and Maintenance Manual, GF-131, for wiring connections and further details.

4.7 Ducted Combustion Air

The Benchmark is approved for ducted combustion air installations; i.e., it can draw combustion air from the outdoors through a metal or PVC duct connected between the Benchmark unit(s) and the outdoors. This configuration is useful for situations in which room air is insufficient or otherwise unsuitable for combustion.

If room air is unsuitable for combustion, combustion air must be supplied with powered duct fans.

The minimum ducted combustion-air duct sizes for the Benchmark boilers are as follows:

BMK750 = 6-inch diameter (15.2 cm)
BMK1000 = 6-inch diameter (15.2 cm)
BMK1500 = 6-inch diameter (15.2 cm)
BMK2000 = 8-inch diameter (20.3 cm)
BMK2500 = 8-inch diameter (20.3 cm)
BMK3000 = 8-inch diameter (20.3 cm)
BMK4000 = 10-inch diameter (25.4 cm)
BMK5000N = 10-inch diameter (25.4 cm)
BMK5000 = 14-inch diameter (35.6 cm)
BMK6000 = 14-inch diameter (35.6 cm)

In many installations, the combustion air duct can be manifolded for multiple unit applications.

The length and restriction of the combustion air duct directly impacts the size, length and restriction of the discharge venting. The ducted air intake must be located at least **3 feet (0.9 m)** below any vent termination within **10 feet (3.1 m)**.

A screen with mesh size not smaller than **1" x 1" (2.54 mm x 2.54 mm)** must be installed at the inlet of the ducted combustion air duct.

IMPORTANT NOTES:

1. Please consult your local AERCO representative or the AERCO factory for all applications utilizing common ducted combustion air with common breeching of exhausts.
2. AERCO boilers and AERCO water heaters may share common combustion air and exhaust breeching. other configurations, not depicted in this guide, are possible. if you intend to implement any of these options, please contact your local AERCO representative or the AERCO factory for project specific venting and combustion air configurations.

4.8 Exhaust Vent And Combustion Air Systems

The Benchmark supports several venting and combustion air options, and although the application parameters vary, there are basic similarities among all systems. Sections 24.1 and 24.2 of this Guide provide tables that address the pressure drop of most applicable vent and duct fittings and sizes. The losses in the vent exit and air duct entrance are also included.

It should be noted that flow and vent or duct diameter have the most significant effects on overall system pressure drop. When using fittings or terminations not listed in the Tables in Section 24, consult the device manufacturer for actual pressure drop values. If a rectangular duct is to be used, consult the table in Section 24.5 for a round diameter duct size that has the identical pressure drop per length of rectangular duct.

4.9 Gross Natural Draft

Flue gases have a lower density (and are lighter) than air and will rise, creating "gross natural draft." Gross natural draft is created when flue gases exit the vent at an elevation above the Benchmark boiler. The amount of draft depends upon the height of the stack and the difference between the flue gas temperature and the surrounding air temperatures (densities). Gross natural draft values for stacks at various heights above the Benchmark unit are presented in Section 24.3. These draft values are based on an installation site at sea level.

Adding the gross natural draft (negative) to the vent and air system pressure drop (positive) determines if the total system will be positive pressure or negative pressure ("net natural draft"). As with most combustion equipment, negative pressure (net natural draft) systems should be treated differently from positive pressure systems when the discharge vents are manifolded. Note that sidewall vent terminations, as well as some vertical terminations, are positive pressure systems.

Contact your AERCO sales representative or AERCO International for design assistance and approval when designing manifolded exhaust vent systems.

CAUTION!
Do NOT install a non-sealed draft control damper.

4.10 Acceptable Pressure Ranges

For individually vented units, the exhaust system must be designed so that pressure measured at every point is in the range from **-0.25" W.C. to +0.81" W.C. (-62 Pa to 202 Pa)**. For common vented units, the exhaust system must be designed so that pressure measured at every point is in the range from **-0.25" W.C. to +0.25" W.C. (-62 Pa to 62 Pa)**. Pressures below **-0.25" W.C. (-62 Pa)** (more negative) may cause flame instability. Pressures above **+0.25" W.C. (62 Pa)** for common vented units, or **+0.81 W.C. (202 Pa)** for individually vented units (more positive), will prevent flue gases from exiting.

4.11 Exhaust Fans

If the Benchmark boiler's exhaust system incorporates an exhaust fan, the system designer must size the vent pipe diameters, select the fan and determine the location of the fan sensor to maintain a **-0.25" W.C. to +0.25" W.C. (-62 Pa to 62 Pa)** pressure range at the outlet of each boiler. Also, the designer must ensure that the exhaust fan material is acceptable for use with Category IV appliances.

4.12 Corrections For Altitude

The table in Section 24.4 lists correction factors for installation altitudes above sea level. These factors must be applied to both the natural draft and pressure drops of vent and air ducts. *The pressure drop through vents and combustion air ducts will increase at higher elevations, while the natural draft will decrease.*

4.13 Manifolded Systems

In many instances it may be practical to connect multiple units using a manifolded vent or exhaust configuration. However, when multiple units are connected by a manifolded air intake or exhaust vent, the operation of a given unit can be affected by the others, if the venting or combustion air system is not designed properly. Properly designed common vent and air supply systems can be installed that will prevent "operational interaction" between units.

Do not use static regain method on common ductwork, but rather, use one duct size for the common run (See Figure 13).

Contact your AERCO sales representative or AERCO International for design assistance and review when designing manifolded exhaust and manifolded combustion air systems.

4.14 Elbow Quantity And Separation

The quantity and angle of elbows and the distances between them can influence the system's exhaust and combustion air pressures, as well as its acoustical behavior. Designers should consider minimizing the number of elbows in the design and the use of angles less than 90°, whenever possible. Five or fewer elbows are recommended for individual venting/connections; five or fewer are recommended for common sections. **In flue runs, the minimum distance required between two elbows is 5 feet (1.5 m); the same distance is recommended for combustion air ducting as well**.

4.15 Exhaust Muffler Guidelines

An exhaust muffler is recommended for Benchmark boilers when installed in a noise-sensitive application and when the exhaust vent ducting is relatively short in length. The following criteria must

be used to determine when to include a field-installed muffler in a Benchmark installation:

- The exhaust is **sidewall vented** and the vent is terminated in close proximity to residences, offices, hotel/hospital rooms, classrooms etc.
  OR
- The **total vertical and horizontal section** of exhaust vent is **less than 25 linear feet (7.6 m)** in length from the last unit, and the vent terminates in close proximity to residences, offices, hotel/hospital rooms, classrooms etc.

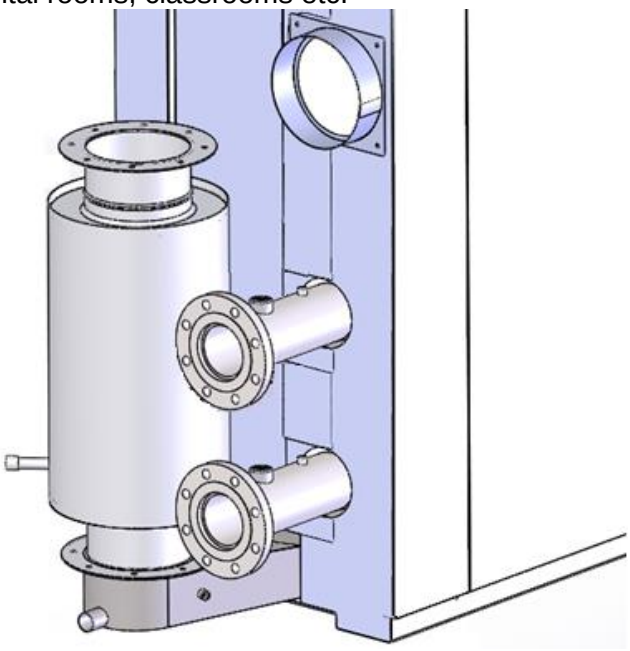


Figure 7: Flanged AERCO Exhaust Muffler

For ***manifolded exhaust*** systems, the total vertical section length includes both horizontal and common vertical; individual boiler vertical connectors are included in the determination as well.

EXAMPLE: For an installation that has a **20 foot (6 m)** common vertical, **5 foot (1.5 m)** common horizontal after the last boiler, and each boiler has a **10 foot (3.1 m)** vertical connector, the total section linear length considered is **35 feet (10.7 m)**. Because this length is greater than **25 linear feet (7.6 m)**, a muffler is ***not*** required.

Contact your local AERCO sales representative for more information on the AERCO exhaust muffler.

4.16 Vent & Combustion Air System Design Requirements

The minimum exhaust vent and combustion air duct sizes for Benchmark Low NOx boilers models are as follows:

	Minimum Diameter	
Model	**Combustion Air Duct**	**Exhaust Vent Diameter**
BMK750	6 inch (15.2 cm)	6 inch (15.2 cm)
BMK1000	6 inch (15.2 cm)	6 inch (15.2 cm)
BMK1500	6 inch (15.2 cm)	6 inch (15.2 cm)
BMK2000	8 inch (20.3 cm)	8 inch (20.3 cm)
BMK2500	8 inch (20.3 cm)	8 inch (20.3 cm)
BMK3000	8 inch (20.3 cm)	8 inch (20.3 cm)
BMK4000 BMK5000N	10 inch (25.4 cm)	12 inch (30.5 cm)
BMK5000 BMK6000	14 inch (35.6 cm)	14 inch (35.6 cm) (<9ppm NO_x Optional Calibration)
		*12 inch (30.5 cm) optional (Standard <20ppm NO_x emissions only)

***** Optional **12 inch (30.5 cm)** diameter exhaust venting requires a **12" (30.5 cm)** vent adapter. Consult your local AERCO sales representative or vent manufacturer for more information on the 12" (30.5 cm) adapter.

A **1/4-inch (6.35 mm)** NPT combustion test hole is provided on each unit's exhaust manifold connection (see Figures 8a, 8b, 8c and 8d, below). A **24 inch (61 cm)** length of straight vent is required downstream of the exhaust manifold, as illustrated in these figures.

The vent system should always be pitched up **1/4 inch per foot (21 mm per m)** of run towards the vent termination to enable condensate to drain back to the unit for disposal. Low spots in the vent must be avoided. Periodic inspection must be performed to assure correct drainage.

Benchmark vents must not be interconnected to those of other manufacturers' equipment.

Horizontal vent and ductwork must be supported to prevent sagging, in accordance with local code and the vent manufacturer's requirements. Vertical vent and ductwork must be supported to prevent excessive stress on the horizontal runs. The exhaust manifold and inlet air adapter must never be used as weight-supporting elements. The supports must be so arranged and the overall layout designed to assure that stresses on the vent and combustion air connections are minimized.

The vents and combustion air ducts may be insulated in accordance with the vent manufacturer's instructions and local codes.

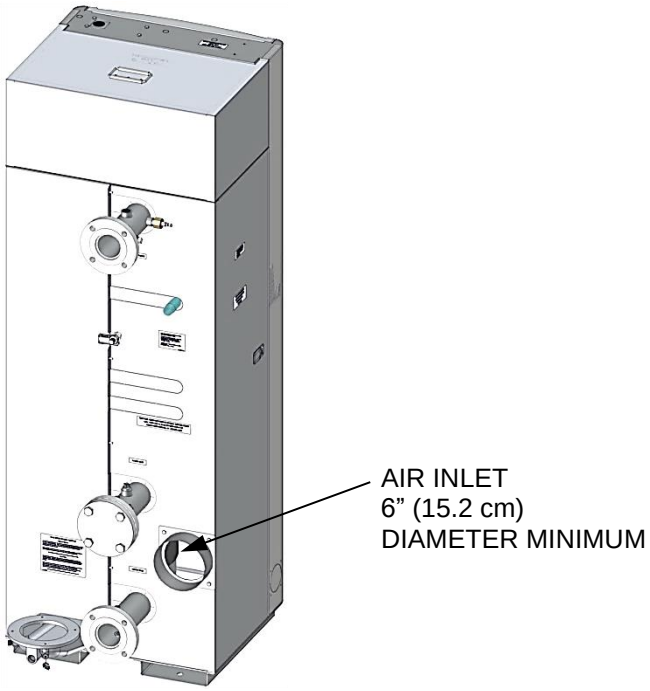


Figure 8a: Ducted Combustion Connection for BMK750 & BMK1000 Boilers

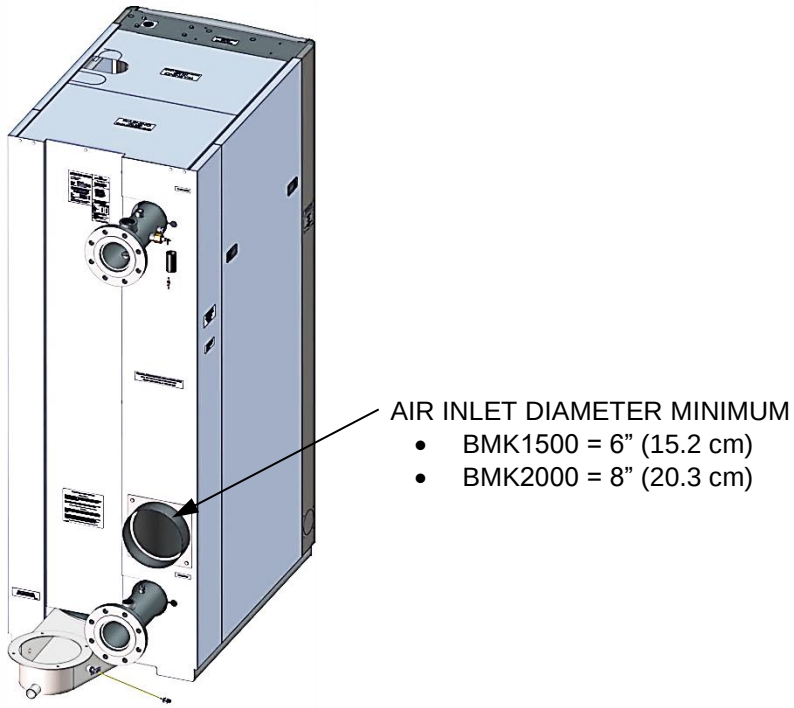


Figure 8b: Ducted Combustion Connection for BMK1500 & BMK2000 Boilers

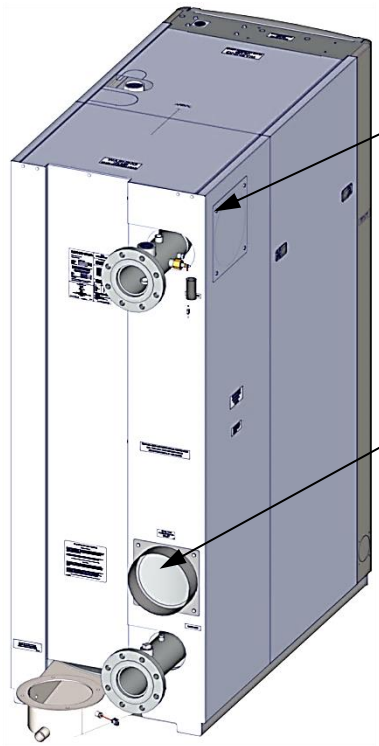


Figure 8c: Ducted Combustion Connection for BMK2500, BMK3000, BMK4000 & BMK5000N Boilers

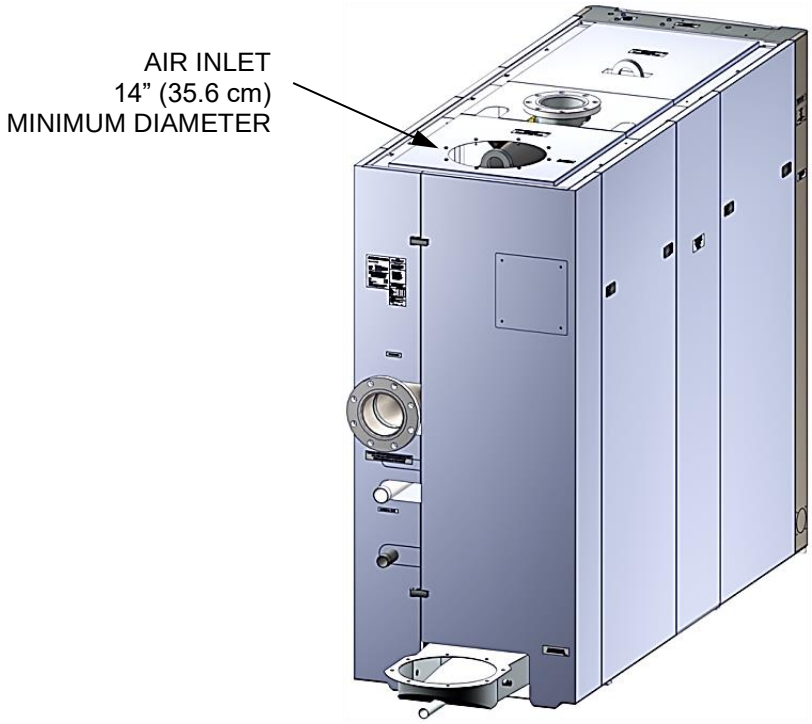
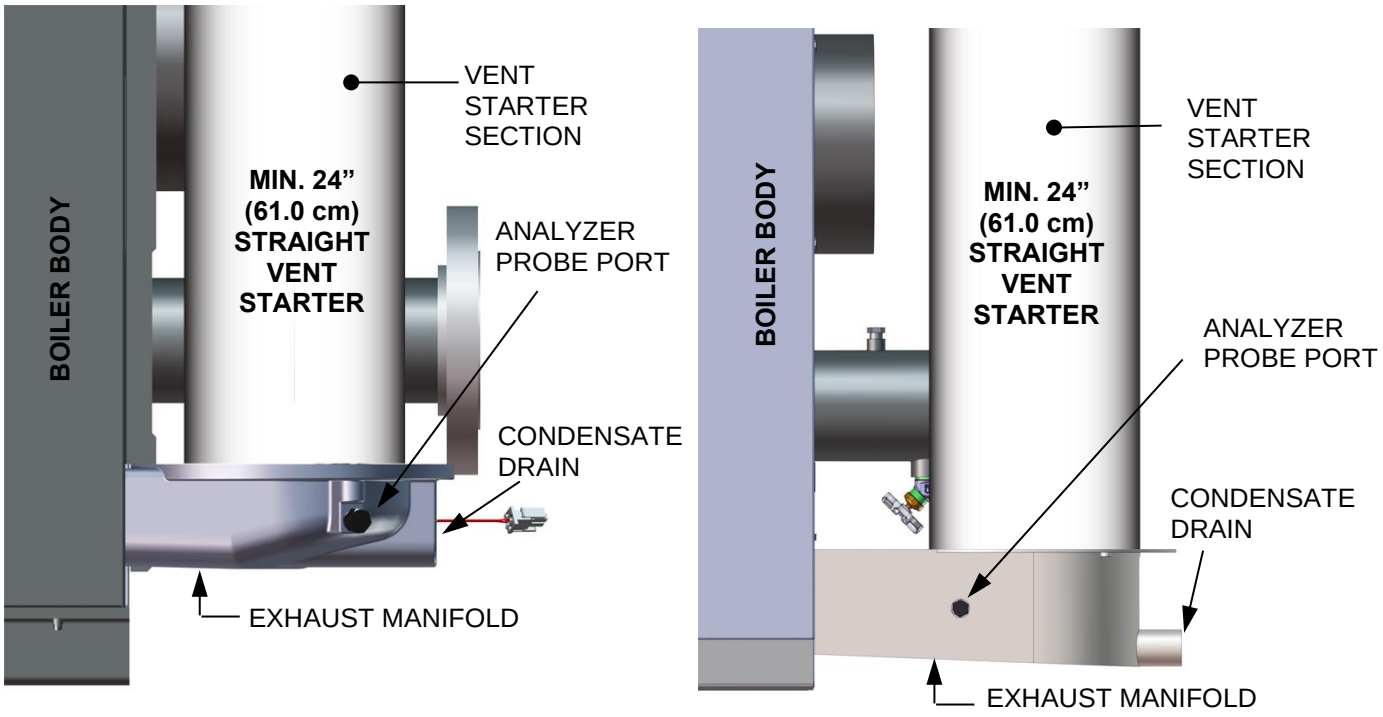
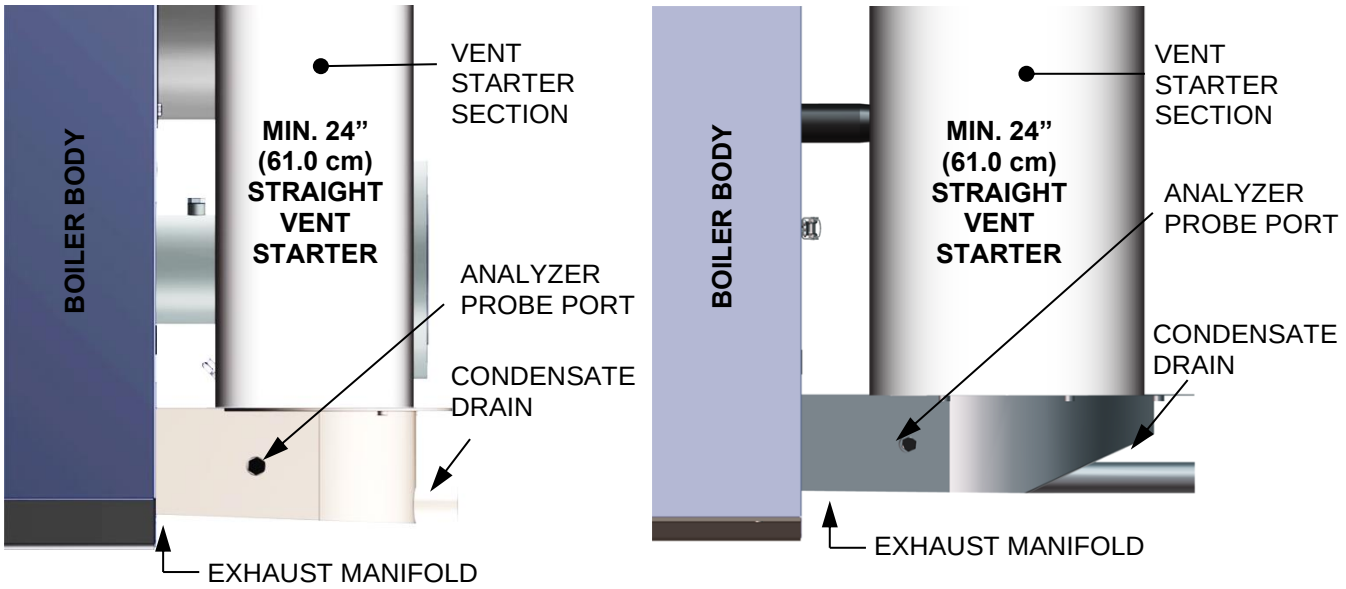


Figure 8d: Ducted Combustion Connection for BMK5000 & 6000 Boilers



BMK750 & BMK1000 ***BMK1500 & BMK2000***

Figure 9a: Vent Starter Section – Left Side View



BMK2500/3000/4000/5000N **BMK5000/6000**

Figure 9b: Vent Starter Section – Left Side View

5. CONDENSATE REMOVAL

The exhaust vent system must be pitched back toward the Benchmark unit by a minimum of **1/4 inch per foot (21 mm per m)** of duct length to enable condensate to drain back to the unit for disposal. Low spots in the vent must be avoided to prevent the condensate from collecting.

The condensate trap assembly is located directly below the exhaust manifold. Plastic hose must be connected to the trap assembly and run to drain. Care must be taken to avoid hose kinks and to avoid raising the hose above the trap assembly. Condensate must flow freely to drain. The condensate-to-drain run must not be hard-piped so the trap can be removed periodically for maintenance purposes.

If the condensate must be lifted above the trap assembly to a drain, it must be drained into a sump. From there, a pump can lift the condensate away.

Each unit will produce the following approximate condensate quantities in the full condensing mode:

- BMK750 = 6 gallons (22.7 L) per hour
- BMK1000 = 8 gallons (30.3 L) per hour
- BMK1500 = 9 gallons (34.1 L) per hour
- BMK2000 = 10 gallons (37.9 L) per hour
- BMK2500 = 15 gallons (56.8 L) per hour
- BMK3000 = 20 gallons (75.7 L) per hour
- BMK4000 = 30 gallons (113.6 L) per hour
- BMK5000N = 33 gallons (124.9 L) per hour
- BMK5000 = 33 gallons (124.9 L) per hour
- BMK6000 = 40 gallons (151.4 L) per hour

Condensate drain systems must be sized for full condensing mode.

In multiple boiler applications, it is common to manifold these drains together in a plastic pipe manifold to a floor drain. Condensate manifolds must be large enough to handle the anticipated flow and must be properly secured and protected. Manifolds are generally located behind the boilers so that short runs of plastic tubing into the manifold can be used for the condensate drain. A base drain must be installed at the bottom of vertical common flue piping.

The pH level of the condensate produced by Benchmark boilers ranges between 3.0 and 3.2. The installation must be designed in accordance with local codes that specify acceptable pH limits. If required, any type of commercially available neutralizer may be used.

6. INDIVIDUALLY VENTED SYSTEMS

Systems with individual vents may be used with any of the combustion air systems described previously and illustrated in Figures 9a and 9b, above. The maximum combined pressure drop of the vent and combustion air system must not exceed **140 equivalent feet (42.7 m)** of length.

To calculate the pressure drop:

1) Calculate the exhaust vent pressure drop.
2) Calculate the combustion duct pressure drop.
3) Divide the vent pressure drop by the altitude correction factor (CF) listed in the table in Section 24.4 to correct for installations above sea level.
4) Determine the natural draft, if any, from the table in Section 24.3 and multiply it by the altitude CF.
5) Add the altitude corrected vent pressure drop (positive) and the draft (negative) to get the total vent pressure drop.
6) Add the total vent pressure drop to the altitude corrected combustion air duct pressure drop.

The total system pressure drop must not exceed **140 equivalent feet (42.7 m)**.

6.1 Bmk1500 Example

Calculate the maximum pressure drop for a single boiler installation at 500 feet (150 m) above sea level having a winter design temperature of 20 °F (-6.7 °C). The duct system consists of:

1) A 6-inch (15.2 cm) diameter exhaust vent with two (2) 90° elbows, one (1) 45° elbows, 10 feet (3.05 m) of horizontal run, 20 feet (6.1 m) of vertical run
2) A rain cap termination
3) A 6-inch (15.2 cm) diameter ducted combustion air duct with two 90° elbows and 15 feet (4.6 m) of run

CALCULATION:

6-inch Diameter Exhaust Vent Pressure

Two 90° elbows: 2 x 13.11 = 26.22 ft. (7.99 m)
One 45° elbow: 1 x 9.98 = 9.98 ft. (3.04 m)
30 feet (9.1 m) total run (10 horizontal + 20 vertical):
30 x 1.77 = 53.10 ft. (16.18 m)
Rain cap exit loss: 1 x 21.95 = 21.95 ft. (6.69 m)
Vent drop subtotal: = 111.25 ft. (33.91 m)
Altitude correction: $\frac{110.69}{0.982\ (CF)}$ = 113.29 ft. (34.53 m)

Natural draft for 20 feet (6.1 m) @ 20 °F (-6.7 °C) outside temperature:
= -12.6 ft. (-3.84 m)
Altitude correction: -12.6 x 0.982 CF = -12.37 ft. (-3.77 m)
Total vent drop: = 100.92 ft. (30.76 m)

6-inch Diameter Combustion Air Duct Pressure

Two 90° elbows: 2 x 5.84 = 11.68 ft. (3.56 m)
15 feet (4.6 m) total run: 15 x 1.06 = 15.9 ft. (4.85 m)
Entrance loss: 1 x 8.60 = 8.60 ft. (2.62 m)

Combustion air drop subtotal: = 36.18 ft. (11.03 m)

Altitude correction: = $\frac{36.18}{0.982\ CF}$ = 36.84 ft. (11.23 m)
Combustion air drop total: = 36.84 ft. (11.23 m)

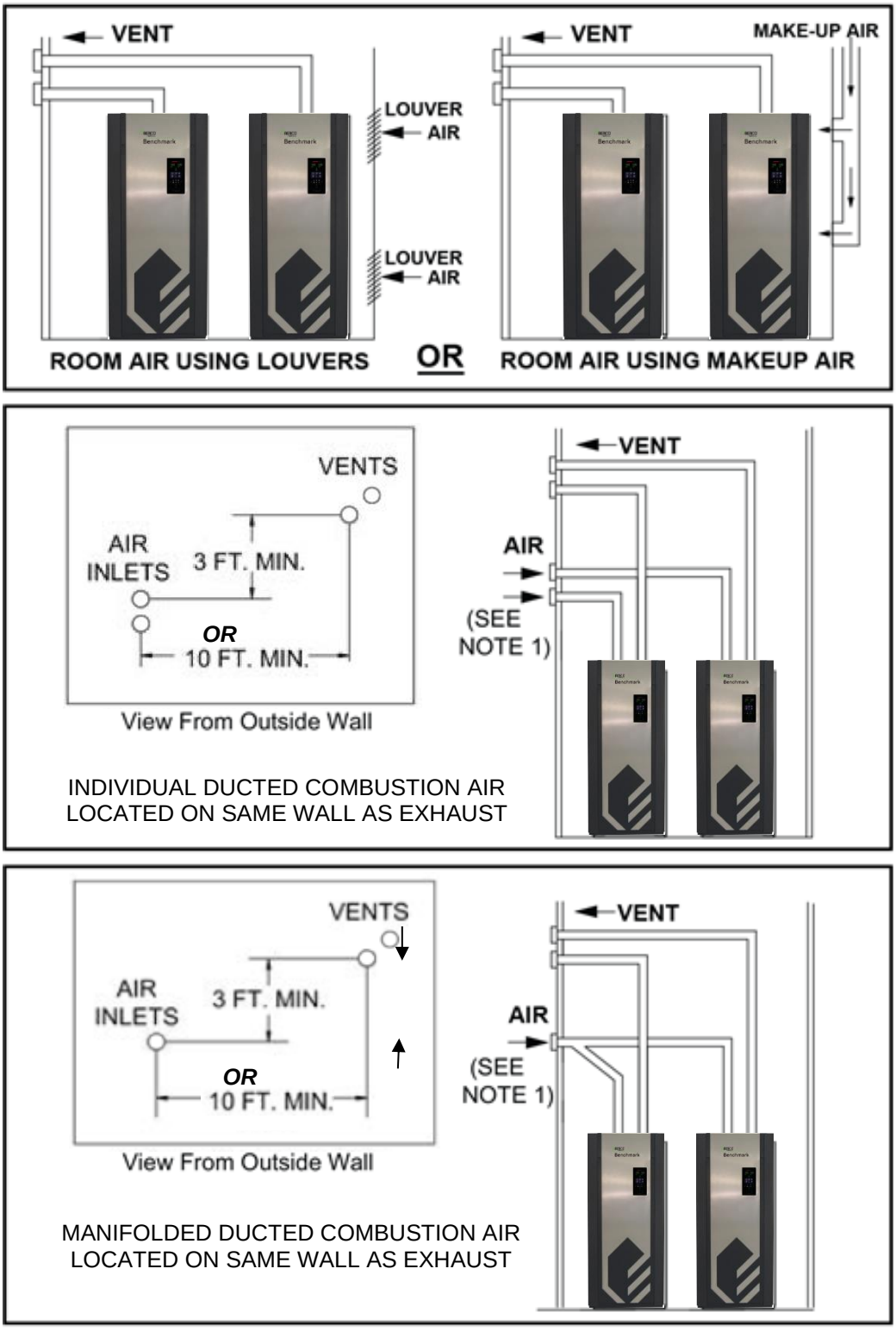
System total pressure drop

Vent drop + combustion air duct pressure drop
= 100.92 + 36.84
= 137.76 ft. (41.99 m)

Conclusion:
Pressure drop is less than 140 equivalent feet (42.7 m) – **System OK**.

7. MANIFOLDED DUCTED COMBUSTION AIR

For systems using manifolded ducted combustion ductwork, use the longest length of common duct and the individual branch to the furthest boiler to calculate the pressure drop.

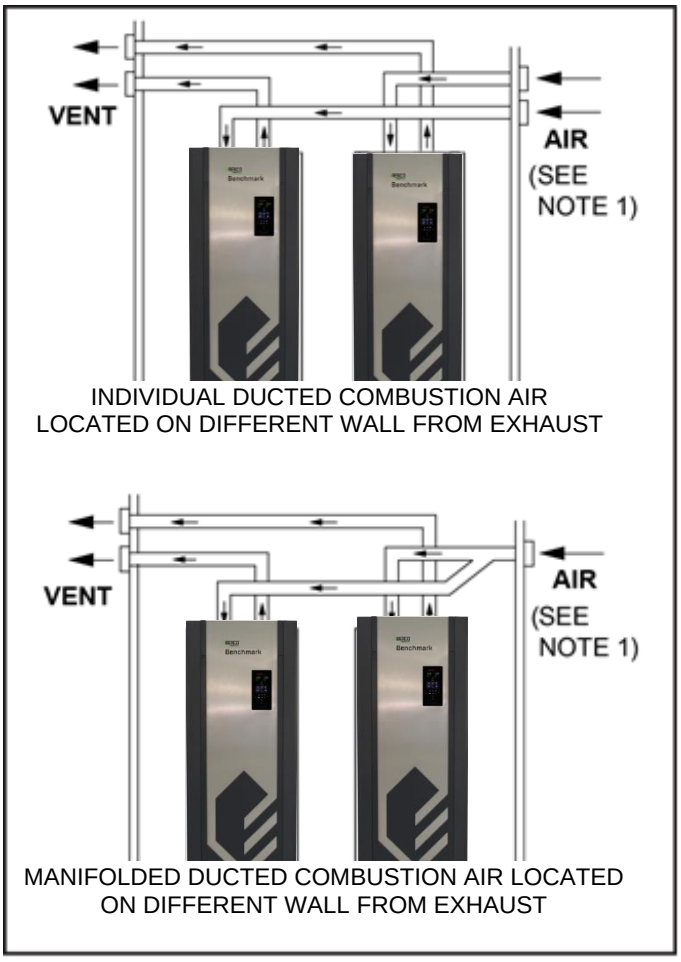


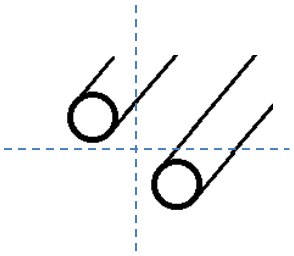
NOTE: Do not install flues directly above another flue termination as this can refer to NFPA 54 for details on code required vent termination.

Figure 10a: Individual Vents – Preferred Installations

NOTE:

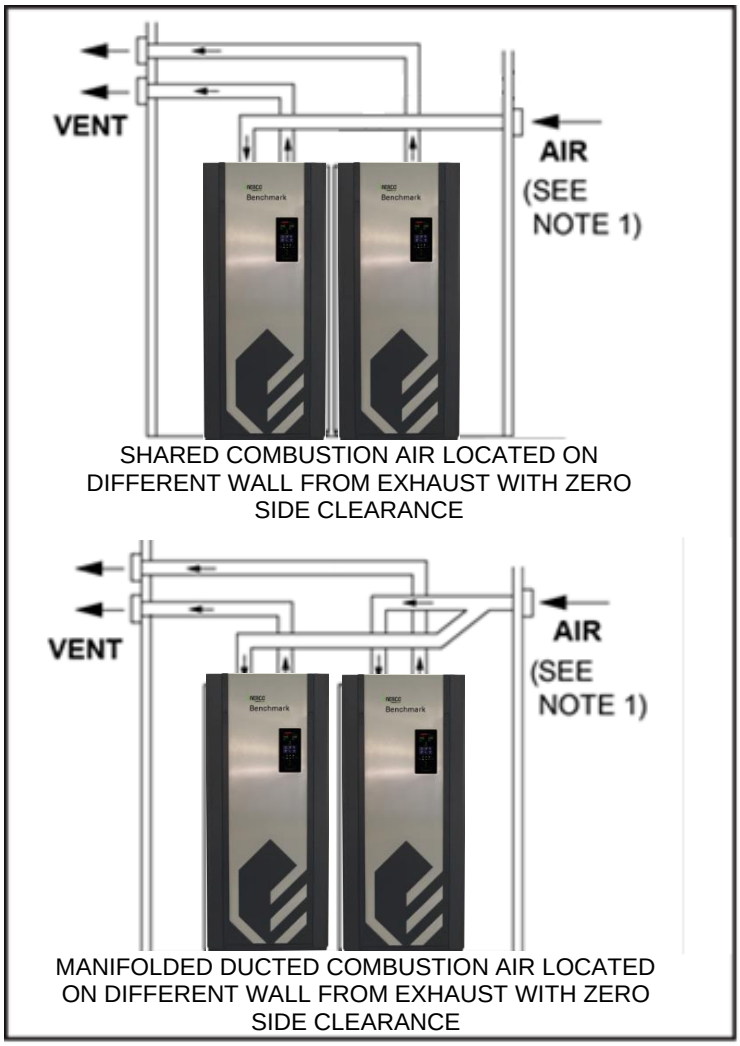
- For high wind sites, a tee must be installed at the fresh air inlet. The leg of the tee connects to the combustion air intake.
- On the flue vent side, a tee or exit cone (velocity cone) may be utilized in place of a rain cap for high wind sites.
- The branches of the tee can be in the horizontal or vertical direction, as determined by the system designer and site conditions.
- In cooler climates, flue terminations should be horizontally offset to eliminate ice formation, due to condensate, from blocking the lower exhaust (see diagram below).





NOTE: Do not install flues directly above another flue termination as this can refer to NFPA 54 for details on code required vent termination.

Figure 10b: Individual Vents – <u>Acceptable Installations</u>



NOTE: The panels should be removed and the internal gap between the units should be sealed using weather tape, rubber strip or other sealant.

Figure 10c: Individual Vents – <u>ACCEPTABLE Installations</u>

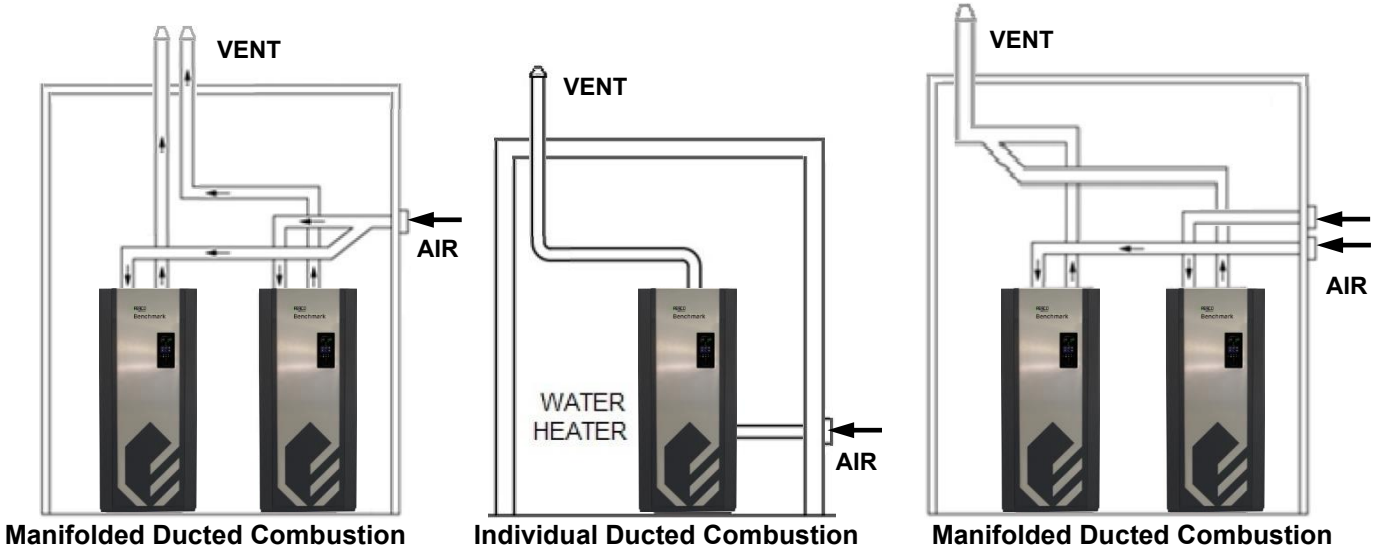
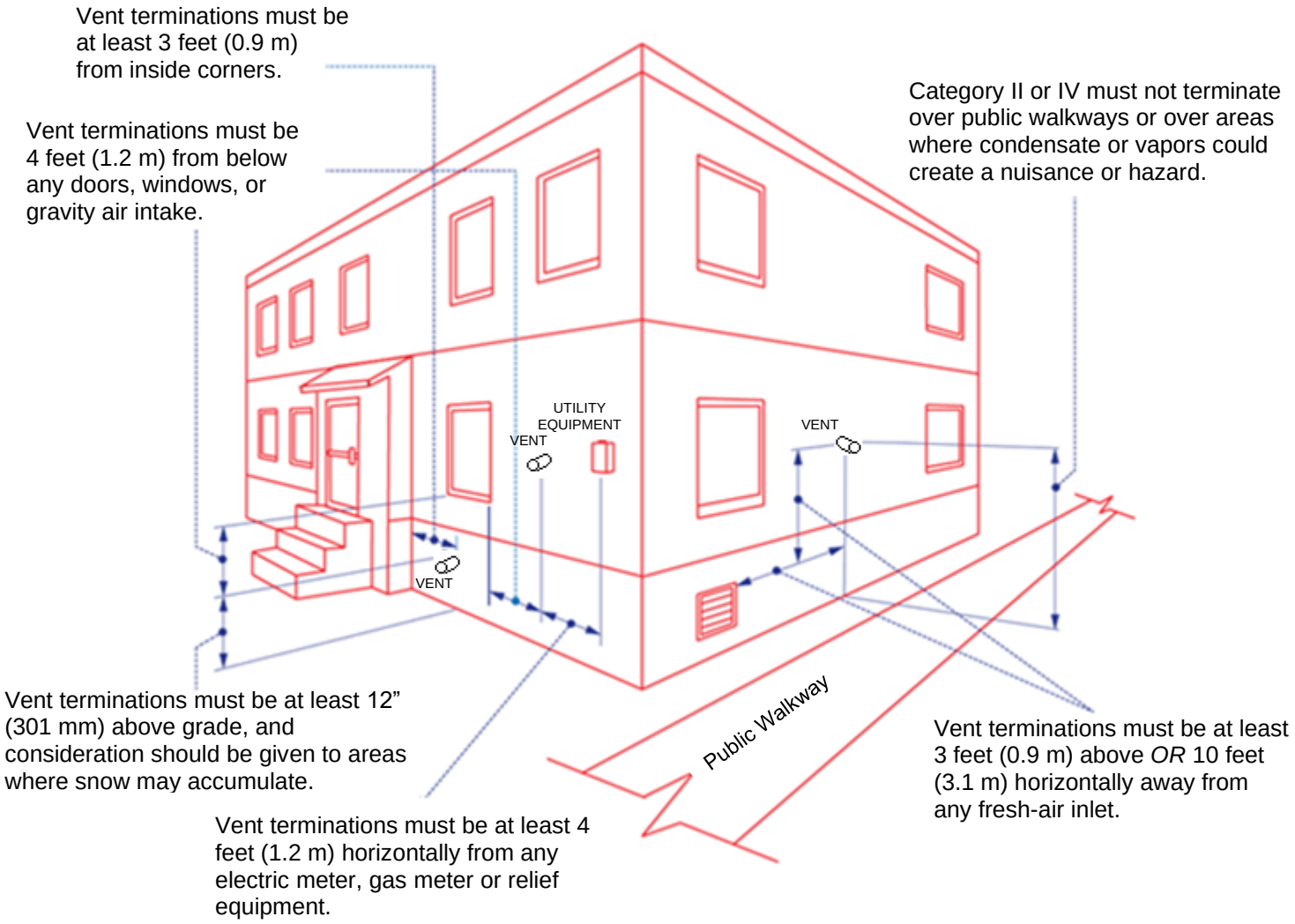


Figure 10d: Individual Vents – <u>ACCEPTABLE Installations</u>

NOTE: For high wind sites, a tee may be installed at the fresh air inlet. The leg of the tee connects to the combustion air intake. The branches of the tee can be in the horizontal or vertical direction, as determined by the system designer and site conditions.

IMPORTANT NOTES:

1. Please consult the AERCO factory for all applications utilizing common ducted combustion air with common breeching of exhausts.
2. AERCO boilers and AERCO water heaters may share common combustion air and exhaust breeching. Other configurations, not depicted in this guide, are possible. If you intend to implement any of these options, please contact your local AERCO representative or the AERCO factory for project specific venting and combustion air configurations.



NOTE: Vertical terminations shall extend at least 3 feet (0.9 m) above the highest point where it passes through a roof of a building and at least 2 feet (0.6 m) higher than any portion of the building within a horizontal distance of 10 feet (3.1 m). Termination that extend more than 2 feet (0.6 m) above the roof must be laterally supported

Figure 10d: Determining Location of Vent Outlet

7.1 Installation Requirements For Vertical Venting

WARNING!

DO NOT INSULATE OR OTHERWISE WRAP VENT PIPE OR FITTINGS. FOLLOW THE VENT PIPE MANUFACTURERS INSTALLATION INSTRUCTIONS FOR VERTICAL VENTING.

The vent termination must be located as follows (refer to Figure 10e):

a. Combustion air inlet must be 3 ft. (0.9 m) below any vent outlet that is within 10 ft. (3.1 m).

b. Vertical terminations shall extend at least 3 ft. (0.9 m) above the highest point where it passes through a roof of a building and at least 2 ft. (0.6 m) higher than any portion of the building within a horizontal distance of 10 ft. (3.1 m). Terminations that extend more than 2 ft. above the roof must be laterally supported.

c. Combustion air inlet must also face away from the vent outlet.

d. Use vent pipe manufacturer's vent cap or exit cone (velocity cone), fire stop, support collar, roof flushing and storm collar.

e. AERCO recommends the use of an exit cone in lieu of a termination rain cap for normal installations and T- termination for high-wind areas.

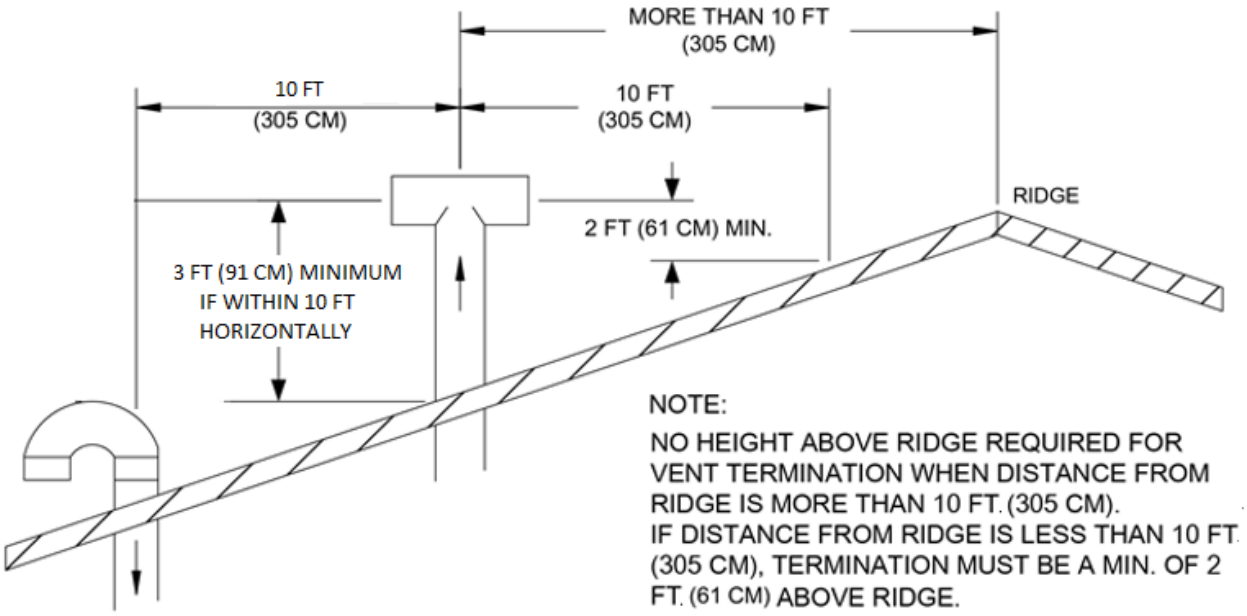


Figure 10e: Acceptable Combustion Air Inlet & Vent Outlet Configuration

8. COMMON VENT BREECHING (MANIFOLDED)

IMPORTANT NOTES:

1. AERCO forced draft boilers are designed for application in common vent systems.
2. Please consult the AERCO factory for all applications utilizing common ducted combustion air with common breeching of exhausts.
3. AERCO boilers and AERCO water heaters may share common combustion air and exhaust breeching. Other configurations, not depicted in this guide, are possible. If you intend to implement any of these options, please contact your local AERCO representative or the AERCO factory for project specific venting and combustion air configurations and for design assistance and approval when designing manifolded exhaust vent systems.
4. For applications requiring side wall termination of common venting, please contact AERCO representative.

Connections to common vent breeching or duct work must be accomplished with a 45° elbow in the direction of flow in the main breeching. “Tees” must not be used to accomplish these connections - see Figure 11a. The required minimum common venting vertical vent run should be 10 feet (3.1 m) up to vertical termination after the last boiler is connected to common header.

Figure 11a: Required Connections to Common Vent Breeching

Interconnection of groups of units must *never* be accomplished via a “tee”. As shown in Figure 11b, change the direction with one of the mains and then connect the second three diameters (common section diameter) from this turn via a 45° connection.

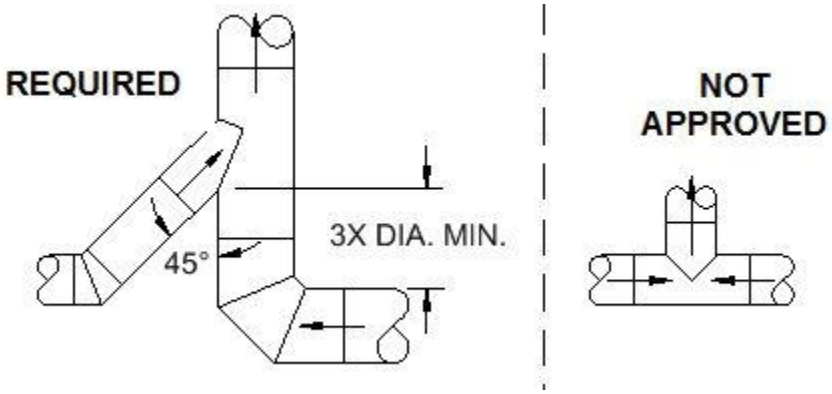


Figure 11b: Required Interconnection of Groups of Units

Figure 12 illustrates the preferable “transition vent section” when making the 45° connection into a main. The main can also remain at one diameter, as long as it is sized for the total number of units vented and the 45° branch connection is retained. Use of the recommended “transition” assembly will reduce the overall system pressure drop.

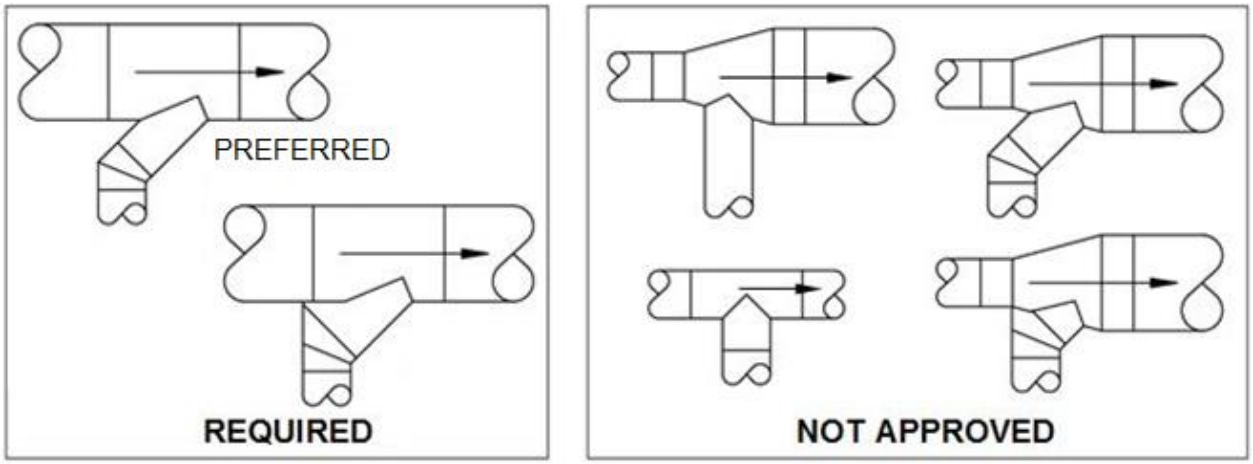


Figure 12: Required Transition Vent Sections

The vent system should always be pitched up ¼-inch per foot (21 mm per m) of run towards the vent termination (see Figure 13). This will enable condensate to drain back to the unit for disposal. Low spots in the vent must be avoided. Inspect periodically to ensure correct drainage.

As shown in Figure 13, the unit at the end of the vent main must be connected via an elbow. An end cap must not be used as it may cause vibration and flue pressure fluctuations.

As discussed previously, the static regain method should not be used for common ductwork, but rather, the one duct size should be used for the common run.

Benchmark vents must never be interconnected to those connected to another manufacturers’ equipment.

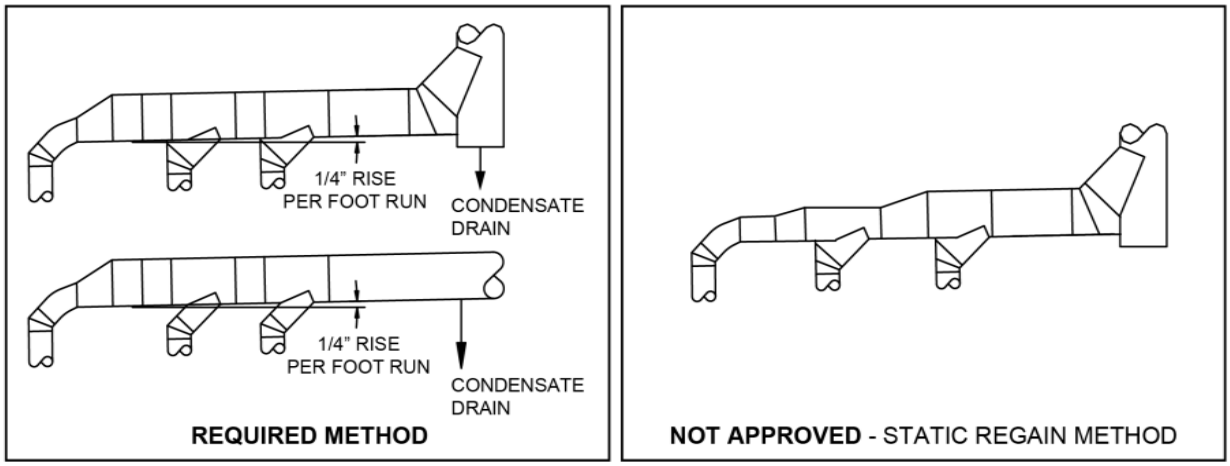


Figure 13: Connection of Unit at End of Vent Main

9. PRESSURE DROP AND DRAFT DATA TABLES

9.1 Discharge Flue Vent Pressure Drop

Table 1-a: Discharge Flue Vent Pressure Drop (Eq. Ft.) for Single BMK750 Boiler

(Assuming 180 °F (82.2 °C) Water Temperature and 20 °F (11 °C) Rise at Sea Level)

Flue Vent Inch Dia. (cm)	Flue Velocity in Ft./sec (m/sec)	Straight Run in Eq. Ft. / Foot (m/m)	90° elbow Eq. Ft. (m)	45° elbow Eq. Ft. (m)	Exit Loss Horiz. Term. Eq. Ft. (m)	Exit Loss Rain Cap Eq. Ft. (m)
6 (15.2)	16.65 (5.07)	0.45 (0.45)	2.90 (0.88)	2.15 (0.66)	3.59 (1.09)	5.13 (1.56)
8 (20.3)	9.37 (2.86)	0.11 (0.11)	0.74 (0.23)	0.56 (0.17)	1.14 (0.35)	2.11 (0.64)
10 (25.4)	5.99 (1.83)	0.04 (0.04)	0.26 (0.08)	0.20 (0.06)	0.47 (0.14)	0.86 (0.26)
12 (30.5)	4.16 (1.27)	0.02 (0.02)	0.11 (0.03)	0.09 (0.03)	0.22 (0.07)	0.42 (0.13)
14 (35.6)	3.06 (0.93)	0.01 (0.01)	0.06 (0.02)	0.04 (0.01)	0.12 (0.04)	0.23 (0.07)

Table 1-b: Discharge Flue Vent Pressure Drop (Eq. Ft.) for Single BMK1000 Boiler

(Assuming 180 °F (82.2 °C) Water Temperature and 20 °F (11 °C) Rise at Sea Level)

Flue Vent Inch Dia. (cm)	Flue Velocity in Ft./sec (m/sec)	Straight Run in Eq. Ft. / Foot (m/m)	90° elbow Eq. Ft. (m)	45° elbow Eq. Ft. (m)	Exit Loss Horiz. Term. Eq. Ft. (m)	Exit Loss Rain Cap Eq. Ft. (m)
6 (15.2)	22.20 (6.77)	0.77 (0.77)	5.15 (1.57)	3.82 (1.16)	6.39 (1.95)	9.12 (2.78)
8 (20.3)	12.49 (3.81)	0.18 (0.18)	1.32 (0.40)	0.99 (0.30)	2.02 (0.62)	3.75 (1.14)
10 (25.4)	7.99 (2.44)	0.06 (0.06)	0.47 (0.14)	0.36 (0.11)	0.83 (0.25)	1.54 (0.47)
12 (30.5)	5.55 (1.69)	0.03 (0.03)	0.20 (0.06)	0.16 (0.05)	0.40 (0.12)	0.74 (0.23)
14 (35.6)	4.08 (1.24)	0.01 (0.01)	0.10 (0.03)	0.08 (0.02)	0.22 (0.07)	0.40 (0.12)

Table 1-c: Discharge Flue Vent Pressure Drop (Eq. Ft.) for Single BMK1500 Boiler

(Assuming 180 °F (82.2 °C) Water Temperature and 20 °F (11 °C) Rise at Sea Level)

Flue Vent Inch Dia. (cm)	Flue Velocity in Ft./sec (m/sec)	Straight Run in Eq. Ft. / Foot (m/m)	90° elbow Eq. Ft. (m)	45° elbow Eq. Ft. (m)	Exit Loss Horiz. Term. Eq. Ft. (m)	Exit Loss Rain Cap Eq. Ft. (m)
6 (15.2)	34.43 (10.49)	1.77 (1.77)	13.11 (4.00)	9.98 (3.04)	15.37 (4.68)	21.95 (6.69)
8 (20.3)	19.37 (5.90)	0.40 (0.40)	3.13 (0.95)	2.36 (0.72)	4.86 (1.48)	9.03 (2.75)
10 (25.4)	12.4 (3.78)	0.13 (0.13)	1.06 (0.32)	0.80 (0.24)	1.99 (0.61)	3.70 (1.13)
12 (30.5)	8.62 (2.63)	0.05 (0.05)	0.46 (0.14)	0.35 (0.11)	0.96 (0.29)	1.78 (0.54)
14 (35.6)	6.33 (1.93)	0.03 (0.03)	0.24 (0.07)	0.19 (0.06)	0.52 (0.16)	0.96 (0.29)
16 (40.6)	4.85 (1.48)	0.01 (0.01)	0.14 (0.04)	0.11 (0.03)	0.3 (0.09)	0.56 (0.17)

Table 1-d: Discharge Venting Pressure Drop for Single BMK2000 Boiler

(Assuming 180 °F (82.2 °C) Water Temperature and 20 °F (11 °C) Rise at Sea Level)

Flue Vent Inch Dia. (cm)	Flue Velocity in Ft./sec (m/sec)	Straight Run in Eq. Ft. / Foot (m/m)	90° elbow Eq. Ft. (m)	45° elbow Eq. Ft. (m)	Exit Loss Horiz. Term. Eq. Ft. (m)	Exit Loss Rain Cap Eq. Ft. (m)
8 (20.3)	26.35 (8.03)	0.71 (0.71)	5.86 (1.79)	4.42 (1.35)	9.00 (2.74)	16.71 (5.09)
10 (25.4)	16.87 (5.14)	0.23 (0.23)	2.08 (0.63)	1.59 (0.48)	3.69 (1.12)	6.85 (2.09)
12 (30.5)	11.71 (3.57)	0.09 (0.09)	0.91 (0.28)	0.70 (0.21)	1.78 (0.54)	3.30 (1.01)
14 (35.6)	8.60 (2.62)	0.04 (0.04)	0.46 (0.14)	0.35 (0.11)	0.96 (0.29)	1.78 (0.54)
16 (40.6)	6.59 (2.01)	0.02 (0.02)	0.25 (0.08)	0.20 (0.06)	0.56 (0.17)	1.04 (0.32)
18 (45.7)	5.21 (1.59)	0.01 (0.01)	0.15 (0.05)	0.12 (0.04)	0.35 (0.11)	0.65 (0.20)

Table 1-e: Discharge Venting Pressure Drop for Single BMK2500 Boiler

(Assuming 180 °F (82.2 °C) Water Temperature and 20 °F (11 °C) Rise at Sea Level)

Flue Vent Inch Dia. (cm)	Flue Velocity in Ft./sec (m/sec)	Straight Run in Eq. Ft. / Foot (m/m)	90° elbow Eq. Ft. (m)	45° elbow Eq. Ft. (m)	Exit Loss Horiz. Term. Eq. Ft. (m)	Exit Loss Rain Cap Eq. Ft. (m)
8 (20.3)	25.62 (7.81)	0.93 (0.93)	5.54 (1.69)	4.17 (1.27)	8.51 (2.59)	15.89 (4.84)
10 (25.4)	16.49 (5.03)	0.30 (0.30)	1.97 (0.60)	1.51 (0.46)	3.48 (1.06)	6.47 (1.97)
12 (30.5)	11.39 (3.47)	0.12 (0.12)	0.86 (0.26)	0.67 (0.20)	1.68 (0.51)	3.12 (0.95)
14 (35.6)	8.37 (2.55)	0.06 (0.06)	0.43 (0.13)	0.34 (0.10)	0.91 (0.28)	1.68 (0.51)
16 (40.6)	6.40 (1.95)	0.03 (0.03)	0.24 (0.07)	0.19 (0.06)	0.53 (0.16)	0.99 (0.30)
18 (45.7)	5.06 (1.54)	0.02 (0.02)	0.14 (0.04)	0.11 (0.03)	0.33 (0.10)	0.62 (0.19)

Table 1-f: Discharge Flue Vent Pressure Drop (Eq. Ft.) for Single BMK3000 Boiler

(Assuming 180 °F (82.2 °C) Water Temperature and 20 °F (11 °C) Rise at Sea Level)

Flue Vent Inch Dia. (cm)	Flue Velocity in Ft./sec (m/sec)	Straight Run in Eq. Ft. / Foot (m/m)	90° elbow Eq. Ft. (m)	45° elbow Eq. Ft. (m)	Exit Loss Horiz. Term. Eq. Ft. (m)	Exit Loss Rain Cap Eq. Ft. (m)
8 (20.3)	29.28 (8.92)	1.46 (0.45)	11.98 (3.65)	9.01 (2.75)	18.6 (5.67)	34.54 (10.53)
10 (25.4)	19.13 (5.83)	0.47 (0.14)	4.05 (1.23)	3.04 (0.93)	7.62 (2.32)	14.15 (4.31)
12 (30.5)	13.28 (4.05)	0.19 (0.06)	1.76 (0.54)	1.34 (0.41)	3.67 (1.12)	6.82 (2.08)
14 (35.6)	9.76 (2.97)	0.09 (0.03)	0.92 (0.28)	0.71 (0.22)	1.98 (0.60)	3.68 (1.12)
16 (40.6)	7.47 (2.28)	0.05 (0.02)	0.53 (0.16)	0.42 (0.13)	1.16 (0.35)	2.16 (0.66)
18 (45.7)	5.90 (1.80)	0.03 (0.01)	0.33 (0.16)	0.26 (0.08)	0.73 (0.22)	1.35 (0.41)

Table 1-g: Discharge Flue Vent Pressure Drop (Eq. Ft.) for Single BMK4000 Boiler

(Assuming 180 °F (82.2 °C) Water Temperature and 20 °F (11 °C) Rise at Sea Level)

Flue Vent Inch Dia. (cm)	Flue Velocity in Ft./sec (m/sec)	Straight Run in Eq. Ft. / Foot (m/m)	90° elbow Eq. Ft. (m)	45° elbow Eq. Ft. (m)	Exit Loss Horiz. Term. Eq. Ft. (m)	Exit Loss Rain Cap Eq. Ft. (m)
12 (30.5)	24.41 (7.44)	0.38 (0.38)	3.95 (1.2)	3.06 (0.93)	7.74 (2.36)	14.34 (4.37)
14 (35.6)	17.93 (5.47)	0.18 (0.18)	1.98 (0.6)	1.54 (0.47)	4.18 (1.27)	7.74 (2.36)
16 (40.6)	13.72 (4.18)	0.09 (0.09)	1.09 (0.33)	0.85 (0.26)	2.45 (0.75)	4.53 (1.38)
18 (45.7)	10.84 (3.3)	0.05 (0.05)	0.65 (0.2)	0.51 (0.16)	1.53 (0.47)	2.83 (0.86)
20 (6.1)	8.78 (2.68)	0.03 (0.03)	0.41 (0.12)	0.32 (0.1)	1 (0.3)	1.85 (0.56)

Table 1-h: Discharge Flue Vent Pressure Drop (Eq. Ft.) for Single BMK5000N Boiler

(Assuming 180 °F (82.2 °C) Water Temperature and 20 °F (11 °C) Rise at Sea Level)

Flue Vent Inch Dia. (cm)	Flue Velocity in Ft./sec (m/sec)	Straight Run in Eq. Ft. / Foot (m/m)	90° elbow Eq. Ft. (m)	45° elbow Eq. Ft. (m)	Exit Loss Horiz. Term. Eq. Ft. (m)	Exit Loss Rain Cap Eq. Ft. (m)
12 (30.5)	30.54 (9.31)	0.58 (0.58)	6.18 (1.88)	4.78 (1.46)	12.12 (3.69)	22.45 (6.84)
14 (35.6)	22.43 (6.84)	0.27 (0.27)	3.09 (0.94)	2.41 (0.73)	6.54 (1.99)	12.11 (3.69)
16 (40.6)	17.17 (5.23)	0.14 (0.14)	1.71 (0.52)	1.33 (0.41)	3.83 (1.17)	7.1 (2.16)
18 (45.7)	13.56 (4.13)	0.08 (0.08)	1.01 (0.31)	0.79 (0.24)	2.39 (0.73)	4.43 (1.35)
20 (6.1)	10.98 (3.35)	0.05 (0.05)	0.63 (0.19)	0.5 (0.15)	1.57 (0.48)	2.9 (0.88)

Table 1-i: Discharge Flue Vent Pressure Drop (Eq. Ft.) for Single BMK5000/6000 Boiler

(Assuming 180 °F (82.2 °C) Water Temperature and 20 °F (11 °C) Rise at Sea Level)

Flue Vent Inch Dia. (cm)	Flue Velocity in Ft./sec (m/sec)	Straight Run in Eq. Ft. / Foot (m/m)	90° elbow Eq. Ft. (m)	45° elbow Eq. Ft. (m)	Exit Loss Horiz. Term. Eq. Ft. (m)	Exit Loss Rain Cap Eq. Ft. (m)
12 (30.5)	30.59 (9.32)	0.64 (0.64)	6.20 (1.89)	4.80 (1.46)	12.13 (3.7)	22.53 (6.87)
14 (35.6)	22.48 (6.85)	0.29 (0.29)	3.11 (0.95)	2.42 (0.74)	6.55 (2.0)	12.16 (3.71)
16 (40.6)	17.21 (5.25)	0.15 (0.15)	1.72 (0.52)	1.34 (0.41)	3.84 (1.17)	7.13 (2.17)
18 (45.7)	13.60 (4.15)	0.08 (0.08)	1.02 (0.31)	0.79 (0.24)	2.40 (0.73)	4.45 (1.36)
20 (6.1)	11.01 (3.36)	0.05 (0.05)	0.64 (0.2)	0.50 (0.15)	1.57 (0.48)	2.92 (0.89)

9.2 Ducted Combustion Air Duct Pressure Drop

Table 2-a: Ducted Combustion Air Duct Pressure Drop in Eq. Ft. (m) for BMK750 Boiler

		Outside Air Temperature in °F (°C)								
Inlet Duct & No. Boilers	**Duct Section Type**	**-30 °F (-34.4)**	**-15 °F (-26.1)**	**0 °F (-17.8)**	**20 °F (-6.7)**	**40 °F (4.4)**	**60 °F (15.6)**	**80 °F (26.7)**	**100 °F (37.8)**	**120 °F (48.9)**
6" Duct Single Boiler	Straight Run	0.27 (0.27)	0.27 (0.27)	0.28 (0.28)	0.29 (0.29)	0.30 (0.30)	0.31 (0.31)	0.32 (0.32)	0.33 (0.33)	0.34 (0.34)
	90° Elbow	1.18 (0.36)	1.23 (0.375)	1.29 (0.393)	1.38 (0.421)	1.47 (0.448)	1.57 (0.479)	1.68 0.512)	1.79 (0.546)	1.91 (0.582)
	45° Elbow	0.87 (0.265)	0.91 (0.277)	0.96 (0.293)	1.02 (0.311)	1.09 (0.332)	1.16 (0.354)	1.24 (0.378)	1.32 (0.402)	1.41 (0.43)
	Ent. Loss	1.83 (0.558)	1.92 (0.585)	2.02 (0.616)	2.15 (0.655)	2.29 (0.698)	2.45 (0.747)	2.61 (0.796)	2.79 (0.85)	2.97 (0.905)
8" Duct Single Boiler	Straight Run	0.07 (0.07)	0.07 (0.07)	0.07 (0.07)	0.07 (0.07)	0.07 (0.07)	0.08 (0.08)	0.08 (0.08)	0.08 (0.08)	0.08 (0.08)
	90° Elbow	0.30 (0.091)	0.31 (0.094)	0.33 (0.101)	0.35 (0.107)	0.38 (0.116)	0.40 (0.122)	0.43 (0.131)	0.46 (0.14)	0.49 (0.149)
	45° Elbow	0.23 (0.07)	0.24 (0.073)	0.25 (0.076)	0.27 (0.082)	0.28 (0.085)	0.30 (0.091)	0.32 (0.098)	0.34 (0.104)	0.37 (0.113)
	Ent. Loss	0.58 (0.177)	0.61 (0.186)	0.64 (0.195)	0.68 (0.207)	0.73 (0.223)	0.77 (0.235)	0.83 (0.253)	0.88 (0.268)	0.94 (0.287)
8" Duct Two Boilers	Straight Run	0.20 (0.20)	0.21 (0.21)	0.22 (0.22)	0.23 (0.23)	0.25 (0.25)	0.26 (0.26)	0.28 (0.28)	0.30 (0.30)	0.32 (0.32)
	90° Elbow	1.20 (0.366)	1.26 (0.384)	1.32 (0.402)	1.41 (0.43)	1.5 (0.457)	1.6 (0.488)	1.71 (0.521)	1.83 (0.558)	1.95 (0.594)
	45° Elbow	0.90 (0.274)	0.95 (0.29)	1.00 (0.305)	1.06 (0.323)	1.13 (0.344)	1.21 (0.369)	1.29 (0.393)	1.38 (0.421)	1.47 (0.448)
	Ent. Loss	2.32 (0.707)	2.43 (0.741)	2.55 (0.777)	2.72 (0.829)	2.90 (0.884)	3.10 (0.945)	3.31 (1.009)	3.53 (1.076)	3.76 (1.146)
10" Duct Two Boilers	Straight Run	0.07 (0.07)	0.07 (0.07)	0.07 (0.07)	0.08 (0.08)	0.08 (0.08)	0.09 (0.09)	0.09 (0.09)	0.10 (0.10)	0.11 (0.11)
	90° Elbow	0.43 (0.131)	0.45 (0.137)	0.47 (0.143)	0.5 (0.152)	0.53 (0.162)	0.57 (0.174)	0.61 (0.186)	0.65 (0.198)	0.69 (0.21)
	45° Elbow	0.33 (0.101)	0.34 (0.104)	0.36 (0.11)	0.38 (0.116)	0.41 (0.125)	0.44 (0.134)	0.47 (0.143)	0.50 (0.152)	0.53 (0.162)
	Ent. Loss	0.95 (0.29)	1.00 0.305)	1.05 (0.32)	1.11 (0.338)	1.19 (0.363)	1.27 (0.387)	1.35 (0.411)	1.44 (0.439)	1.54 (0.469)
10" Duct Three Boilers	Straight Run	0.14 (0.14)	0.15 (0.15)	0.15 (0.15)	0.16 (0.16)	0.17 (0.17)	0.19 (0.19)	0.2 (0.20)	0.21 (0.21)	0.23 (0.23)
	90° Elbow	0.96 (0.293)	1.01 (0.308)	1.06 (0.323)	1.13 (0.344)	1.20 (0.366)	1.28 (0.39)	1.37 (0.418)	1.46 (0.445)	1.56 (0.475)
	45° Elbow	0.74 (0.226)	0.77 (0.235)	0.81 (0.247)	0.86 (0.262)	0.92 (0.28)	0.98 (0.299)	1.05 (0.32)	1.12 (0.341)	1.19 (0.363)
	Ent. Loss	2.14 (0.652)	2.24 (0.683)	2.35 (0.716)	2.51 (0.765)	2.68 (0.817)	2.86 (0.872)	3.05 (0.93)	3.25 (0.991)	3.47 (1.058)

Table 2-a: Ducted Combustion Air Duct Pressure Drop in Eq. Ft. (m) for BMK750 Boiler – Continued

		Outside Air Temperature in °F (°C)								
Inlet Duct & No. Boilers	**Duct Section Type**	**-30 °F (-34.4)**	**-15 °F (-26.1)**	**0 °F (-17.8)**	**20 °F (-6.7)**	**40 °F (4.4)**	**60 °F (15.6)**	**80 °F (26.7)**	**100 °F (37.8)**	**120 °F (48.9)**
12" Duct Three Boilers	Straight Run	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.07 (0.07)	0.07 (0.07)	0.08 (0.08)	0.08 (0.08)	0.09 (0.09)	0.09 (0.09)
	90° Elbow	0.42 (0.128)	0.44 (0.134)	0.46 (0.14)	0.49 (0.149)	0.53 (0.162)	0.56 (0.171)	0.6 (0.183)	0.64 (0.195)	0.68 (0.207)
	45° Elbow	0.32 (0.098)	0.34 (0.104)	0.36 (0.11)	0.38 (0.116)	0.41 (0.125)	0.43 (0.131)	0.46 (0.14)	0.49 (0.149)	0.53 (0.162)
	Ent. Loss	1.03 (0.314)	1.08 (0.329)	1.13 (0.344)	1.21 (0.369)	1.29 (0.393)	1.38 (0.421)	1.47 (0.448)	1.57 (0.479)	1.67 (0.509)
12" Duct Four Boilers	Straight Run	0.10 (0.10)	0.10 (0.10)	0.11 (0.11)	0.11 (0.11)	0.12 (0.12)	0.13 (0.13)	0.14 (0.14)	0.15 (0.15)	0.16 (0.16)
	90° Elbow	0.74 (0.226)	0.78 (0.238)	0.82 (0.25)	0.87 (0.265)	0.93 0.283)	1.00 (0.305)	1.06 (0.323)	1.13 (0.344)	1.21 (0.369)
	45° Elbow	0.58 (0.177)	0.60 (0.183)	0.63 (0.192)	0.68 (0.207)	0.72 (0.219)	0.77 (0.235)	0.82 (0.25)	0.88 (0.268)	0.94 (0.287)
	Ent. Loss	1.83 (0.558)	1.92 (0.585)	2.02 (0.616)	2.15 (0.655)	2.29 (0.698)	2.45 (0.747)	2.61 (0.796)	2.79 (0.85)	2.97 (0.905)
14" Duct Four Boilers	Straight Run	0.05 (0.05)	0.05 (0.05)	0.05 (0.05)	0.05 (0.05)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.07 (0.07)	0.07 (0.07)
	90° Elbow	0.37 (0.113)	0.39 (0.119)	0.41 (0.125)	0.44 (0.134)	0.47 (0.143)	0.5 (0.152)	0.53 (0.162)	0.57 (0.174)	0.61 (0.186)
	45° Elbow	0.29 (0.088)	0.30 (0.091)	0.32 (0.098)	0.34 (0.104)	0.36 (0.11)	0.39 (0.119)	0.41 (0.125)	0.44 (0.134)	0.47 (0.143)
	Ent. Loss	0.99 (0.302)	1.04 (0.317)	1.09 (0.332)	1.16 (0.354)	1.24 (0.378)	1.32 (0.402)	1.41 (0.43)	1.50 (0.457)	1.60 (0.488)

NOTES:
1) Calculation assumes 165 SCFM (4.67 m^3/min) per boiler at full fire rate
2) Units for "Straight Run" pressure drop values are equivalent feet per foot (eq. m / m)
3) Units for "Elbows" and "Ent. Loss" are equivalent feet per item (eq. m / item)

Table 2-b: Ducted Combustion Air Duct Pressure Drop in Eq. Ft. (m) for BMK1000 Boiler

		Outside Air Temperature in °F (°C)								
Inlet Duct & No. Boilers	**Duct Section Type**	**-30 °F (-34.4)**	**-15 °F (-26.1)**	**0 °F (-17.8)**	**20 °F (-6.7)**	**40 °F (4.4)**	**60 °F (15.6)**	**80 °F (26.7)**	**100 °F (37.8)**	**120 °F (48.9)**
6" Duct Single Boiler	Straight Run	0.46 (0.46)	0.47 (0.47)	0.48 (0.48)	0.50 (0.50)	0.51 (0.51)	0.53 (0.53)	0.54 (0.54)	0.56 (0.56)	0.58 (0.58)
	90° Elbow	2.09 (0.637)	2.19 (0.668)	2.30 (0.701)	2.45 (0.747)	2.62 (0.799)	2.79 (0.85)	2.98 (0.908)	3.18 (0.969)	3.39 (1.033)
	45° Elbow	1.55 (0.472)	1.62 (0.494)	1.70 (0.518)	1.82 (0.555)	1.94 (0.591)	2.07 (0.631)	2.21 (0.674)	2.35 (0.716)	2.51 (0.765)
	Ent. Loss	3.26 (0.994)	3.42 (1.042)	3.58 (1.091)	3.82 (1.164)	4.08 (1.244)	4.35 (1.326)	4.64 (1.414)	4.95 (1.509)	5.29 (1.612)
8" Duct Single Boiler	Straight Run	0.11 (0.11)	0.11 (0.11)	0.12 (0.12)	0.12 (0.12)	0.12 (0.12)	0.13 (0.13)	0.13 (0.13)	0.14 (0.14)	0.14 (0.14)
	90° Elbow	0.53 (0.162)	0.56 (0.171)	0.59 (0.18)	0.63 (0.192)	0.67 (0.204)	0.71 (0.216)	0.76 (0.232)	0.81 (0.247)	0.87 (0.265)
	45° Elbow	0.4 (0.122)	0.42 (0.128)	0.44 (0.134)	0.47 (0.143)	0.50 (0.152)	0.54 (0.165)	0.57 (0.174)	0.61 (0.186)	0.65 (0.198)
	Ent. Loss	1.03 (0.314)	1.08 (0.329)	1.13 (0.344)	1.21 (0.369)	1.29 (0.393)	1.38 (0.421)	1.47 (0.448)	1.57 (0.479)	1.67 (0.509)
8" Duct Two Boilers	Straight Run	0.34 (0.34)	0.36 (0.36)	0.37 (0.37)	0.40 (0.40)	0.42 (0.42)	0.45 (0.45)	0.48 (0.48)	0.51 (0.51)	0.55 (0.55)
	90° Elbow	2.13 (0.649)	2.24 (0.683)	2.35 (0.716)	2.51 (0.765)	2.67 (0.814)	2.85 (0.869)	3.04 (0.927)	3.25 (0.991)	3.47 (1.058)
	45° Elbow	1.61 (0.491)	1.69 (0.515)	1.77 (0.539)	1.89 (0.576)	2.02 (0.616)	2.15 (0.655)	2.29 (0.698)	2.45 (0.747)	2.61 (0.796)
	Ent. Loss	4.12 (1.256)	4.32 (1.317)	4.54 (1.384)	4.84 (1.475)	5.16 (1.573)	5.51 (1.679)	5.88 (1.792)	6.27 (1.911)	6.69 (2.039)
10" Duct Two Boilers	Straight Run	0.11 (0.11)	0.12 (0.12)	0.12 (0.12)	0.13 (0.13)	0.14 (0.14)	0.15 (0.15)	0.16 (0.16)	0.17 (0.17)	0.18 (0.18)
	90° Elbow	0.76 (0.232)	0.80 (0.244)	0.84 (0.256)	0.89 (0.271)	0.95 (0.29)	1.01 (0.308)	1.08 (0.329)	1.15 (0.351)	1.23 (0.375)
	45° Elbow	0.58 (0.177)	0.61 (0.186)	0.64 (0.195)	0.68 (0.207)	0.73 (0.223)	0.78 (0.238)	0.83 (0.253)	0.88 (0.268)	0.94 (0.287)
	Ent. Loss	1.69 (0.515)	1.77 (0.539)	1.86 (0.567)	1.98 (0.604)	2.11 (0.643)	2.26 (0.689)	2.41 (0.735)	2.57 (0.783)	2.74 (0.835)
10" Duct Three Boilers	Straight Run	0.24 (0.24)	0.25 (0.25)	0.26 (0.26)	0.28 (0.28)	0.30 (0.30)	0.32 (0.32)	0.34 (0.34)	0.36 (0.36)	0.38 (0.38)
	90° Elbow	1.71 (0.521)	1.79 (0.546)	1.88 (0.573)	2.00 (0.61)	2.14 (0.652)	2.28 (0.695)	2.43 (0.741)	2.60 (0.792)	2.77 (0.844)
	45° Elbow	1.31 (0.399)	1.37 (0.418)	1.44 (0.439)	1.53 (0.466)	1.64 (0.5)	1.75 (0.533)	1.86 (0.567)	1.99 (0.607)	2.12 (0.646)
	Ent. Loss	3.80 (1.158)	3.98 (1.213)	4.18 (1.274)	4.46 (1.359)	4.76 (1.451)	5.08 (1.548)	5.42 (1.652)	5.78 (1.762)	6.16 (1.878)

Table 2-b: Ducted Combustion Air Duct Pressure Drop in Eq. Ft. (m) for BMK1000 Boiler – Continued

		Outside Air Temperature in °F (°C)								
Inlet Duct & No. Boilers	**Duct Section Type**	**-30 °F (-34.4)**	**-15 °F (-26.1)**	**0 °F (-17.8)**	**20 °F (-6.7)**	**40 °F (4.4)**	**60 °F (15.6)**	**80 °F (26.7)**	**100 °F (37.8)**	**120 °F (48.9)**
12" Duct Three Boilers	Straight Run	0.10 (0.10)	0.1 (0.10)	0.11 (0.11)	0.11 (0.11)	0.12 (0.12)	0.13 (0.13)	0.14 (0.14)	0.15 (0.15)	0.16 (0.16)
	90° Elbow	0.74 (0.226)	0.78 (0.238)	0.82 (0.25)	0.87 (0.265)	0.93 (0.283)	1 (0.305)	1.06 (0.323)	1.13 (0.344)	1.21 (0.369)
	45° Elbow	0.58 (0.177)	0.60 (0.183)	0.63 (0.192)	0.68 (0.207)	0.72 (0.219)	0.77 (0.235)	0.82 (0.25)	0.88 (0.268)	0.94 (0.287)
	Ent. Loss	1.83 (0.558)	1.92 (0.585)	2.02 (0.616)	2.15 (0.655)	2.29 (0.698)	2.45 (0.747)	2.61 (0.796)	2.79 (0.85)	2.97 (0.905)
12" Duct Four Boilers	Straight Run	0.16 (0.16)	0.17 (0.17)	0.18 (0.18)	0.19 (0.19)	0.21 (0.21)	0.22 (0.22)	0.23 (0.23)	0.25 (0.25)	0.26 (0.26)
	90° Elbow	1.32 (0.402)	1.39 (0.424)	1.46 (0.445)	1.56 (0.475)	1.66 (0.506)	1.77 (0.539)	1.89 (0.576)	2.02 (0.616)	2.15 (0.655)
	45° Elbow	1.02 (0.311)	1.08 (0.329)	1.13 (0.344)	1.20 (0.366)	1.28 (0.39)	1.37 (0.418)	1.46 (0.445)	1.56 (0.475)	1.66 (0.506)
	Ent. Loss	3.26 (0.994)	3.42 (1.042)	3.58 (1.091)	3.82 (1.164)	4.08 (1.244)	4.35 (1.326)	4.64 (1.414)	4.95 (1.509)	5.29 (1.612)
14" Duct Four Boilers	Straight Run	0.08 (0.08)	0.08 (0.08)	0.08 (0.08)	0.09 (0.09)	0.10 (0.10)	0.10 (0.10)	0.11 (0.11)	0.12 (0.12)	0.12 (0.12)
	90° Elbow	0.66 (0.201)	0.70 (0.213)	0.73 (0.223)	0.78 (0.238)	0.83 (0.253)	0.89 (0.271)	0.95 (0.29)	1.01 (0.308)	1.08 (0.329)
	45° Elbow	0.52 (0.158)	0.54 (0.165)	0.57 (0.174)	0.61 (0.186)	0.65 (0.198)	0.69 (0.21)	0.74 (0.226)	0.79 (0.241)	0.84 (0.256)
	Ent. Loss	1.76 (0.536)	1.84 (0.561)	1.93 (0.588)	2.06 (0.628)	2.20 (0.671)	2.35 (0.716)	2.51 (0.765)	2.67 (0.814)	2.85 (0.869)

NOTES:

1) Calculation assumes 200 SCFM (5.66 m^3/min) per boiler at full fire rate
2) Units for "Straight Run" pressure drop values are equivalent feet per foot (eq. m / m)
3) Units for "Elbows" and "Ent. Loss" are equivalent feet per item (eq. m / item)

Table 2-c: Ducted Combustion Air Duct Pressure Drop in Eq. Ft. (m) for BMK1500 Boiler

		Outside Air Temperature in °F (°C)								
Inlet Duct & No. Boilers	**Duct Section Type**	**-30 °F (-34.4)**	**-15 °F (-26.1)**	**0 °F (-17.8)**	**20 °F (-6.7)**	**40 °F (4.4)**	**60 °F (15.6)**	**80 °F (26.7)**	**100 °F (37.8)**	**120 °F (48.9)**
6" Duct Single Boiler	Straight Run	0.98 (0.98)	1.00 (1.00)	1.02 (1.02)	1.06 (1.06)	1.09 (1.09)	1.13 (1.13)	1.16 (1.16)	1.20 (1.20)	1.24 (1.24)
	90° Elbow	4.97 (1.515)	5.21 (1.588)	5.47 (1.667)	5.84 (1.78)	6.23 (1.899)	6.64 (2.024)	7.09 (2.161)	7.56 (2.304)	8.07 (2.46)
	45° Elbow	3.78 (1.152)	3.97 (1.21)	4.17 (1.271)	4.44 (1.353)	4.74 (1.445)	5.06 (1.542)	5.4 (1.646)	5.76 (1.756)	6.14 (1.871)
	Ent. Loss	7.33 (2.234)	7.69 (2.344)	8.07 (2.46)	8.60 (2.621)	9.18 (2.798)	9.79 (2.984)	10.45 (3.185)	11.15 (3.399)	11.89 (3.624)
8" Duct Single Boiler	Straight Run	0.23 (0.23)	0.24 (0.24)	0.24 (0.24)	0.25 (0.25)	0.26 (0.26)	0.27 (0.27)	0.28 (0.28)	0.29 (0.29)	0.30 (0.30)
	90° Elbow	1.19 (0.363)	1.25 (0.381)	1.31 (0.399)	1.39 (0.424)	1.49 (0.454)	1.59 (0.485)	1.69 (0.515)	1.81 (0.552)	1.93 (0.588)
	45° Elbow	0.89 (0.271)	0.94 (0.287)	0.98 (0.299)	1.05 (0.32)	1.12 (0.341)	1.19 (0.363)	1.27 (0.387)	1.36 (0.415)	1.45 (0.442)
	Ent. Loss	2.32 (0.707)	2.43 (0.741)	2.55 (0.777)	2.72 (0.829)	2.90 (0.884)	3.10 (0.945)	3.31 (1.009)	3.53 (1.076)	3.76 (1.146)
10" Duct Two Boilers	Straight Run	0.24 (0.24)	0.25 (0.25)	0.26 (0.26)	0.28 (0.28)	0.30 (0.30)	0.32 (0.32)	0.34 (0.34)	0.36 (0.36)	0.38 (0.38)
	90° Elbow	1.60 (0.488)	1.68 (0.512)	1.77 (0.539)	1.88 (0.573)	2.01 (0.613)	2.14 (0.652)	2.29 (0.698)	2.44 (0.744)	2.60 (0.792)
	45° Elbow	1.21 (0.369)	1.27 (0.387)	1.33 (0.405)	1.42 (0.433)	1.51 (0.46)	1.61 (0.491)	1.72 (0.524)	1.84 (0.561)	1.96 (0.597)
	Ent. Loss	3.80 (1.158)	3.98 (1.213)	4.18 (1.274)	4.46 (1.359)	4.76 (1.451)	5.08 (1.548)	5.42 (1.652)	5.78 (1.762)	6.16 (1.878)
12" Duct Two Boilers	Straight Run	0.10 (0.10)	0.10 (0.10)	0.11 (0.11)	0.11 (0.11)	0.12 (0.12)	0.13 (0.13)	0.14 (0.14)	0.15 (0.15)	0.16 (0.16)
	90° Elbow	0.70 (0.213)	0.73 (0.223)	0.77 (0.235)	0.82 (0.25)	0.88 (0.268)	0.93 (0.283)	1.00 (0.305)	1.06 (0.323)	1.13 (0.344)
	45° Elbow	0.53 (0.162)	0.56 (0.171)	0.59 (0.18)	0.62 (0.189)	0.67 (0.204)	0.71 (0.216)	0.76 (0.232)	0.81 (0.247)	0.86 (0.262)
	Ent. Loss	1.83 (0.558)	1.92 (0.585)	2.02 (0.616)	2.15 (0.655)	2.29 (0.698)	2.45 (0.747)	2.61 (0.796)	2.79 (0.85)	2.97 (0.905)
12" Duct Three Boilers	Straight Run	0.20 (0.20)	0.21 (0.21)	0.22 (0.22)	0.24 (0.24)	0.26 (0.26)	0.27 (0.27)	0.29 (0.29)	0.31 (0.31)	0.33 (0.33)
	90° Elbow	1.57 (0.479)	1.65 (0.503)	1.73 (0.527)	1.85 (0.564)	1.97 (0.6)	2.10 (0.64)	2.24 (0.683)	2.39 (0.728)	2.55 (0.777)
	45° Elbow	1.20 (0.366)	1.26 (0.384)	1.32 (0.402)	1.41 (0.43)	1.50 (0.457)	1.60 (0.488)	1.71 (0.521)	1.82 (0.555)	1.94 (0.591)
	Ent. Loss	4.12 (1.256)	4.32 (1.317)	4.54 (1.384)	4.84 (1.475)	5.16 (1.573)	5.51 (1.679)	5.88 (1.792)	6.27 (1.911)	6.69 (2.039)

Table 2-c: Ducted Combustion Air Duct Pressure Drop in Eq. Ft. (m) for BMK1500 Boiler – Continued

		Outside Air Temperature in °F (°C)								
Inlet Duct & No. Boilers	**Duct Section Type**	**-30 °F (-34.4)**	**-15 °F (-26.1)**	**0 °F (-17.8)**	**20 °F (-6.7)**	**40 °F (4.4)**	**60 °F (15.6)**	**80 °F (26.7)**	**100 °F (37.8)**	**120 °F (48.9)**
14" Duct Three Boilers	Straight Run	0.09 (0.09)	0.10 (0.10)	0.10 (0.10)	0.11 (0.11)	0.12 (0.12)	0.13 (0.13)	0.14 (0.14)	0.14 (0.14)	0.15 (0.15)
	90° Elbow	0.82 (0.25)	0.86 (0.262)	0.9 (0.274)	0.96 (0.293)	1.02 (0.311)	1.09 (0.332)	1.17 (0.357)	1.24 (0.378)	1.33 (0.405)
	45° Elbow	0.63 (0.192)	0.66 (0.201)	0.70 (0.213)	0.74 (0.226)	0.79 (0.241)	0.85 (0.259)	0.90 (0.274)	0.96 (0.293)	1.03 (0.314)
	Ent. Loss	2.22 (0.677)	2.33 (0.71)	2.45 (0.747)	2.61 (0.796)	2.79 (0.85)	2.97 (0.905)	3.17 (0.966)	3.38 (1.03)	3.61 (1.100)
14" Duct Four Boilers	Straight Run	0.16 (0.16)	0.17 (0.17)	0.18 (0.18)	0.19 (0.19)	0.2 (0.20)	0.22 (0.22)	0.23 (0.23)	0.25 (0.25)	0.26 (0.26)
	90° Elbow	1.45 (0.442)	1.53 (0.466)	1.60 (0.488)	1.71 (0.521)	1.82 (0.555)	1.94 (0.591)	2.07 (0.631)	2.21 (0.674)	2.36 (0.719)
	45° Elbow	1.12 (0.341)	1.18 (0.36)	1.24 (0.378)	1.32 (0.402)	1.41 (0.43)	1.50 (0.457)	1.60 (0.488)	1.71 (0.521)	1.83 (0.558)
	Ent. Loss	3.95 (1.204)	4.15 (1.265)	4.35 (1.326)	4.64 (1.414)	4.95 (1.509)	5.29 (1.612)	5.64 (1.719)	6.02 (1.835)	6.42 (1.957)
16" Duct Four Boilers	Straight Run	0.08 (0.08)	0.09 (0.09)	0.09 (0.09)	0.10 (0.10)	0.10 (0.10)	0.11 (0.11)	0.12 (0.12)	0.13 (0.13)	0.13 (0.13)
	90° Elbow	0.84 (0.256)	0.88 (0.268)	0.93 (0.283)	0.99 (0.302)	1.06 (0.323)	1.13 (0.344)	1.20 (0.366)	1.28 (0.39)	1.37 (0.418)
	45° Elbow	0.66 (0.201)	0.69 (0.21)	0.73 (0.223)	0.78 (0.238)	0.83 (0.253)	0.88 (0.268)	0.94 (0.287)	1 (0.305)	1.07 (0.326)
	Ent. Loss	2.32 (0.707)	2.43 (0.741)	2.55 (0.777)	2.72 (0.829)	2.9 (0.884)	3.10 (0.945)	3.31 (1.009)	3.53 (1.076)	3.76 (1.146)

NOTES: 1) Calculation assumes 300 SCFM (8.49 m^3/min) per boiler at full fire rate

2) Units for "Straight Run" pressure drop values are equivalent feet per foot (eq. m / m)

3) Units for "Elbows" and "Ent. Loss" are equivalent feet per item (eq. m / item)

Table 2-d: Ducted Combustion Air Duct Pressure Drop in Eq. Ft. (m) for BMK2000 Boiler

		Outside Air Temperature in °F (°C)								
Inlet Duct & No. Boilers	**Duct Section Type**	**-30 °F (-34.4)**	**-15 °F (-26.1)**	**0 °F (-17.8)**	**20 °F (-6.7)**	**40 °F (4.4)**	**60 °F (15.6)**	**80 °F (26.7)**	**100 °F (37.8)**	**120 °F (48.9)**
8" Duct Single Boiler	Straight Run	0.40 (0.40)	0.41 (0.41)	0.42 (0.42)	0.43 (0.43)	0.44 (0.44)	0.46 (0.46)	0.47 (0.47)	0.49 (0.49)	0.50 (0.50)
	90° Elbow	2.13 (0.649)	2.24 (0.683)	2.35 (0.716)	2.51 (0.765)	2.67 (0.814)	2.85 (0.869)	3.04 (0.927)	3.25 (0.991)	3.47 (1.058)
	45° Elbow	1.61 (0.491)	1.69 (0.515)	1.77 (0.539)	1.89 (0.576)	2.02 (0.616)	2.15 (0.655)	2.29 (0.698)	2.45 (0.747)	2.61 (0.796)
	Ent. Loss	4.12 (1.256)	4.32 (1.317)	4.54 (1.384)	4.84 (1.475)	5.16 (1.573)	5.51 (1.679)	5.88 (1.792)	6.27 (1.911)	6.69 (2.039)
10" Duct Single Boiler	Straight Run	0.13 (0.13)	0.13 (0.13)	0.14 (0.14)	0.14 (0.14)	0.15 (0.15)	0.15 (0.15)	0.16 (0.16)	0.16 (0.16)	0.17 (0.17)
	90° Elbow	0.76 (0.232)	0.80 (0.244)	0.84 (0.256)	0.89 (0.271)	0.95 (0.29)	1.01 (0.308)	1.08 (0.329)	1.15 (0.351)	1.23 (0.375)
	45° Elbow	0.58 (0.177)	0.61 (0.186)	0.64 (0.195)	0.68 (0.207)	0.73 (0.223)	0.78 (0.238)	0.83 (0.253)	0.88 (0.268)	0.94 (0.287)
	Ent. Loss	1.69 (0.515)	1.77 (0.539)	1.86 (0.567)	1.98 (0.604)	2.11 (0.643)	2.26 (0.689)	2.41 (0.735)	2.57 (0.783)	2.74 (0.835)
12" Duct Two Boilers	Straight Run	0.16 (0.16)	0.17 (0.17)	0.18 (0.18)	0.19 (0.19)	0.21 (0.21)	0.22 (0.22)	0.23 (0.23)	0.25 (0.25)	0.26 (0.26)
	90° Elbow	1.32 (0.402)	1.39 (0.424)	1.46 (0.445)	1.56 (0.475)	1.66 (0.506)	1.77 (0.539)	1.89 (0.576)	2.02 (0.616)	2.15 (0.655)
	45° Elbow	1.02 (0.311)	1.08 (0.329)	1.13 (0.344)	1.20 (0.366)	1.28 (0.39)	1.37 (0.418)	1.46 (0.445)	1.56 (0.475)	1.66 (0.506)
	Ent. Loss	3.26 (0.994)	3.42 (1.042)	3.58 (1.091)	3.82 (1.164)	4.08 (1.244)	4.35 (1.326)	4.64 (1.414)	4.95 (1.509)	5.29 (1.612)
14" Duct Two Boilers	Straight Run	0.08 (0.08)	0.08 (0.08)	0.08 (0.08)	0.09 (0.09)	0.10 (0.10)	0.10 (0.10)	0.11 (0.11)	0.12 (0.12)	0.12 (0.12)
	90° Elbow	0.66 (0.201)	0.70 (0.213)	0.73 (0.223)	0.78 (0.238)	0.83 (0.253)	0.89 (0.271)	0.95 (0.29)	1.01 (0.308)	1.08 (0.329)
	45° Elbow	0.52 (0.158)	0.54 (0.165)	0.57 (0.174)	0.61 (0.186)	0.65 (0.198)	0.69 (0.21)	0.74 (0.226)	0.79 (0.241)	0.84 (0.256)
	Ent. Loss	1.76 (0.536)	1.84 (0.561)	1.93 (0.588)	2.06 (0.628)	2.2 (0.671)	2.35 (0.716)	2.51 (0.765)	2.67 (0.814)	2.85 (0.869)
16" Duct Three Boilers	Straight Run	0.08 (0.08)	0.09 (0.09)	0.09 (0.09)	0.10 (0.10)	0.10 (0.10)	0.11 (0.11)	0.12 (0.12)	0.13 (0.13)	0.13 (0.13)
	90° Elbow	0.82 (0.25)	0.86 (0.262)	0.91 (0.277)	0.97 (0.296)	1.03 (0.314)	1.10 (0.335)	1.18 (0.36)	1.25 (0.381)	1.34 (0.408)
	45° Elbow	0.64 (0.195)	0.67 (0.204)	0.71 (0.216)	0.76 (0.232)	0.81 (0.247)	0.86 (0.262)	0.92 (0.28)	0.98 (0.299)	1.04 (0.317)
	Ent. Loss	2.32 (0.707)	2.43 (0.741)	2.55 (0.777)	2.72 (0.829)	2.90 (0.884)	3.10 (0.945)	3.31 (1.009)	3.53 (1.076)	3.76 (1.146)

Table 2-d: Ducted Combustion Air Duct Pressure Drop in Eq. Ft. (m) for BMK2000 Boiler – Continued

Inlet Duct & No. Boilers	Duct Section Type	Outside Air Temperature in °F (°C)								
		-30 °F (-34.4)	-15 °F (-26.1)	0 °F (-17.8)	20 °F (-6.7)	40 °F (4.4)	60 °F (15.6)	80 °F (26.7)	100 °F (37.8)	120 °F (48.9)
18" Duct Three Boilers	Straight Run	0.05 (0.05)	0.05 (0.05)	0.05 (0.05)	0.05 (0.05)	0.06 (0.06)	0.06 (0.06)	0.07 (0.07)	0.07 (0.07)	0.08 (0.08)
	90° Elbow	0.49 (0.149)	0.51 (0.155)	0.54 (0.165)	0.57 (0.174)	0.61 (0.186)	0.65 (0.198)	0.7 (0.213)	0.74 (0.226)	0.79 (0.241)
	45° Elbow	0.38 (0.116)	0.4 (0.122)	0.42 (0.128)	0.45 (0.137)	0.48 (0.146)	0.51 (0.155)	0.54 (0.165)	0.58 (0.177)	0.62 (0.189)
	Ent. Loss	1.45 (0.442)	1.52 (0.463)	1.59 (0.485)	1.70 (0.518)	1.81 (0.552)	1.93 (0.588)	2.06 (0.628)	2.20 (0.671)	2.35 (0.716)
18" Duct Four Boilers	Straight Run	0.08 (0.08)	0.08 (0.08)	0.09 (0.09)	0.09 (0.09)	0.10 (0.10)	0.11 (0.11)	0.11 (0.11)	0.12 (0.12)	0.13 (0.13)
	90° Elbow	0.87 (0.265)	0.91 (0.277)	0.96 (0.293)	1.02 (0.311)	1.09 (0.332)	1.16 (0.354)	1.24 (0.378)	1.32 (0.402)	1.41 (0.43)
	45° Elbow	0.68 (0.207)	0.71 (0.216)	0.75 (0.229)	0.80 (0.244)	0.85 (0.259)	0.91 (0.277)	0.97 (0.296)	1.03 (0.314)	1.10 (0.335)
	Ent. Loss	2.57 (0.783)	2.70 (0.823)	2.83 (0.863)	3.02 (0.92)	3.22 (0.981)	3.44 (1.049)	3.67 (1.119)	3.91 (1.192)	4.18 (1.274)
20" Duct Four Boilers	Straight Run	0.05 (0.05)	0.05 (0.05)	0.05 (0.05)	0.06 (0.06)	0.06 (0.06)	0.06 (0.06)	0.07 (0.07)	0.07 (0.07)	0.08 (0.08)
	90° Elbow	0.55 (0.168)	0.57 (0.174)	0.60 (0.183)	0.64 (0.195)	0.68 (0.207)	0.73 (0.223)	0.78 (0.238)	0.83 (0.253)	0.88 (0.268)
	45° Elbow	0.43 (0.131)	0.45 (0.137)	0.47 (0.143)	0.5 (0.152)	0.53 (0.162)	0.57 (0.174)	0.61 (0.186)	0.65 (0.198)	0.69 (0.21)
	Ent. Loss	1.69 (0.515)	1.77 (0.539)	1.86 (0.567)	1.98 (0.604)	2.11 (0.643)	2.26 (0.689)	2.41 (0.735)	2.57 (0.783)	2.74 (0.835)

NOTES: 1) Calculation assumes 500 SCFM (14.16 m^3/min) per boiler at full fire rate

2) Units for "Straight Run" pressure drop values are equivalent feet per foot (eq. m / m)

3) Units for "Elbows" and "Ent. Loss" are equivalent feet per item (eq. m / item)

Table 2-e: Ducted Combustion Air Duct Pressure Drop in Eq. Ft. (m) for BMK2500 Boiler

		Outside Air Temperature in °F (°C)								
Inlet Duct & No. Boilers	**Duct Section Type**	**-30 °F (-34.4)**	**-15 °F (-26.1)**	**0 °F (-17.8)**	**20 °F (-6.7)**	**40 °F (4.4)**	**60 °F (15.6)**	**80 °F (26.7)**	**100 °F (37.8)**	**120 °F (48.9)**
8" Duct Single Boiler	Straight Run	0.71 (0.71)	0.73 (0.73)	0.74 (0.74)	0.76 (0.76)	0.78 (0.78)	0.81 (0.81)	0.83 (0.83)	0.86 (0.86)	0.88 (0.88)
	90° Elbow	3.96 (1.21)	4.15 (1.27)	4.36 (1.33)	4.65 (1.42)	4.96 (1.51)	5.29 (1.61)	5.64 (1.72)	6.03 (1.84)	6.43 (1.96)
	45° Elbow	2.98 (0.91)	3.13 (0.95)	3.28 (1.00)	3.50 (1.07)	3.73 (1.14)	3.98 (1.21)	4.24 (1.29)	4.53 (1.38)	4.83 (1.47)
	Ent. Loss	7.73 (2.35)	8.11 (2.47)	8.51 (2.59)	9.08 (2.77)	9.68 (2.95)	10.33 (3.15)	11.02 (3.36)	11.76 (3.58)	12.54 (3.82)
10" Duct Single Boiler	Straight Run	0.23 (0.23)	0.23 (0.23)	0.24 (0.24)	0.25 (0.25)	0.26 (0.26)	0.27 (0.27)	0.27 (0.27)	0.28 (0.28)	0.28 (0.28)
	90° Elbow	1.33 (0.41)	1.40 (0.43)	1.48 (0.45)	1.57 (0.48)	1.68 (0.51)	1.78 (0.54)	1.91 (0.58)	2.03 (0.62)	2.17 (0.66)
	45° Elbow	1.01 (0.31)	1.06 (0.32)	1.11 (0.34)	1.18 (0.36)	1.26 (0.38)	1.34 (0.41)	1.43 (0.44)	1.53 (0.47)	1.63 (0.50)
	Ent. Loss	3.17 (0.97)	3.32 (1.01)	3.48 (1.06)	3.72 (1.13)	3.97 (1.21)	4.23 (1.29)	4.52 (1.38)	4.82 (1.47)	5.13 (1.57)
12" Duct Two Boilers	Straight Run	0.29 (0.29)	0.31 (0.31)	0.32 (0.32)	0.34 (0.34)	0.36 (0.36)	0.38 (0.38)	0.41 (0.41)	0.43 (0.43)	0.46 (0.46)
	90° Elbow	2.33 (0.71)	2.44 (0.74)	2.57 (0.78)	2.73 (0.83)	2.92 (0.89)	3.12 (0.95)	3.33 (1.01)	3.54 (1.08)	3.78 (1.15)
	45° Elbow	1.78 (0.54)	1.86 (0.57)	1.95 (0.59)	2.08 (0.64)	2.23 (0.68)	2.38 (0.72)	2.53 (0.77)	2.70 (0.82)	2.88 (0.88)
	Ent. Loss	6.11 (1.86)	6.41 (1.95)	6.73 (2.05)	7.17 (2.18)	7.65 (2.33)	8.16 (2.49)	8.71 (2.65)	9.29 (2.83)	9.91 (3.02)
14" Duct Two Boilers	Straight Run	0.13 (0.13)	0.14 (0.14)	0.15 (0.15)	0.16 (0.16)	0.17 (0.17)	0.18 (0.18)	0.19 (0.19)	0.20 (0.20)	0.21 (0.21)
	90° Elbow	1.21 (0.37)	1.28 (0.39)	1.33 (0.41)	1.43 (0.43)	1.52 (0.46)	1.62 (0.49)	1.73 (0.53)	1.84 (0.56)	1.97 (0.60)
	45° Elbow	0.93 (0.28)	0.98 (0.30)	1.03 (0.32)	1.10 (0.34)	1.18 (0.36)	1.25 (0.38)	1.33 (0.41)	1.43 (0.43)	1.53 (0.47)
	Ent. Loss	3.29 (1.00)	3.46 (1.05)	3.63 (1.11)	3.87 (1.18)	4.13 (1.26)	4.41 (1.34)	4.70 (1.43)	5.02 (1.53)	5.35 (1.63)
16" Duct Three Boilers	Straight Run	0.15 (0.15)	0.16 (0.16)	0.16 (0.16)	0.18 (0.18)	0.18 (0.18)	0.19 (0.19)	0.21 (0.21)	0.23 (0.23)	0.23 (0.23)
	90° Elbow	1.58 (0.48)	1.66 (0.51)	1.74 (0.53)	1.86 (0.57)	1.98 (0.60)	2.12 (0.65)	2.26 (0.69)	2.41 (0.73)	2.57 (0.78)
	45° Elbow	1.24 (0.38)	1.30 (0.40)	1.37 (0.42)	1.45 (0.44)	1.55 (0.47)	1.66 (0.51)	1.77 (0.54)	1.88 (0.57)	2.01 (0.61)
	Ent. Loss	4.34 (1.32)	4.56 (1.39)	4.78 (1.46)	5.10 (1.55)	5.44 (1.66)	5.81 (1.77)	6.20 (1.89)	6.62 (2.02)	7.06 (2.15)

Table 2-e: Ducted Combustion Air Duct Pressure Drop in Eq. Ft. (m) for BMK2500 Boiler – Continued

		Outside Air Temperature in °F (°C)								
Inlet Duct & No. Boilers	**Duct Section Type**	**-30 °F (-34.4)**	**-15 °F (-26.1)**	**0 °F (-17.8)**	**20 °F (-6.7)**	**40 °F (4.4)**	**60 °F (15.6)**	**80 °F (26.7)**	**100 °F (37.8)**	**120 °F (48.9)**
18" Duct Three Boilers	Straight Run	0.08 (0.08)	0.08 (0.08)	0.09 (0.09)	0.09 (0.09)	0.10 (0.10)	0.11 (0.11)	0.12 (0.12)	0.13 (0.13)	0.13 (0.13)
	90° Elbow	0.97 (0.29)	1.02 (0.31)	1.07 (0.33)	1.14 (0.35)	1.22 (0.37)	1.30 (0.40)	1.38 (0.42)	1.48 (0.45)	1.58 (0.48)
	45° Elbow	0.77) (0.23	0.80 (0.24)	0.84 (0.26)	0.90 (0.27)	0.96 (0.29)	1.03 (0.31)	1.09 (0.33)	1.17 (0.36)	1.24 (0.38)
	Ent. Loss	2.72) (0.83)	2.85 (0.87)	2.98 (0.91)	3.18 (0.97)	3.40 (1.04)	3.63 (1.10)	3.87 (1.18)	4.13 (1.26)	4.41 (1.34)
18" Duct Four Boilers	Straight Run	0.14 (0.14)	0.15 (0.15)	0.16 (0.16)	0.17 (0.17)	0.18 (0.18)	0.18 (0.18)	0.20 (0.20)	0.21 (0.21)	0.23 (0.23)
	90° Elbow	1.73 (0.53)	1.81 (0.55)	1.90 (0.58)	2.03 (0.62)	2.16 (0.66)	2.31 (0.70)	2.46 (0.75)	2.63 (0.80)	2.80 (0.85)
	45° Elbow	1.36 (0.41)	1.43 (0.43)	1.50 (0.46)	1.60 (0.49)	1.70 (0.52)	1.82 (0.55)	1.94 (0.59)	2.07 (0.63)	2.21 (0.67)
	Ent. Loss	4.83 (1.47)	5.06 (1.54)	5.31 (1.62)	5.67) (1.73	6.04 (1.84)	6.45 (1.97)	6.88 (2.10)	7.34 (2.24)	7.83 (2.39)
20" Duct Four Boilers	Straight Run	0.08 (0.08)	0.09 (0.09)	0.09 (0.09)	0.10 (0.10)	0.10 (0.10)	0.11 (0.11)	0.12 (0.12)	0.13 (0.13)	0.13 (0.13)
	90° Elbow	1.08 (0.33)	1.14 (0.35)	1.20 (0.37)	1.28 (0.39)	1.36 (0.41)	1.45 (0.44)	1.55 (0.47)	1.65 (0.50)	1.77 (0.54)
	45° Elbow	0.86 (0.26)	0.90 (0.27)	0.94 (0.29)	1.01 (0.31)	1.08) (0.33)	1.14 (0.35)	1.22 (0.37)	1.30 (0.40)	1.39 (0.42)
	Ent. Loss	3.17 (0.97)	3.32 (1.01)	3.48 (1.06)	3.72 (1.13)	3.97 (1.21)	4.23 (1.29)	4.52 (1.38)	4.82 (1.47)	5.13 (1.56)

NOTES: 1) Calculation assumes 600 SCFM (16.99 m^3/min) per boiler at full fire rate

2) Units for "Straight Run" pressure drop values are equivalent feet per foot (eq. m / m)

3) Units for "Elbows" and "Ent. Loss" are equivalent feet per item (eq. m / item)

Table 2-f: Ducted Combustion Air Duct Pressure Drop in Eq. Ft. (m) for BMK3000 Boiler

		Outside Air Temperature in °F (°C)								
Inlet Duct & No. Boilers	**Duct Section Type**	**-30 °F (-34.4)**	**-15 °F (-26.1)**	**0 °F (-17.8)**	**20 °F (-6.7)**	**40 °F (4.4)**	**60 °F (15.6)**	**80 °F (26.7)**	**100 °F (37.8)**	**120 °F (48.9)**
8" Duct Single Boiler	Straight Run	0.85 (0.85)	0.87 (0.87)	0.89 (0.89)	0.91 (0.91)	0.94 (0.94)	0.97 (0.97)	1.00 (1.00)	1.03 (1.03)	1.06 (1.06)
	90° Elbow	4.75 (1.448)	4.98 (1.518)	5.23 (1.594)	5.58 (1.701)	5.95 (1.814)	6.35 (1.935)	6.77 (2.063)	7.23 (2.204)	7.71 (2.35)
	45° Elbow	3.57 (1.088)	3.75 (1.143)	3.93 (1.198)	4.2 (1.28)	4.48 (1.366)	4.78 (1.457)	5.09 (1.551)	5.44 (1.658)	5.8 (1.768)
	Ent. Loss	9.27 (2.825)	9.73 (2.966)	10.21 (3.112)	10.89 (3.319)	11.62 (3.542)	12.39 (3.776)	13.22 (4.029)	14.11 (4.301)	15.05 (4.587)
10" Duct Single Boiler	Straight Run	0.28 (0.28)	0.28 (0.28)	0.29 (0.29)	0.3 (0.30)	0.31 (0.31)	0.32 (0.32)	0.32 (0.32)	0.33 (0.33)	0.34 (0.34)
	90° Elbow	1.6 (0.488)	1.68 (0.512)	1.77 (0.539)	1.88 (0.573)	2.01 (0.613)	2.14 (0.652)	2.29 (0.698)	2.44 (0.744)	2.6 (0.792)
	45° Elbow	1.21 (0.369)	1.27 (0.387)	1.33 (0.405)	1.42 (0.433)	1.51 (0.46)	1.61 (0.491)	1.72 (0.524)	1.84 (0.561)	1.96 (0.597)
	Ent. Loss	3.8 (1.158)	3.98 (1.213)	4.18 (1.274)	4.46 (1.359)	4.76 (1.451)	5.08 (1.548)	5.42 (1.652)	5.78 (1.762)	6.16 (1.878)
12" Duct Two Boilers	Straight Run	0.35 (0.35)	0.37 (0.37)	0.38 (0.38)	0.41 (0.41)	0.43 (0.43)	0.46 (0.46)	0.49 (0.49)	0.52 (0.52)	0.55 (0.55)
	90° Elbow	2.8 (0.853)	2.93 (0.893)	3.08 (0.939)	3.28 (1)	3.5 (1.067)	3.74 (1.14)	3.99 (1.216)	4.25 (1.295)	4.54 (1.384)
	45° Elbow	2.13 (0.649)	2.23 (0.68)	2.34 (0.713)	2.5 (0.762)	2.67 (0.814)	2.85 (0.869)	3.04 (0.927)	3.24 (0.988)	3.46 (1.055)
	Ent. Loss	7.33 (2.234)	7.69 (2.344)	8.07 (2.46)	8.6 (2.621)	9.18 (2.798)	9.79 (2.984)	10.45 (3.185)	11.15 (3.399)	11.89 (3.624)
14" Duct Two Boilers	Straight Run	0.16 (0.16)	0.17 (0.17)	0.18 (0.18)	0.19 (0.19)	0.2 (0.20)	0.21 (0.21)	0.23 (0.23)	0.24 (0.24)	0.25 (0.25)
	90° Elbow	1.45 (0.442)	1.53 (0.466)	1.6 (0.488)	1.71 (0.521)	1.82 (0.555)	1.94 (0.591)	2.07 (0.631)	2.21 (0.674)	2.36 (0.719)
	45° Elbow	1.12 (0.341)	1.18 (0.36)	1.24 (0.378)	1.32 (0.402)	1.41 (0.43)	1.5 (0.457)	1.6 (0.488)	1.71 (0.521)	1.83 (0.558)
	Ent. Loss	3.95 (1.204)	4.15 (1.265)	4.35 (1.326)	4.64 (1.414)	4.95 (1.509)	5.29 (1.612)	5.64 (1.719)	6.02 (1.835)	6.42 (1.957)
16" Duct Three Boilers	Straight Run	0.18 (0.18)	0.19 (0.19)	0.19 (0.19)	0.21 (0.21)	0.22 (0.22)	0.23 (0.23)	0.25 (0.25)	0.27 (0.27)	0.28 (0.28)
	90° Elbow	1.90 (0.579)	1.99 (0.607)	2.09 (0.637)	2.23 (0.68)	2.38 (0.725)	2.54 (0.774)	2.71 (0.826)	2.89 (0.881)	3.08 (0.939)
	45° Elbow	1.49 (0.454)	1.56 (0.475)	1.64 (0.5)	1.74 (0.53)	1.86 (0.567)	1.99 (0.607)	2.12 (0.646)	2.26 (0.689)	2.41 (0.735)
	Ent. Loss	5.21 (1.588)	5.47 (1.667)	5.74 (1.75)	6.12 (1.865)	6.53 (1.99)	6.97 (2.124)	7.44 (2.268)	7.94 (2.42)	8.47 (2.582)

Table 2-f: Ducted Combustion Air Duct Pressure Drop in Eq. Ft. (m) for BMK3000 Boiler – Continued

Inlet Duct & No. Boilers	Duct Section Type	Outside Air Temperature in °F (°C)								
		-30 °F (-34.4)	-15 °F (-26.1)	0 °F (-17.8)	20 °F (-6.7)	40 °F (4.4)	60 °F (15.6)	80 °F (26.7)	100 °F (37.8)	120 °F (48.9)
18" Duct Three Boilers	Straight Run	0.10 (0.10)	0.10 (0.10)	0.11 (0.11)	0.11 (0.11)	0.12 (0.12)	0.13 (0.13)	0.14 (0.14)	0.15 (0.15)	0.16 (0.16)
	90° Elbow	1.16 (0.354)	1.22 (0.372)	1.28 (0.39)	1.37 (0.418)	1.46 (0.445)	1.56 (0.475)	1.66 (0.506)	1.77 (0.539)	1.89 (0.576)
	45° Elbow	0.92 (0.28)	0.96 (0.293)	1.01 (0.308)	1.08 (0.329)	1.15 (0.351)	1.23 (0.375)	1.31 (0.399)	1.4 (0.427)	1.49 (0.454)
	Ent. Loss	3.26 (0.994)	3.42 (1.042)	3.58 (1.091)	3.82 (1.164)	4.08 (1.244)	4.35 (1.326)	4.64 (1.414)	4.95 (1.509)	5.29 (1.612)
18" Duct Four Boilers	Straight Run	0.17 (0.17)	0.18 (0.18)	0.19 (0.19)	0.2 (0.20)	0.21 (0.21)	0.22 (0.22)	0.24 (0.24)	0.25 (0.25)	0.27 (0.27)
	90° Elbow	2.07 (0.631)	2.17 (0.661)	2.28 (0.695)	2.43 (0.741)	2.59 (0.789)	2.77 (0.844)	2.95 (0.899)	3.15 (0.96)	3.36 (1.024)
	45° Elbow	1.63 (0.497)	1.71 (0.521)	1.80 (0.549)	1.92 (0.585)	2.04 (0.622)	2.18 (0.664)	2.33 (0.71)	2.48 (0.756)	2.65 (0.808)
	Ent. Loss	5.79 (1.765)	6.07 (1.85)	6.37 (1.942)	6.8 (2.073)	7.25 (2.21)	7.74 (2.359)	8.25 (2.515)	8.81 (2.685)	9.40 (2.865)
20" Duct Four Boilers	Straight Run	0.10 (0.10)	0.11 (0.11)	0.11 (0.11)	0.12 (0.12)	0.12 (0.12)	0.13 (0.13)	0.14 (0.14)	0.15 (0.15)	0.16 (0.16)
	90° Elbow	1.3 (0.396)	1.37 (0.418)	1.44 (0.439)	1.53 (0.466)	1.63 (0.497)	1.74 (0.53)	1.86 (0.567)	1.98 (0.604)	2.12 (0.646)
	45° Elbow	1.03 (0.314)	1.08 (0.329)	1.13 (0.344)	1.21 (0.369)	1.29 (0.393)	1.37 (0.418)	1.46 (0.445)	1.56 (0.475)	1.67 (0.509)
	Ent. Loss	3.8 (1.158)	3.98 (1.213)	4.18 (1.274)	4.46 (1.359)	4.76 (1.451)	5.08 (1.548)	5.42 (1.652)	5.78 (1.762)	6.16 (1.878)

NOTES: 1) Calculation assumes 700 SCFM (19.82 m^3/min) per boiler at full fire rate

2) Units for "Straight Run" pressure drop values are equivalent feet per foot (eq. m / m)

3) Units for "Elbows" and "Ent. Loss" are equivalent feet per item (eq. m / item)

Table 2-g: Ducted Combustion Air Duct Pressure Drop in Eq. Ft. (m) for BMK4000 Boiler

		Outside Air Temperature in °F (°C)						
Inlet Duct & No. Boilers	**Duct Section Type**	**-15 °F (-26.1)**	**0 °F (-17.8)**	**20 °F (-6.7)**	**40 °F (4.4)**	**60 °F (15.6)**	**80 °F (26.7)**	**100 °F (37.8)**
10" Duct Single Boiler	Straight Run	0.69 (0.69)	0.71 (0.71)	0.73 (0.73)	0.76 (0.76)	0.78 (0.78)	0.81 (0.81)	0.83 (0.83)
	90° Elbow	4.56 (1.39)	4.79 (1.46)	5.11 (1.56)	5.45 (1.66)	5.82 (1.77)	6.21 (1.89)	6.62 (2.02)
	45° Elbow	3.5 (1.07)	3.67 (1.12)	3.92 (1.19)	4.17 (1.27)	4.45 (1.36)	4.75 (1.45)	5.08 (1.55)
	Ent. Loss	10.15 (3.09)	10.65 (3.25)	11.36 (3.46)	12.11 (3.69)	12.93 (3.94)	13.8 (4.21)	14.73 (4.49)
12" Duct Single Boiler	Straight Run	0.24 (0.24)	0.25 (0.25)	0.27 (0.27)	0.29 (0.29)	0.31 (0.31)	0.33 (0.33)	0.35 (0.35)
	90° Elbow	1.99 (0.61)	2.09 (0.64)	2.23 (0.68)	2.38 (0.73)	2.54 (0.77)	2.71 (0.83)	2.89 (0.88)
	45° Elbow	1.54 (0.47)	1.62 (0.49)	1.72 (0.52)	1.84 (0.56)	1.96 (0.6)	2.1 (0.64)	2.23 (0.68)
	Ent. Loss	4.89 (1.49)	5.14 (1.57)	5.48 (1.67)	5.84 (1.78)	6.23 (1.9)	6.65 (2.03)	7.1 (2.16)
16" Duct Two Boilers	Straight Run	0.21 (0.21)	0.22 (0.22)	0.24 (0.24)	0.25 (0.25)	0.27 (0.27)	0.29 (0.29)	0.31 (0.31)
	90° Elbow	2.21 (0.67)	2.32 (0.71)	2.46 (0.75)	2.64 (0.8)	2.81 (0.86)	3 (0.91)	3.2 (0.98)
	45° Elbow	1.72 (0.52)	1.81 (0.55)	1.93 (0.59)	2.05 (0.62)	2.2 (0.67)	2.34 (0.71)	2.5 (0.76)
	Ent. Loss	6.2 (1.89)	6.5 (1.98)	6.93 (2.11)	7.39 (2.25)	7.89 (2.4)	8.42 (2.57)	8.98 (2.74)
18" Duct Two Boilers	Straight Run	0.12 (0.12)	0.12 (0.12)	0.13 (0.13)	0.14 (0.14)	0.15 (0.15)	0.16 (0.16)	0.17 (0.17)
	90° Elbow	1.31 (0.4)	1.38 (0.42)	1.46 (0.45)	1.56 (0.48)	1.67 (0.51)	1.78 (0.54)	1.9 (0.58)
	45° Elbow	1.02 (0.31)	1.07 (0.33)	1.15 (0.35)	1.22 (0.37)	1.31 (0.4)	1.39 (0.42)	1.48 (0.45)
	Ent. Loss	3.87 (1.18)	4.06 (1.24)	4.33 (1.32)	4.62 (1.41)	4.93 (1.5)	5.26 (1.6)	5.61 (1.71)
20" Duct Three Boilers	Straight Run	0.15 (0.15)	0.16 (0.16)	0.17 (0.17)	0.18 (0.18)	0.19 (0.19)	0.2 (0.2)	0.22 (0.22)
	90° Elbow	1.84 (0.56)	1.94 (0.59)	2.06 (0.63)	2.21 (0.67)	2.35 (0.72)	2.51 (0.77)	2.67 (0.81)
	45° Elbow	1.44 (0.44)	1.51 (0.46)	1.61 (0.49)	1.72 (0.52)	1.83 (0.56)	1.95 (0.59)	2.09 (0.64)
	Ent. Loss	5.71 (1.74)	5.99 (1.83)	6.39 (1.95)	6.82 (2.08)	7.27 (2.22)	7.76 (2.37)	8.28 (2.52)

Table 2-g: Ducted Combustion Air Duct Pressure Drop in Eq. Ft. (m) for BMK4000 Boiler – Continued

		Outside Air Temperature in °F (°C)						
Inlet Duct & No. Boilers	**Duct Section Type**	**-15 °F (-26.1)**	**0 °F (-17.8)**	**20 °F (-6.7)**	**40 °F (4.4)**	**60 °F (15.6)**	**80 °F (26.7)**	**100 °F (37.8)**
22" Duct Three Boilers	Straight Run	0.09 (0.09)	0.1 (0.1)	0.1 (0.1)	0.11 (0.11)	0.12 (0.12)	0.13 (0.13)	0.14 (0.14)
	90° Elbow	1.21 (0.37)	1.27 (0.39)	1.35 (0.41)	1.44 (0.44)	1.54 (0.47)	1.63 (0.5)	1.74 (0.53)
	45° Elbow	0.94 (0.29)	0.99 (0.3)	1.05 (0.32)	1.12 (0.34)	1.2 (0.37)	1.28 (0.39)	1.37 (0.42)
	Ent. Loss	3.9 (1.19)	4.09 (1.25)	4.37 (1.33)	4.66 (1.42)	4.97 (1.51)	5.29 (1.61)	5.66 (1.73)
22" Duct Four Boilers	Straight Run	0.16 (0.16)	0.17 (0.17)	0.18 (0.18)	0.19 (0.19)	0.2 (0.2)	0.22 (0.22)	0.23 (0.23)
	90° Elbow	2.15 (0.66)	2.24 (0.68)	2.4 (0.73)	2.56 (0.78)	2.73 (0.83)	2.92 (0.89)	3.11 (0.95)
	45° Elbow	1.67 (0.51)	1.76 (0.54)	1.87 (0.57)	2 (0.61)	2.12 (0.65)	2.27 (0.69)	2.43 (0.74)
	Ent. Loss	6.93 (2.11)	7.27 (2.22)	7.76 (2.37)	8.28 (2.52)	8.83 (2.69)	9.42 (2.87)	10.05 (3.06)
24" Duct Four Boilers	Straight Run	0.1 (0.1)	0.11 (0.11)	0.12 (0.12)	0.12 (0.12)	0.13 (0.13)	0.14 (0.14)	0.15 (0.15)
	90° Elbow	1.45 (0.44)	1.53 (0.47)	1.62 (0.49)	1.73 (0.53)	1.84 (0.56)	1.96 (0.6)	2.1 (0.64)
	45° Elbow	1.12 (0.34)	1.18 (0.36)	1.26 (0.38)	1.34 (0.41)	1.44 (0.44)	1.54 (0.47)	1.63 (0.5)
	Ent. Loss	4.89 (1.49)	5.14 (1.57)	5.48 (1.67)	5.84 (1.78)	6.23 (1.9)	6.65 (2.03)	7.1 (2.16)

NOTES: 1) Calculation assumes 867 SCFM (24.55 m^3/min) per boiler at full fire rate
2) Units for "Straight Run" pressure drop values are equivalent feet per foot (eq. m / m)
3) Units for "Elbows" and "Ent. Loss" are equivalent feet per item (eq. m / item)

Table 2-h: Ducted Combustion Air Duct Pressure Drop in Eq. Ft. (m) for BMK5000N Boiler

		Outside Air Temperature in °F (°C)						
Inlet Duct & No. Boilers	**Duct Section Type**	**-15 °F (-26.1)**	**0 °F (-17.8)**	**20 °F (-6.7)**	**40 °F (4.4)**	**60 °F (15.6)**	**80 °F (26.7)**	**100 °F (37.8)**
10" Duct Single Boiler	Straight Run	1.06 (1.06)	1.08 (1.08)	1.12 (1.12)	1.16 (1.16)	1.19 (1.19)	1.23 (1.23)	1.27 (1.27)
	90° Elbow	7.14 (2.18)	7.49 (2.28)	7.99 (2.44)	8.53 (2.6)	9.09 (2.77)	9.7 (2.96)	10.36 (3.16)
	45° Elbow	5.47 (1.67)	5.73 (1.75)	6.11 (1.86)	6.53 (1.99)	6.97 (2.12)	7.43 (2.26)	7.93 (2.42)
	Ent. Loss	15.87 (4.84)	16.65 (5.07)	17.76 (5.41)	18.95 (5.78)	20.22 (6.16)	21.57 (6.57)	23.01 (7.01)
12" Duct Single Boiler	Straight Run	0.37 (0.37)	0.39 (0.39)	0.41 (0.41)	0.44 (0.44)	0.47 (0.47)	0.5 (0.5)	0.53 (0.53)
	90° Elbow	3.11 (0.95)	3.27 (1)	3.49 (1.06)	3.72 (1.13)	3.97 (1.21)	4.23 (1.29)	4.51 (1.37)
	45° Elbow	2.42 (0.74)	2.53 (0.77)	2.7 (0.82)	2.88 (0.88)	3.07 (0.94)	3.27 (1)	3.49 (1.06)
	Ent. Loss	7.65 (2.33)	8.03 (2.45)	8.56 (2.61)	9.14 (2.79)	9.75 (2.97)	10.41 (3.17)	11.1 (3.38)
18" Duct Two Boilers	Straight Run	0.18 (0.18)	0.19 (0.19)	0.2 (0.2)	0.21 (0.21)	0.23 (0.23)	0.24 (0.24)	0.26 (0.26)
	90° Elbow	2.05 (0.62)	2.15 (0.66)	2.29 (0.7)	2.44 (0.74)	2.61 (0.8)	2.78 (0.85)	2.96 (0.9)
	45° Elbow	1.6 (0.49)	1.67 (0.51)	1.79 (0.55)	1.9 (0.58)	2.04 (0.62)	2.17 (0.66)	2.32 (0.71)
	Ent. Loss	6.05 (1.84)	6.34 (1.93)	6.77 (2.06)	7.22 (2.2)	7.7 (2.35)	8.22 (2.51)	8.77 (2.67)
20" Duct Two Boilers	Straight Run	0.11 (0.11)	0.11 (0.11)	0.12 (0.12)	0.13 (0.13)	0.14 (0.14)	0.14 (0.14)	0.15 (0.15)
	90° Elbow	1.28 (0.39)	1.34 (0.41)	1.44 (0.44)	1.54 (0.47)	1.63 (0.5)	1.74 (0.53)	1.85 (0.56)
	45° Elbow	1 (0.3)	1.05 (0.32)	1.12 (0.34)	1.2 (0.37)	1.27 (0.39)	1.35 (0.41)	1.45 (0.44)
	Ent. Loss	3.97 (1.21)	4.16 (1.27)	4.44 (1.35)	4.73 (1.44)	5.05 (1.54)	5.39 (1.64)	5.76 (1.76)
22" Duct Three Boilers	Straight Run	0.14 (0.14)	0.15 (0.15)	0.16 (0.16)	0.17 (0.17)	0.18 (0.18)	0.19 (0.19)	0.21 (0.21)
	90° Elbow	1.89 (0.58)	1.98 (0.6)	2.11 (0.64)	2.26 (0.69)	2.4 (0.73)	2.56 (0.78)	2.73 (0.83)
	45° Elbow	1.46 (0.45)	1.54 (0.47)	1.65 (0.5)	1.76 (0.54)	1.87 (0.57)	2 (0.61)	2.14 (0.65)
	Ent. Loss	6.1 (1.86)	6.39 (1.95)	6.82 (2.08)	7.28 (2.22)	7.77 (2.37)	8.28 (2.52)	8.85 (2.7)

Table 2-h: Ducted Combustion Air Duct Pressure Drop in Eq. Ft. (m) for BMK5000N Boiler – Continued

		Outside Air Temperature in °F (°C)						
Inlet Duct & No. Boilers	**Duct Section Type**	**-15 °F (-26.1)**	**0 °F (-17.8)**	**20 °F (-6.7)**	**40 °F (4.4)**	**60 °F (15.6)**	**80 °F (26.7)**	**100 °F (37.8)**
24" Duct Three Boilers	Straight Run	0.09 (0.09)	0.1 (0.1)	0.1 (0.1)	0.11 (0.11)	0.12 (0.12)	0.12 (0.12)	0.13 (0.13)
	90° Elbow	1.27 (0.39)	1.34 (0.41)	1.43 (0.44)	1.53 (0.47)	1.62 (0.49)	1.73 (0.53)	1.84 (0.56)
	45° Elbow	0.99 (0.3)	1.04 (0.32)	1.11 (0.34)	1.18 (0.36)	1.27 (0.39)	1.34 (0.41)	1.44 (0.44)
	Ent. Loss	4.31 (1.31)	4.51 (1.37)	4.82 (1.47)	5.14 (1.57)	5.48 (1.67)	5.86 (1.79)	6.25 (1.9)
24" Duct Four Boilers	Straight Run	0.16 (0.16)	0.17 (0.17)	0.18 (0.18)	0.19 (0.19)	0.2 (0.2)	0.22 (0.22)	0.23 (0.23)
	90° Elbow	2.27 (0.69)	2.38 (0.73)	2.54 (0.77)	2.71 (0.83)	2.88 (0.88)	3.07 (0.94)	3.28 (1)
	45° Elbow	1.76 (0.54)	1.85 (0.56)	1.98 (0.6)	2.11 (0.64)	2.24 (0.68)	2.39 (0.73)	2.56 (0.78)
	Ent. Loss	7.65 (2.33)	8.03 (2.45)	8.56 (2.61)	9.14 (2.79)	9.75 (2.97)	10.41 (3.17)	11.1 (3.38)
26" Duct Four Boilers	Straight Run	0.11 (0.11)	0.11 (0.11)	0.12 (0.12)	0.13 (0.13)	0.14 (0.14)	0.14 (0.14)	0.15 (0.15)
	90° Elbow	1.57 (0.48)	1.65 (0.5)	1.76 (0.54)	1.88 (0.57)	2 (0.61)	2.14 (0.65)	2.28 (0.69)
	45° Elbow	1.22 (0.37)	1.28 (0.39)	1.37 (0.42)	1.46 (0.45)	1.56 (0.48)	1.66 (0.51)	1.77 (0.54)
	Ent. Loss	5.55 (1.69)	5.83 (1.78)	6.22 (1.9)	6.64 (2.02)	7.08 (2.16)	7.55 (2.3)	8.05 (2.45)

NOTES: 1) Calculation assumes 1084 SCFM (30.7 m^3/min) per boiler at full fire rate
2) Units for "Straight Run" pressure drop values are equivalent feet per foot (eq. m / m)
3) Units for "Elbows" and "Ent. Loss" are equivalent feet per item (eq. m / item)

Table 2-i: Ducted Combustion Air Duct Pressure Drop in Eq. Ft. (m) for BMK5000/6000 Boiler

		Outside Air Temperature in °F (°C)								
Inlet Duct & No. Boilers	**Duct Section Type**	**-30 °F (-34.4)**	**-15 °F (-26.1)**	**0 °F (-17.8)**	**20 °F (-6.7)**	**40 °F (4.4)**	**60 °F (15.6)**	**80 °F (26.7)**	**100 °F (37.8)**	**120 °F (48.9)**
14" Duct Single Boiler	Straight Run	0.16 (0.16)	0.17 (0.17)	0.18 (0.18)	0.19 (0.19)	0.20 (0.20)	0.22 (0.22)	0.23 (0.23)	0.25 (0.25)	0.26 (0.26)
	90° Elbow	1.49 (0.454)	1.57 (0.479)	1.64 (0.5)	1.75 (0.533)	1.87 (0.57)	2.00 (0.61)	2.13 (0.649)	2.27 (0.692)	2.42 (0.738)
	45° Elbow	1.16 (0.354)	1.22 (0.372)	1.28 (0.39)	1.36 (0.415)	1.46 (0.445)	1.55 (0.472)	1.66 (0.506)	1.77 (0.539)	1.89 (0.576)
	Ent. Loss	3.95 (1.204)	4.15 (1.265)	4.35 (1.326)	4.64 (1.414)	4.95 (1.509)	5.29 (1.612)	5.64 (1.719)	6.02 (1.835)	6.42 (1.957)
16" Duct Single Boiler	Straight Run	0.08 (0.08)	0.09 (0.09)	0.09 (0.09)	0.10 (0.10)	0.10 (0.10)	0.11 (0.11)	0.12 (0.12)	0.13 (0.13)	0.13 (0.13)
	90° Elbow	0.82 (0.25)	0.86 (0.262)	0.91 (0.277)	0.97 (0.296)	1.03 (0.314)	1.10 (0.335)	1.18 (0.36)	1.25 (0.381)	1.34 (0.408)
	45° Elbow	0.64 (0.195)	0.67 (0.204)	0.71 (0.216)	0.76 (0.232)	0.81 (0.247)	0.86 (0.262)	0.92 (0.28)	0.98 (0.299)	1.04 (0.317)
	Ent. Loss	2.32 (0.707)	2.43 (0.741)	2.55 (0.777)	2.72 (0.829)	2.90 (0.884)	3.10 (0.945)	3.31 (1.009)	3.53 (1.076)	3.76 (1.146)
18" Duct Two Boilers	Straight Run	0.17 (0.17)	0.18 (0.18)	0.19 (0.19)	0.20 (0.20)	0.21 (0.21)	0.23 (0.23)	0.24 (0.24)	0.26 (0.26)	0.28 (0.28)
	90° Elbow	1.96 (0.597)	2.05 (0.625)	2.15 (0.655)	2.30 (0.701)	2.45 (0.747)	2.62 (0.799)	2.79 (0.85)	2.98 (0.908)	3.18 (0.969)
	45° Elbow	1.53 (0.466)	1.60 (0.488)	1.68 (0.512)	1.79 (0.546)	1.91 (0.582)	2.04 (0.622)	2.18 (0.664)	2.32 (0.707)	2.48 (0.756)
	Ent. Loss	5.79 (1.765)	6.07 (1.85)	6.37 (1.942)	6.80 (2.073)	7.25 (2.21)	7.74 (2.359)	8.25 (2.515)	8.81 (2.685)	9.4 (2.865)
20" Duct Two Boilers	Straight Run	0.10 (0.10)	0.11 (0.11)	0.11 (0.11)	0.12 (0.12)	0.13 (0.13)	0.13 (0.13)	0.14 (0.14)	0.15 (0.15)	0.16 (0.16)
	90° Elbow	1.23 (0.375)	1.29 (0.393)	1.35 (0.411)	1.44 (0.439)	1.54 (0.469)	1.64 (0.5)	1.75 (0.533)	1.87 (0.57)	1.99 (0.607)
	45° Elbow	0.96 (0.293)	1.00 (0.305)	1.05 (0.32)	1.12 (0.341)	1.2 (0.366)	1.28 (0.39)	1.36 (0.415)	1.46 (0.445)	1.55 (0.472)
	Ent. Loss	3.8 (1.158)	3.98 (1.213)	4.18 (1.274)	4.46 (1.359)	4.76 (1.451)	5.08 (1.548)	5.42 (1.652)	5.78 (1.762)	6.16 (1.878)
22" Duct Three Boilers	Straight Run	0.13 (0.13)	0.14 (0.14)	0.15 (0.15)	0.16 (0.16)	0.17 (0.17)	0.18 (0.18)	0.19 (0.19)	0.20 (0.20)	0.22 (0.22)
	90° Elbow	1.8 (0.549)	1.89 (0.576)	1.99 (0.607)	2.12 (0.646)	2.26 (0.689)	2.41 (0.735)	2.57 (0.783)	2.75 (0.838)	2.93 (0.893)
	45° Elbow	1.41 (0.43)	1.47 (0.448)	1.55 (0.472)	1.65 (0.503)	1.76 (0.536)	1.88 (0.573)	2.00 (0.61)	2.14 (0.652)	2.28 (0.695)
	Ent. Loss	5.84 (1.78)	6.12 (1.865)	6.43 (1.96)	6.85 (2.088)	7.31 (2.228)	7.8 (2.377)	8.32 (2.536)	8.88 (2.707)	9.47 (2.886)

Table 2-i: Ducted Combustion Air Duct Pressure Drop in Eq. Ft. (m) for BMK5000/6000 Boiler – Continued

		Outside Air Temperature in °F (°C)								
Inlet Duct & No. Boilers	**Duct Section Type**	**-30 °F (-34.4)**	**-15 °F (-26.1)**	**0 °F (-17.8)**	**20 °F (-6.7)**	**40 °F (4.4)**	**60 °F (15.6)**	**80 °F (26.7)**	**100 °F (37.8)**	**120 °F (48.9)**
24" Duct Three Boilers	Straight Run	0.09 (0.09)	0.09 (0.09)	0.10 (0.10)	0.10 (0.10)	0.11 (0.11)	0.12 (0.12)	0.12 (0.12)	0.13 (0.13)	0.14 (0.14)
	90° Elbow	1.22 (0.372)	1.28 (0.39)	1.34 (0.408)	1.43 (0.436)	1.53 (0.466)	1.63 (0.497)	1.74 (0.53)	1.85 (0.564)	1.98 (0.604)
	45° Elbow	0.95 (0.29)	1.00 (0.305)	1.04 (0.317)	1.11 (0.338)	1.19 (0.363)	1.27 (0.387)	1.35 (0.411)	1.44 (0.439)	1.54 (0.469)
	Ent. Loss	4.12 (1.256)	4.32 (1.317)	4.54 (1.384)	4.84 (1.475)	5.16 (1.573)	5.51 (1.679)	5.88 (1.792)	6.27 (1.911)	6.69 (2.039)
24" Duct Four Boilers	Straight Run	0.15 (0.15)	0.16 (0.16)	0.17 (0.17)	0.18 (0.18)	0.19 (0.19)	0.20 (0.20)	0.21 (0.21)	0.23 (0.23)	0.24 (0.24)
	90° Elbow	2.17 (0.661)	2.27 (0.692)	2.39 (0.728)	2.54 (0.774)	2.71 (0.826)	2.9 (0.884)	3.09 (0.942)	3.3 (1.006)	3.52 (1.073)
	45° Elbow	1.69 (0.515)	1.77 (0.539)	1.86 (0.567)	1.98 (0.604)	2.11 (0.643)	2.25 (0.686)	2.40 (0.732)	2.57 (0.783)	2.74 (0.835)
	Ent. Loss	7.33 (2.234)	7.69 (2.344)	8.07 (2.46)	8.60 (2.621)	9.18 (2.798)	9.79 (2.984)	10.45 (3.185)	11.15 (3.399)	11.89 (3.624)
26" Duct Four Boilers	Straight Run	0.10 (0.10)	0.11 (0.11)	0.11 (0.11)	0.12 (0.12)	0.13 (0.13)	0.13 (0.13)	0.14 (0.14)	0.15 (0.15)	0.16 (0.16)
	90° Elbow	1.50 (0.457)	1.57 (0.479)	1.65 (0.503)	1.76 (0.536)	1.88 (0.573)	2.01 (0.613)	2.14 (0.652)	2.28 (0.695)	2.44 (0.744)
	45° Elbow	1.17 (0.357)	1.23 (0.375)	1.29 (0.393)	1.37 (0.418)	1.46 (0.445)	1.56 (0.475)	1.67 (0.509)	1.78 (0.543)	1.90 (0.579)
	Ent. Loss	5.32 (1.622)	5.58 (1.701)	5.86 (1.786)	6.25 (1.905)	6.66 (2.03)	7.11 (2.167)	7.59 (2.313)	5.78 (1.762)	8.63 (2.63)

NOTES: 1) Calculation assumes 1200 SCFM (33.98 m^3/min) per boiler at full fire rate

2) Units for "Straight Run" pressure drop values are equivalent feet per foot (eq. m / m)

3) Units for "Elbows" and "Ent. Loss" are equivalent feet per item (eq. m / item)

9.3 Gross Natural Draft

Table 3-a- Part 1: Gross Natural Draft for BMK1000 & BMK750 Low NOx Boilers – in Inch W.C.

	Outside Air Temperature								
Stack Height in Feet	**-30 °F**	**-15 °F**	**0 °F**	**20 °F**	**40 °F**	**60 °F**	**80 °F**	**100 °F**	**120 °F**
5	0.024	0.022	0.021	0.018	0.016	0.014	0.011	0.009	0.007
10	0.048	0.045	0.041	0.037	0.032	0.028	0.023	0.018	0.014
15	0.072	0.067	0.062	0.055	0.048	0.041	0.034	0.028	0.021
20	0.096	0.089	0.083	0.073	0.064	0.055	0.046	0.037	0.028
25	0.120	0.112	0.103	0.092	0.080	0.069	0.057	0.046	0.034
30	0.144	0.134	0.124	0.110	0.096	0.083	0.069	0.055	0.041
35	0.168	0.156	0.144	0.128	0.112	0.096	0.080	0.064	0.048
40	0.193	0.179	0.165	0.147	0.128	0.110	0.092	0.073	0.055
45	0.217	0.201	0.186	0.165	0.144	0.124	0.103	0.083	0.062
50	0.241	0.223	0.206	0.183	0.160	0.138	0.115	0.092	0.069
75	0.361	0.335	0.309	0.275	0.241	0.206	0.172	0.138	0.103
100	0.481	0.447	0.413	0.367	0.321	0.275	0.229	0.183	0.138
125	0.602	0.559	0.516	0.458	0.401	0.344	0.287	0.229	0.172
150	0.722	0.670	0.619	0.550	0.481	0.413	0.344	0.275	0.206
175	0.842	0.782	0.722	0.642	0.562	0.481	0.401	0.321	0.241
200	0.963	0.894	0.825	0.734	0.642	0.550	0.458	0.367	0.275

Table 3-a- Part 1: Gross Natural Draft for BMK1000 & BMK750 Low NOx Boilers – in Pascals

	Outside Air Temperature								
Stack Height in Meters	**-34.4 °C**	**-26.1 °C**	**-17.8 °C**	**-6.7 °C**	**4.4 °C**	**15.6 °C**	**26.7 °C**	**37.8 °C**	**48.9 °C**
1.52	6.0	5.5	5.2	4.5	4.0	3.5	2.7	2.2	1.7
3.05	12.0	11.2	10.2	9.2	8.0	7.0	5.7	4.5	3.5
4.57	17.9	16.7	15.4	13.7	12.0	10.2	8.5	7.0	5.2
6.1	23.9	22.2	20.7	18.2	15.9	13.7	11.5	9.2	7.0
7.62	29.9	27.9	25.7	22.9	19.9	17.2	14.2	11.5	8.5
9.14	35.9	33.4	30.9	27.4	23.9	20.7	17.2	13.7	10.2
10.67	41.8	38.9	35.9	31.9	27.9	23.9	19.9	15.9	12.0
12.19	48.1	44.6	41.1	36.6	31.9	27.4	22.9	18.2	13.7
13.72	54.1	50.1	46.3	41.1	35.9	30.9	25.7	20.7	15.4
15.24	60.0	55.5	51.3	45.6	39.9	34.4	28.6	22.9	17.2
22.86	89.9	83.4	77.0	68.5	60.0	51.3	42.8	34.4	25.7
30.48	119.8	111.3	102.9	91.4	80.0	68.5	57.0	45.6	34.4
38.1	150.0	139.2	128.5	114.1	99.9	85.7	71.5	57.0	42.8
45.72	179.8	166.9	154.2	137.0	119.8	102.9	85.7	68.5	51.3
53.34	209.7	194.8	179.8	159.9	140.0	119.8	99.9	80.0	60.0
60.96	239.9	222.7	205.5	182.8	159.9	137.0	114.1	91.4	68.5

Table 3-a-Part 2: Gross Natural Draft for BMK1000 & BMK750 Low NOx Boilers – in Eq. Ft.

	Outside Air Temperature – Fahrenheit								
Stack Height in Feet	**-30 °F**	**-15 °F**	**0 °F**	**20 °F**	**40 °F**	**60 °F**	**80 °F**	**100 °F**	**120 °F**
5	4.1	3.8	3.5	3.2	2.8	2.4	2.0	1.6	1.2
10	8.3	7.7	7.1	6.3	5.5	4.7	3.9	3.2	2.4
15	12.4	11.5	10.6	9.5	8.3	7.1	5.9	4.7	3.5
20	16.6	15.4	14.2	12.6	11.0	9.5	7.9	6.3	4.7
25	20.7	19.2	17.7	15.8	13.8	11.8	9.9	7.9	5.9
30	24.8	23.1	21.3	18.9	16.6	14.2	11.8	9.5	7.1
35	29.0	26.9	24.8	22.1	19.3	16.6	13.8	11.0	8.3
40	33.1	30.8	28.4	25.2	22.1	18.9	15.8	12.6	9.5
45	37.3	34.6	31.9	28.4	24.8	21.3	17.7	14.2	10.6
50	41.4	38.4	35.5	31.5	27.6	23.7	19.7	15.8	11.8
75	62.1	57.7	53.2	47.3	41.4	35.5	29.6	23.7	17.7
100	82.8	76.9	71.0	63.1	55.2	47.3	39.4	31.5	23.7
125	103.5	96.1	88.7	78.9	69.0	59.1	49.3	39.4	29.6
150	124.2	115.3	106.4	94.6	82.8	71.0	59.1	47.3	35.5
175	144.9	134.5	124.2	110.4	96.6	82.8	69.0	55.2	41.4
200	165.6	153.8	141.9	126.2	110.4	94.6	78.9	63.1	47.3

Note: Based on 160 °F to 180 °F Boiler Water

Table 3-a-Part 2: Gross Natural Draft for BMK1000 & BMK750 Low NOx Boilers – In Eq. Meters

	Outside Air Temperature – Celsius								
Stack Height in Meters	**-34.4 °C**	**-26.1 °C**	**-17.8 °C**	**-6.7 °C**	**4.4 °C**	**15.6 °C**	**26.7 °C**	**37.8 °C**	**48.9 °C**
1.52	1.2	1.2	1.1	1.0	0.9	0.7	0.6	0.5	0.4
3.05	2.5	2.3	2.2	1.9	1.7	1.4	1.2	1.0	0.7
4.57	3.8	3.5	3.2	2.9	2.5	2.2	1.8	1.4	1.1
6.10	5.1	4.7	4.3	3.8	3.4	2.9	2.4	1.9	1.4
7.62	6.3	5.9	5.4	4.8	4.2	3.6	3.0	2.4	1.8
9.14	7.6	7.0	6.5	5.8	5.1	4.3	3.6	2.9	2.2
10.67	8.8	8.2	7.6	6.7	5.9	5.1	4.2	3.4	2.5
12.19	10.1	9.4	8.7	7.7	6.7	5.8	4.8	3.8	2.9
13.72	11.4	10.5	9.7	8.7	7.6	6.5	5.4	4.3	3.2
15.24	12.6	11.7	10.8	9.6	8.4	7.2	6.0	4.8	3.6
22.86	18.9	17.6	16.2	14.4	12.6	10.8	9.0	7.2	5.4
30.48	25.2	23.4	21.6	19.2	16.8	14.4	12.0	9.6	7.2
38.10	31.5	29.3	27.0	24.0	21.0	18.0	15.0	12.0	9.0
45.72	37.9	35.1	32.4	28.8	25.2	21.6	18.0	14.4	10.8
53.34	44.2	41.0	37.9	33.6	29.4	25.2	21.0	16.8	12.6
60.96	50.5	46.9	43.3	38.5	33.6	28.8	24.0	19.2	14.4

Note: Based on 71 °C to 82 °C Boiler Water

Table 3-b-Part 1: Gross Natural Draft for BMK1500, BMK2000, BMK2500, BMK3000 Low NOx Boilers – in Inch W.C.

	Outside Air Temperature – Fahrenheit								
Stack Height in Feet	**-30°F**	**-15°F**	**0°F**	**20°F**	**40°F**	**60°F**	**80°F**	**100°F**	**120°F**
5	0.024	0.022	0.021	0.018	0.016	0.014	0.011	0.009	0.007
10	0.048	0.045	0.041	0.037	0.032	0.028	0.023	0.018	0.014
15	0.072	0.067	0.062	0.055	0.048	0.041	0.034	0.028	0.021
20	0.096	0.089	0.083	0.073	0.064	0.055	0.046	0.037	0.028
25	0.120	0.112	0.103	0.092	0.080	0.069	0.057	0.046	0.034
30	0.144	0.134	0.124	0.110	0.096	0.083	0.069	0.055	0.041
35	0.168	0.156	0.144	0.128	0.112	0.096	0.080	0.064	0.048
40	0.193	0.179	0.165	0.147	0.128	0.110	0.092	0.073	0.055
45	0.217	0.201	0.186	0.165	0.144	0.124	0.103	0.083	0.062
50	0.241	0.223	0.206	0.183	0.160	0.138	0.115	0.092	0.069
75	0.361	0.335	0.309	0.275	0.241	0.206	0.172	0.138	0.103
100	0.481	0.447	0.413	0.367	0.321	0.275	0.229	0.183	0.138
125	0.602	0.559	0.516	0.458	0.401	0.344	0.287	0.229	0.172
150	0.722	0.670	0.619	0.550	0.481	0.413	0.344	0.275	0.206
175	0.842	0.782	0.722	0.642	0.562	0.481	0.401	0.321	0.241
200	0.963	0.894	0.825	0.734	0.642	0.550	0.458	0.367	0.275

Table 3-b-Part 1: Gross Natural Draft for BMK1500, BMK2000, BMK2500, BMK3000 Low NOx Boilers – in Pascals

	Outside Air Temperature – Celsius								
Stack Height in Meters	**-34.4 °C**	**-26.1 °C**	**-17.8 °C**	**-6.7 °C**	**4.4 °C**	**15.6 °C**	**26.7 °C**	**37.8 °C**	**48.9 °C**
1.52	6.0	5.5	5.2	4.5	4.0	3.5	2.7	2.2	1.7
3.05	12.0	11.2	10.2	9.2	8.0	7.0	5.7	4.5	3.5
4.57	17.9	16.7	15.4	13.7	12.0	10.2	8.5	7.0	5.2
6.10	23.9	22.2	20.7	18.2	15.9	13.7	11.5	9.2	7.0
7.62	29.9	27.9	25.7	22.9	19.9	17.2	14.2	11.5	8.5
9.14	35.9	33.4	30.9	27.4	23.9	20.7	17.2	13.7	10.2
10.67	41.8	38.9	35.9	31.9	27.9	23.9	19.9	15.9	12.0
12.19	48.1	44.6	41.1	36.6	31.9	27.4	22.9	18.2	13.7
13.72	54.1	50.1	46.3	41.1	35.9	30.9	25.7	20.7	15.4
15.24	60.0	55.5	51.3	45.6	39.9	34.4	28.6	22.9	17.2
22.86	89.9	83.4	77.0	68.5	60.0	51.3	42.8	34.4	25.7
30.48	119.8	111.3	102.9	91.4	80.0	68.5	57.0	45.6	34.4
38.10	150.0	139.2	128.5	114.1	99.9	85.7	71.5	57.0	42.8
45.72	179.8	166.9	154.2	137.0	119.8	102.9	85.7	68.5	51.3
53.34	209.7	194.8	179.8	159.9	140.0	119.8	99.9	80.0	60.0
60.96	239.9	222.7	205.5	182.8	159.9	137.0	114.1	91.4	68.5

Table 3-b-Part 2: Gross Natural Draft for BMK1500, BMK2000, BMK2500, BMK3000 Low NOx Boilers – In Eq. Ft.

	Outside Air Temperature (°F)								
Stack Height in Feet	**-30°F**	**-15°F**	**0°F**	**20°F**	**40°F**	**60°F**	**80°F**	**100°F**	**120°F**
5	4.1	3.8	3.5	3.2	2.8	2.4	2.0	1.6	1.2
10	8.3	7.7	7.1	6.3	5.5	4.7	3.9	3.2	2.4
15	12.4	11.5	10.6	9.5	8.3	7.1	5.9	4.7	3.5
20	16.6	15.4	14.2	12.6	11.0	9.5	7.9	6.3	4.7
25	20.7	19.2	17.7	15.8	13.8	11.8	9.9	7.9	5.9
30	24.8	23.1	21.3	18.9	16.6	14.2	11.8	9.5	7.1
35	29.0	26.9	24.8	22.1	19.3	16.6	13.8	11.0	8.3
40	33.1	30.8	28.4	25.2	22.1	18.9	15.8	12.6	9.5
45	37.3	34.6	31.9	28.4	24.8	21.3	17.7	14.2	10.6
50	41.4	38.4	35.5	31.5	27.6	23.7	19.7	15.8	11.8
75	62.1	57.7	53.2	47.3	41.4	35.5	29.6	23.7	17.7
100	82.8	76.9	71.0	63.1	55.2	47.3	39.4	31.5	23.7
125	103.5	96.1	88.7	78.9	69.0	59.1	49.3	39.4	29.6
150	124.2	115.3	106.4	94.6	82.8	71.0	59.1	47.3	35.5
175	144.9	134.5	124.2	110.4	96.6	82.8	69.0	55.2	41.4
200	165.6	153.8	141.9	126.2	110.4	94.6	78.9	63.1	47.3

Note: Based on 160 °F to 180 °F

Table 3-b-Part 2: Gross Natural Draft for BMK1500, BMK2000, BMK2500, BMK3000 Low NOx Boilers – in Eq. Meters

	Outside Air Temperature – Celsius								
Stack Height in Meters	**-34.4 °C**	**-26.1 °C**	**-17.8 °C**	**-6.7 °C**	**4.4 °C**	**15.6 °C**	**26.7 °C**	**37.8 °C**	**48.9 °C**
1.52	1.2	1.2	1.1	1.0	0.9	0.7	0.6	0.5	0.4
3.05	2.5	2.3	2.2	1.9	1.7	1.4	1.2	1.0	0.7
4.57	3.8	3.5	3.2	2.9	2.5	2.2	1.8	1.4	1.1
6.10	5.1	4.7	4.3	3.8	3.4	2.9	2.4	1.9	1.4
7.62	6.3	5.9	5.4	4.8	4.2	3.6	3.0	2.4	1.8
9.14	7.6	7.0	6.5	5.8	5.1	4.3	3.6	2.9	2.2
10.67	8.8	8.2	7.6	6.7	5.9	5.1	4.2	3.4	2.5
12.19	10.1	9.4	8.7	7.7	6.7	5.8	4.8	3.8	2.9
13.72	11.4	10.5	9.7	8.7	7.6	6.5	5.4	4.3	3.2
15.24	12.6	11.7	10.8	9.6	8.4	7.2	6.0	4.8	3.6
22.86	18.9	17.6	16.2	14.4	12.6	10.8	9.0	7.2	5.4
30.48	25.2	23.4	21.6	19.2	16.8	14.4	12.0	9.6	7.2
38.10	31.5	29.3	27.0	24.0	21.0	18.0	15.0	12.0	9.0
45.72	37.9	35.1	32.4	28.8	25.2	21.6	18.0	14.4	10.8
53.34	44.2	41.0	37.9	33.6	29.4	25.2	21.0	16.8	12.6
60.96	50.5	46.9	43.3	38.5	33.6	28.8	24.0	19.2	14.4

Note: Based on 71 °C to 82 °C Boiler Water

Table 3-c-Part 1: Gross Natural Draft for BMK5000/6000 Low NOx Boilers – in Inch W.C.

	Outside Air Design Temperature (°F)								
Stack Height in Feet	**-30 °F**	**-15 °F**	**0 °F**	**20 °F**	**40 °F**	**60 °F**	**80 °F**	**100 °F**	**120 °F**
5	0.024	0.022	0.021	0.018	0.016	0.014	0.011	0.009	0.007
10	0.048	0.045	0.041	0.037	0.032	0.028	0.023	0.018	0.014
15	0.072	0.067	0.062	0.055	0.048	0.041	0.034	0.028	0.021
20	0.096	0.089	0.083	0.073	0.064	0.055	0.046	0.037	0.028
25	0.120	0.112	0.103	0.092	0.080	0.069	0.057	0.046	0.034
30	0.144	0.134	0.124	0.110	0.096	0.083	0.069	0.055	0.041
35	0.168	0.156	0.144	0.128	0.112	0.096	0.080	0.064	0.048
40	0.193	0.179	0.165	0.147	0.128	0.110	0.092	0.073	0.055
45	0.217	0.201	0.186	0.165	0.144	0.124	0.103	0.083	0.062
50	0.241	0.223	0.206	0.183	0.160	0.138	0.115	0.092	0.069
75	0.361	0.335	0.309	0.275	0.241	0.206	0.172	0.138	0.103
100	0.481	0.447	0.413	0.367	0.321	0.275	0.229	0.183	0.138
125	0.602	0.559	0.516	0.458	0.401	0.344	0.287	0.229	0.172
150	0.722	0.670	0.619	0.550	0.481	0.413	0.344	0.275	0.206
175	0.842	0.782	0.722	0.642	0.562	0.481	0.401	0.321	0.241
200	0.963	0.894	0.825	0.734	0.642	0.550	0.458	0.367	0.275

Table 3-c-Part 1: Gross Natural Draft for BMK5000/6000 Low NOx Boilers – in Pascals

	Outside Air Temperature – Celsius								
Stack Height in Meters	**-34.4 °C**	**-26.1 °C**	**-17.8 °C**	**-6.7 °C**	**4.4 °C**	**15.6 °C**	**26.7 °C**	**37.8 °C**	**48.9 °C**
1.52	6.0	5.5	5.2	4.5	4.0	3.5	2.7	2.2	1.7
3.05	12.0	11.2	10.2	9.2	8.0	7.0	5.7	4.5	3.5
4.57	17.9	16.7	15.4	13.7	12.0	10.2	8.5	7.0	5.2
6.10	23.9	22.2	20.7	18.2	15.9	13.7	11.5	9.2	7.0
7.62	29.9	27.9	25.7	22.9	19.9	17.2	14.2	11.5	8.5
9.14	35.9	33.4	30.9	27.4	23.9	20.7	17.2	13.7	10.2
10.67	41.8	38.9	35.9	31.9	27.9	23.9	19.9	15.9	12.0
12.19	48.1	44.6	41.1	36.6	31.9	27.4	22.9	18.2	13.7
13.72	54.1	50.1	46.3	41.1	35.9	30.9	25.7	20.7	15.4
15.24	60.0	55.5	51.3	45.6	39.9	34.4	28.6	22.9	17.2
22.86	89.9	83.4	77.0	68.5	60.0	51.3	42.8	34.4	25.7
30.48	119.8	111.3	102.9	91.4	80.0	68.5	57.0	45.6	34.4
38.10	150.0	139.2	128.5	114.1	99.9	85.7	71.5	57.0	42.8
45.72	179.8	166.9	154.2	137.0	119.8	102.9	85.7	68.5	51.3
53.34	209.7	194.8	179.8	159.9	140.0	119.8	99.9	80.0	60.0
60.96	239.9	222.7	205.5	182.8	159.9	137.0	114.1	91.4	68.5

Table 3-c-Part 2: Gross Natural Draft for BMK5000/6000 Low NOx Boilers – in Eq. Ft.

	Outside Air Temperature (°F)								
Stack Height in Feet	**-30 °F**	**-15 °F**	**0 °F**	**20 °F**	**40 °F**	**60 °F**	**80 °F**	**100 °F**	**120 °F**
5	4.1	3.8	3.5	3.2	2.8	2.4	2.0	1.6	1.2
10	8.3	7.7	7.1	6.3	5.5	4.7	3.9	3.2	2.4
15	12.4	11.5	10.6	9.5	8.3	7.1	5.9	4.7	3.5
20	16.6	15.4	14.2	12.6	11.0	9.5	7.9	6.3	4.7
25	20.7	19.2	17.7	15.8	13.8	11.8	9.9	7.9	5.9
30	24.8	23.1	21.3	18.9	16.6	14.2	11.8	9.5	7.1
35	29.0	26.9	24.8	22.1	19.3	16.6	13.8	11.0	8.3
40	33.1	30.8	28.4	25.2	22.1	18.9	15.8	12.6	9.5
45	37.3	34.6	31.9	28.4	24.8	21.3	17.7	14.2	10.6
50	41.4	38.4	35.5	31.5	27.6	23.7	19.7	15.8	11.8
75	62.1	57.7	53.2	47.3	41.4	35.5	29.6	23.7	17.7
100	82.8	76.9	71.0	63.1	55.2	47.3	39.4	31.5	23.7
125	103.5	96.1	88.7	78.9	69.0	59.1	49.3	39.4	29.6
150	124.2	115.3	106.4	94.6	82.8	71.0	59.1	47.3	35.5
175	144.9	134.5	124.2	110.4	96.6	82.8	69.0	55.2	41.4
200	165.6	153.8	141.9	126.2	110.4	94.6	78.9	63.1	47.3

Note: Based on 160 °F to 180 °F Boiler Water

Table 3-c-Part 2: Gross Natural Draft for BMK5000/6000 Low NOx Boilers – in Eq. Meters

	Outside Air Temperature – Celsius								
Stack Height in Meters	**-34.4 °C**	**-26.1 °C**	**-17.8 °C**	**-6.7 °C**	**4.4 °C**	**15.6 °C**	**26.7 °C**	**37.8 °C**	**48.9 °C**
1.52	1.2	1.2	1.1	1.0	0.9	0.7	0.6	0.5	0.4
3.05	2.5	2.3	2.2	1.9	1.7	1.4	1.2	1.0	0.7
4.57	3.8	3.5	3.2	2.9	2.5	2.2	1.8	1.4	1.1
6.10	5.1	4.7	4.3	3.8	3.4	2.9	2.4	1.9	1.4
7.62	6.3	5.9	5.4	4.8	4.2	3.6	3.0	2.4	1.8
9.14	7.6	7.0	6.5	5.8	5.1	4.3	3.6	2.9	2.2
10.67	8.8	8.2	7.6	6.7	5.9	5.1	4.2	3.4	2.5
12.19	10.1	9.4	8.7	7.7	6.7	5.8	4.8	3.8	2.9
13.72	11.4	10.5	9.7	8.7	7.6	6.5	5.4	4.3	3.2
15.24	12.6	11.7	10.8	9.6	8.4	7.2	6.0	4.8	3.6
22.86	18.9	17.6	16.2	14.4	12.6	10.8	9.0	7.2	5.4
30.48	25.2	23.4	21.6	19.2	16.8	14.4	12.0	9.6	7.2
38.10	31.5	29.3	27.0	24.0	21.0	18.0	15.0	12.0	9.0
45.72	37.9	35.1	32.4	28.8	25.2	21.6	18.0	14.4	10.8
53.34	44.2	41.0	37.9	33.6	29.4	25.2	21.0	16.8	12.6
60.96	50.5	46.9	43.3	38.5	33.6	28.8	24.0	19.2	14.4

Note: Based on 71 °C to 82 °C Boiler Water

9.4 Altitude Correction

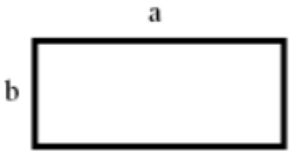
Table 4:
Altitude Correction

Site Elevation Above Sea Level		Altitude Correction Factor (CF)
Feet	**Meters**	
0	0	1
500	152.4	0.982
1000	304.8	0.964
1500	457.2	0.947
2000	609.6	0.930
2500	762.0	0.913
3000	914.4	0.896
3500	1066.8	0.880
4000	1219.2	0.864
4500	1371.6	0.848
5000	1524.0	0.832
5500	1676.4	0.817
6000	1828.8	0.801
6500	1981.2	0.787
7000	2133.6	0.772
7500	2286.0	0.758
8000	2438.4	0.743
8500	2590.8	0.729
9000	2743.2	0.715
9500	2895.6	0.701
10000	3048.0	0.688

9.5 Round Vs Square Duct

Table 5: Round Duct of Identical Pressure Drop to Rectangular Duct

Formula: $d_e = 1.3\,(a \times b)^{0.625} / (a + b)^{0.25}$



In Inches

Adjacent Side of Duct in inches	Side of Rectangular Duct in Inches									
	6	8	10	12	14	16	18	20	22	24
6	6.6									
8	7.6	8.7								
10	8.4	9.8	10.9							
12	9.1	10.7	12	13.1						
14	9.8	11.5	12.9	14.2	15.3					
16	10.4	12.2	13.7	15.1	16.4	17.5				
18	11	12.9	14.5	16	17.3	18.5	19.7			
20	11.5	13.5	15.2	16.8	18.2	19.5	20.7	21.9		
22	12	14.1	15.9	17.6	19.1	20.4	21.7	22.9	24	
24	12.4	14.6	16.5	18.3	19.9	21.3	22.7	23.9	25.1	26.2

In Centimeters

Adjacent Side of Duct in cm	Side of Rectangular Duct in *Centimeters*									
	15.24	20.32	25.4	30.48	35.56	40.64	45.72	50.8	55.88	60.96
15.24	16.76									
20.32	19.30	22.10								
25.4	21.34	24.89	27.69							
30.48	23.11	27.18	30.48	33.27						
35.56	24.89	29.21	32.77	36.07	38.86					
40.64	26.42	30.99	34.80	38.35	41.66	44.45				
45.72	27.94	32.77	36.83	40.64	43.94	46.99	50.04			
50.8	29.21	34.29	38.61	42.67	46.23	49.53	52.58	55.63		
55.88	30.48	35.81	40.39	44.70	48.51	51.82	55.12	58.17	60.96	
60.96	31.50	37.08	41.91	46.48	50.55	54.10	57.66	60.71	63.75	66.55

Reference:

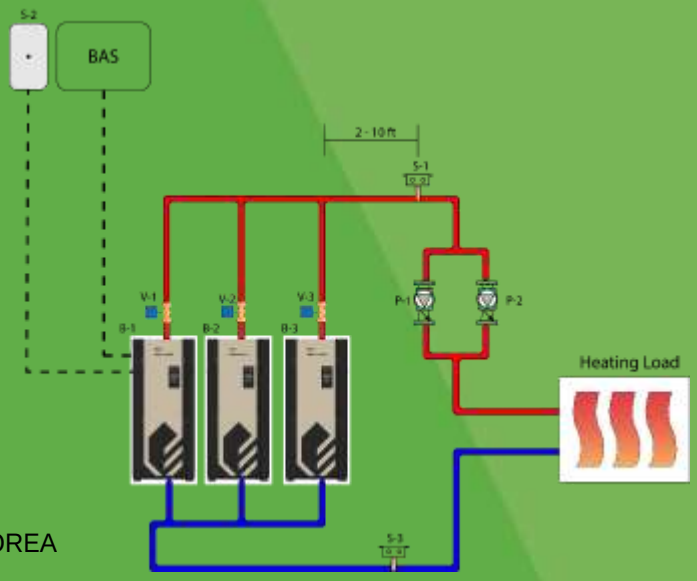
1. *National Fuel Gas Code, 2006 edition*, American National Standards Institute, Inc (ANSI Z223.1-2006) and National Fire Protection Association (NFPA54-2006)
2. CSA B149.1 (For Canada installations)

Change Log:		
Date	**Description**	**Changed by**
11/19/2020	**REV AF:** Removed references to “wind blocked” sites, NOTE 1 in Section 22.	Chris Blair
4/5/2023	**REV AG:** In Figure 10d, changed vent termination wording to “Vent terminations must be at least 3 feet (0.9 m) above *OR* 10 feet (3.1 m) horizontally away from any fresh-air inlet.” (“and” changed to “*OR*”).	Chris Blair
4/5/2023	**REV AH:** In 10. Ducted Combustion Air, corrected the diameters for BMK 4000 and 5000N to 10 inch diameter (25.4 cm). Additional edits from Systems Engineering team.	DWBarron
5/16/2023	**Rev AI:** Removed all reference to Platinum	DWBarron

Application Design Guide

Benchmark® Boilers with Edge [ii] Controller

Models 750 through 6000



Other documents for this product include:

OMM-0127 BMK750K-3000K Installation-Startup KOREA
OMM-0128 BMK750K-3000K Operation- Maintenance KOREA
OMM-0136 BMK750-6000 Edge [II] Installation-Startup
OMM-0137 BMK750-6000 Edge [II] Operation-Service
OMM-0138 BMK750-6000 Edge [II] Reference Manual
OMM-0144 BMK750-6000 Edge [I] Installation-Startup
OMM-0145 BMK750-6000 Edge [I] Operation-Service
OMM-0146 BMK750-6000 Edge [I] Reference Manual

TAG-0022 Benchmark Vent & Combustion Air Guide
TAG-0047 Benchmark Gas Guide
TAG-0048 Benchmark Electrical Power Guide

GAS-FIRED C UL US LISTED

AHRI CERTIFIED www.ahridirectory.org Commercial Boilers AHRI Standard BTS 2000

ASME H

Heating and Hot Water Solutions

AERCO International, Inc. • 100 Oritani Drive • Blauvelt, NY 10913
USA: T: (845) 580-8000 • Toll Free: (800) 526-0288 • AERCO.com
Technical Support • (800) 526-0288 • Mon-Fri, 8 am - 5 pm EST

Table of Contents

1. GENERAL

AERCO Benchmark (BMK) condensing boilers optimizes hydronic system for peak performance and efficiency. They operate with high turndown to match the changing requirements of the energy input, minimize cycling and maximize seasonal efficiency. Their compact footprint allows flexibility and reduce total project installation costs. This guide helps designers apply the BMK boilers to the most common types of systems. If a special application is needed, please call your local AERCO Representative or the AERCO factory for specific application information.

2. SINGLE AND MULTIPLE APPLICATIONS

AERCO Benchmark boilers can be applied either as stand-alone single units or in multiple batteries of boilers with unlimited input. Actual boiler sizing and selection are the responsibility of the designer. ASHRAE standards recommend sizing equipment with a minimum of over sizing for maximum system efficiency.

3. PIPING

3.1 Pressure and Temperature Ratings

The maximum allowable working pressure (MAWP) for the Benchmark boilers are as follows:

BMK Model	MAWP
BMK750 – BMK5000N	160 psig (1103 kPa)
BMK5000 and BMK6000	80 and 150 psig (551 kPa and 1034 kPa) models available

Individual ASME pressure relief valves are supplied on each boiler in setpoints of 30, 50, 60, 75, 100, 125, 150, or 160 psig (207, 414, 517, 689, 862, 1034, or 1103 kPa), as specified.
BMK units are applicable to systems with temperatures of 50 °F to 190 °F (10 °C to 88 °C). Due to their condensing design, normal low temperature restrictions do not apply. While most heating applications are designed with a 20 °F (11 °C) temperature drop, BMK boilers are capable of 100 °F (55 °C) temperature drop through the heat exchanger without thermal stress.

3.2 Flow Rate Specifications

AERCO BMK boilers require the following minimum flow rate per boiler for proper and stable boiler temperature control operation. To prevent erosion of construction materials, maximum flow per boiler are limited as shown below.

BMK Model	Minimum Flow Rate	Maximum Flow Rate
BMK750	12 gpm (45 lpm)	175 gpm (662 lpm)
BMK1000	12 gpm (45 lpm)	175 gpm (662 lpm)
BMK1500	25 gpm (95 lpm)	250 gpm (946 lpm)
BMK2000	25 gpm (95 lpm)	350 gpm (1325 lpm)
BMK2500	25 gpm (95 lpm)	350 gpm (1325 lpm)
BMK3000	25 gpm (95 lpm)	350 gpm (1325 lpm)
BMK4000/5000N	35 gpm (284 lpm)	500 gpm (1892 lpm)
BMK5000/BMK6000	75 gpm (284 lpm)	600 gpm (2271 lpm)

3.3 Pipe Design Provisions

Minimum flow must be observed in piping design. Ancillary flow devices including pumps and valves must be selected and operated to provide minimum flow. Controls (internal boiler controls and/or building automation system) must be configured to operate pumps and valves to allow flow through BMK boilers in operation.

For multiple boiler installations, the piping must be designed to ensure balanced flow through all the boilers. This can be accomplished by using reverse-return piping or a balancing valve at the outlet of each boiler. Failure to balance flow evenly through the boilers will prevent full delivery of boiler capability at design conditions and may cause over-cycling and unnecessary stress on the boilers.

The BMK boiler is approved for zero-side clearance in two-unit pairs in applications where space is at a premium. Piping should be located to allow free access between boilers. For maintenance purposes, each BMK boiler shall have individual valves on supply and return from the system.

When used with a refrigeration (chiller) system, the boilers must be installed to prevent the chilled medium from entering the boiler.

3.4 Dual Returns

Benchmark 750-6000 boilers come standard with dual return connections. Utilizing this feature can boost seasonal efficiency by up to 6%. Installations with space heating and the following applications that can take advantage of this feature include:

- Domestic hot water applications
- Higher ΔT zones with lower return temperatures
- Air preheat
- Heat pump injection
- And more

Rather than blend the separate zones, the lower return temperature zones/systems could be piped separately to the primary water connection, raising the overall thermal efficiency and allowing the boiler to be in condensing mode for longer periods throughout the year

Multiple flow configurations are possible. There is no minimum flow requirement for the primary low temperature return, as long as the minimum flow requirements of the boiler models are met through the secondary-high temperature return. If the flow split between the high and low temperature returns is constant, the total flow must be no less than the minimum flow requirements of the boiler models. Due to the varying flow conditions possible when utilizing dual returns, AERCO recommends installing check valves at both inlets of the boilers.

4. TYPICAL APPLICATIONS

BMK boilers can be used in any closed-loop heating system within their design limitations. The following typical piping and wiring schematic diagrams represent the most common types of installation detail. These diagrams are not intended for any particular system but are rather composites of how AERCO boilers interface with heating and domestic hot water applications in the real world. The designer should incorporate BMK boilers in each system so as to achieve maximum operating efficiency. With ultimate control over the energy transfer process under a broad range of temperatures, the designer should first consider how the system best needs the supplied energy. The boilers should then be applied in the manner that best enables them to use their finite control and capability to supplement the system, using minimum applied energy. The following examples illustrate typical piping and wiring diagrams with brief description of the application and its features:

IMPORTANT!

For all applications, the header sensor (S-1) must be located 2-10 ft from the nearest boiler.

- Diagram 4-1 – Space Heating
- Diagram 4-2 – Space Heating (Primary-Secondary Piping)
- Diagram 4-3 – Combination Plant with One Swing Valve and 2-port Buffer Tank
- Diagram 4-4 – Combination Plant with One Swing Valve and 4-port Buffer Tank
- Diagram 4-5 – Combination Plant with One Swing Valve and Domestic Hot Water Tank
- Diagram 4-6 – Combination Plant with Two Swing Valves and 2-port Buffer Tank
- Diagram 4-7 – Combination Plant with Two Swing Valves and 4-port Buffer Tank
- Diagram 4-8 – Combination Plant with Two Swing Valves and 4-port Buffer Tank (Primary-Secondary Piping)
- Diagram 4-9 – Combination Plant with Two Swing Valves and Domestic Hot Water Tank
- Diagram 4-10 – Space Heating with Temperature Boost and 2-port Buffer Tank
- Diagram 4-11 – Space Heating with Temperature Boost and 4-port Buffer Tank
- Diagram 4-12 – Space Heating with Temperature Boost and Domestic Hot Water Tank

NOTE: For Essential System Setting parameters see *EZ Setup* or *Advanced Setup*.
Address of boilers where pumps, swing valves and DHW sensor are connected must be entered in EZ Setup or Advanced Setup.
See Edge [ii] Controls manual OMM-0139 for additional information.

See Section 5 for complete Input/Output Reference diagram.

Concept Drawings: The following illustrations are only concept drawings, not engineered drawings. They are not intended to describe a complete system, nor any particular system. It is up to the system designer to determine the necessary components for and configuration of the particular system being designed, including ancillary mechanical and control components, and any safety devices which in the judgement of the designer are appropriate, in order to properly size, configure and design that system and to ensure compliance with building and safety code requirements.

4.1 Space Heating

Application Description & Features: AERCO Benchmark boilers are operated via Boiler Sequencing Technology (BST) to provide space heating. Supply temperature is maintained via constant setpoint, outdoor air reset or remote setpoint command (from building automation system or remote analog signal). Application utilizes AERCO supplied header sensor, sequencing valves and outdoor air sensor; return header sensor is optional.

- The AERCO Edge controller sequences the boiler plant for maximum system efficiency by running as many boilers as available, each operating at its most efficient firing rate.
- Sequencing valves isolate standby boilers, reducing minimum flow requirement.
- Edge[ii] controller supports integration with BAS via BACnet MSTP, BACnet IP, Modbus RTU and Modbus TCP.

Essential System Settings:

Parameter	Setting
Application	SH *(Space Heating)*
SH Operating Mode	Constant Setpoint, Outdoor Air Reset or Remote Setpoint
CASCADE CONFIGURATION-Hdr Temp Sensor	Direct
CASCADE CONFIGURATION-Outdoor Air Temp Sensor *(If SH Operating Mode = Outdoor Air Reset)*	Direct
VALVE CONFIGURATION-Select Output	Cascade Valve
VALVE CONFIGURATION-Valve Feedback	Enabled

Legend:
S-1 = Header Sensor

S-2 = Outdoor Air Sensor
S-3 = Return Sensor

P-1a, P-1b = System Pump(s)
V-1, V-2, V-3 = Sequencing Valves

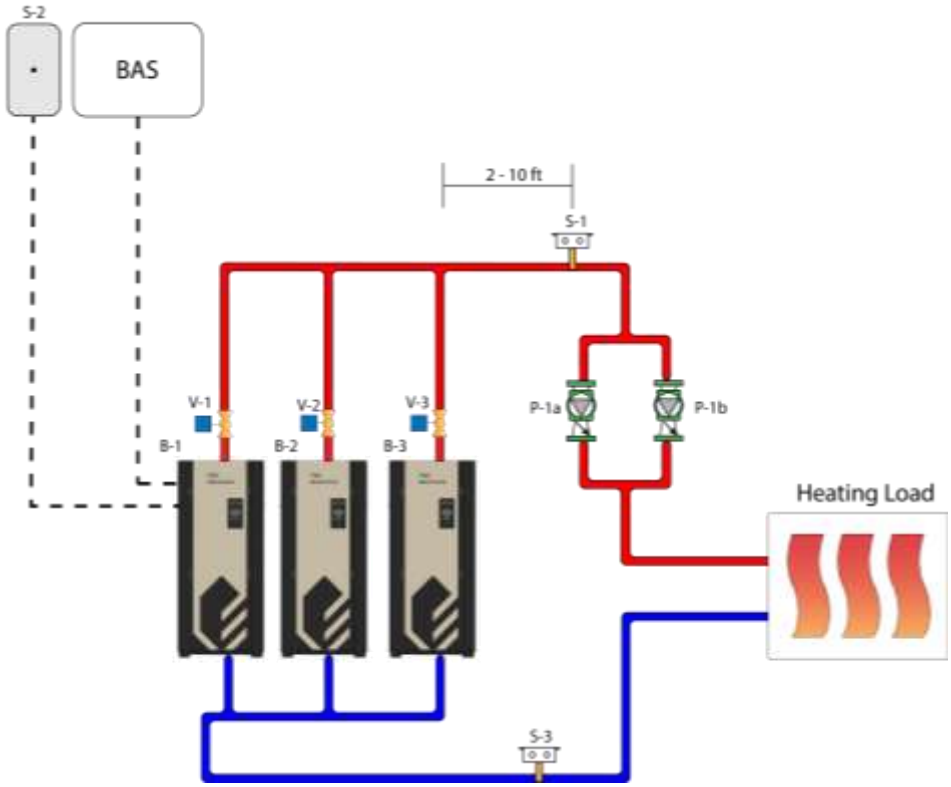


Diagram 4-1a: Space Heating Piping

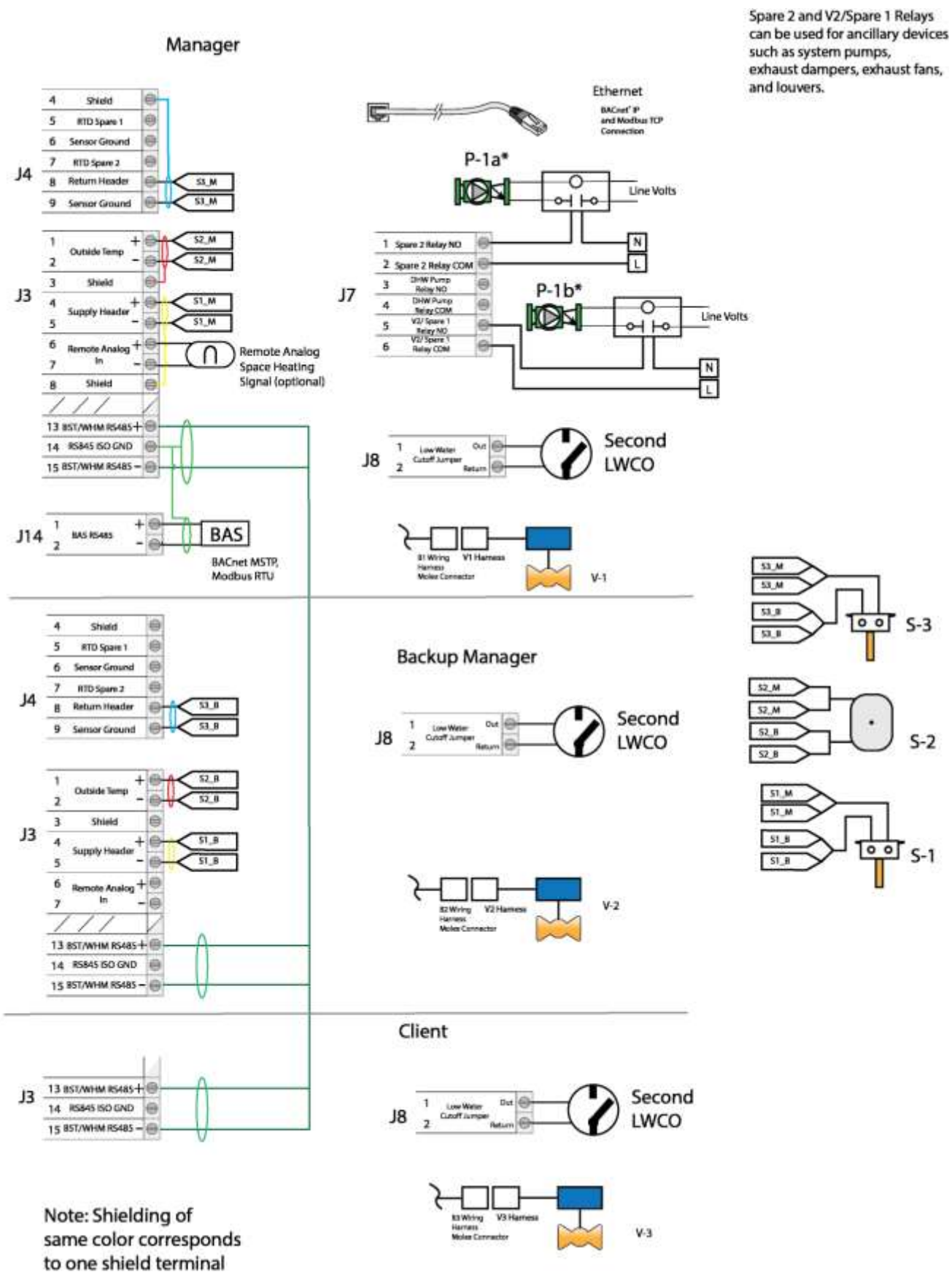


Diagram 4-1b: Space Heating Wiring

4.2 Space Heating (Primary-Secondary Piping)

Application Description & Features: Boiler plant is piped in primary-secondary method with individual boiler pumps. Benchmark boilers are operated via Boiler Sequencing Technology (BST) to provide space heating. Supply temperature is maintained via constant setpoint, outdoor air reset or remote setpoint command (from building automation system or remote analog signal). Application utilizes AERCO supplied header sensor and outdoor air sensor; return header sensor is optional (required if VSP Pump Mode=Return Temp).

- The AERCO Edge controller sequences the boiler plant for maximum system efficiency by running as many boilers as available, each operating at its most efficient firing rate.
- Use of variable speed boiler pumps prevents hot water recirculation at the low loss header, resulting to increased efficiency.
- Edge[ii] controller supports integration with BAS via BACnet MSTP, BACnet IP, Modbus RTU and Modbus TCP.

Note: For more information on variable speed pump control modes, consult Edge [ii] Controls Manual OMM-0139.

Essential System Settings:

Parameter	Setting
Application	Space Heating
SH Operating Mode	Constant Setpoint, Outdoor Air Reset or Remote Setpoint
CASCADE CONFIGURATION-Hdr Temp Sensor	Direct
CASCADE CONFIGURATION-Outdoor Air Temp Sensor *(If SH Operating Mode=Outdoor Air Reset)*	Direct
VSP Pump Mode	Return Temp or Fire Rate
VSP Piping Configuration	1 Pump Per Blr

Legend:
S-1 = Header Sensor
S-2 = Outdoor Air Sensor
S-3 = Return Sensor
P-1, P-2, P-3 = Boiler Pumps

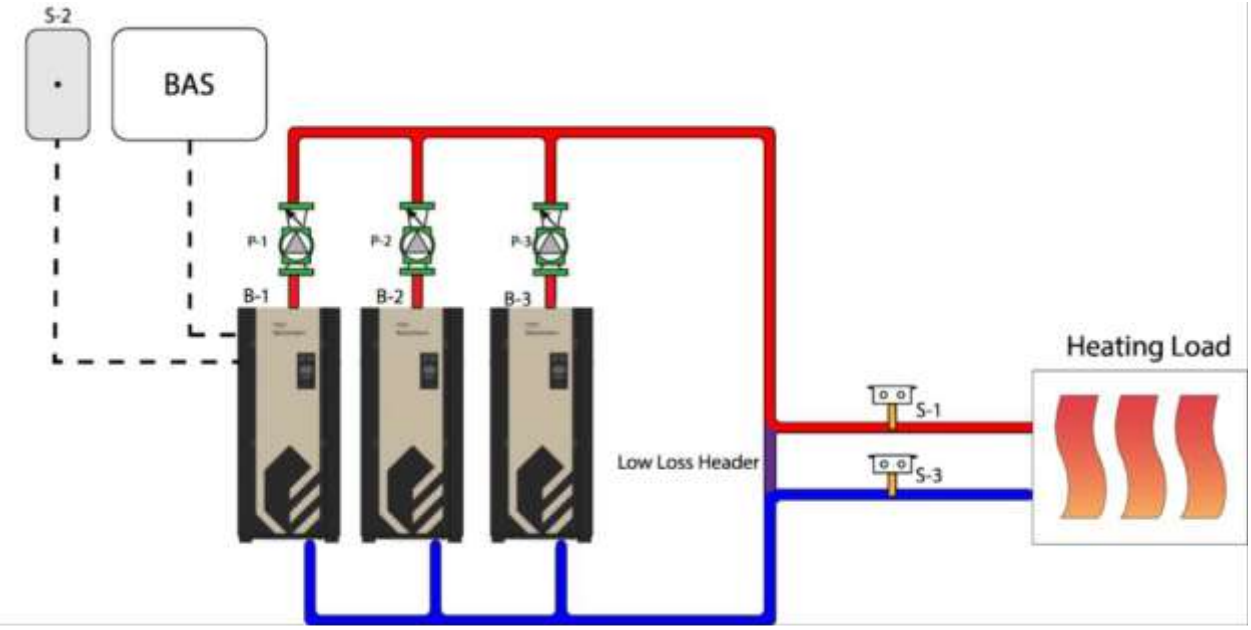


Diagram 4-2a: Space Heating (Primary-Secondary) Piping

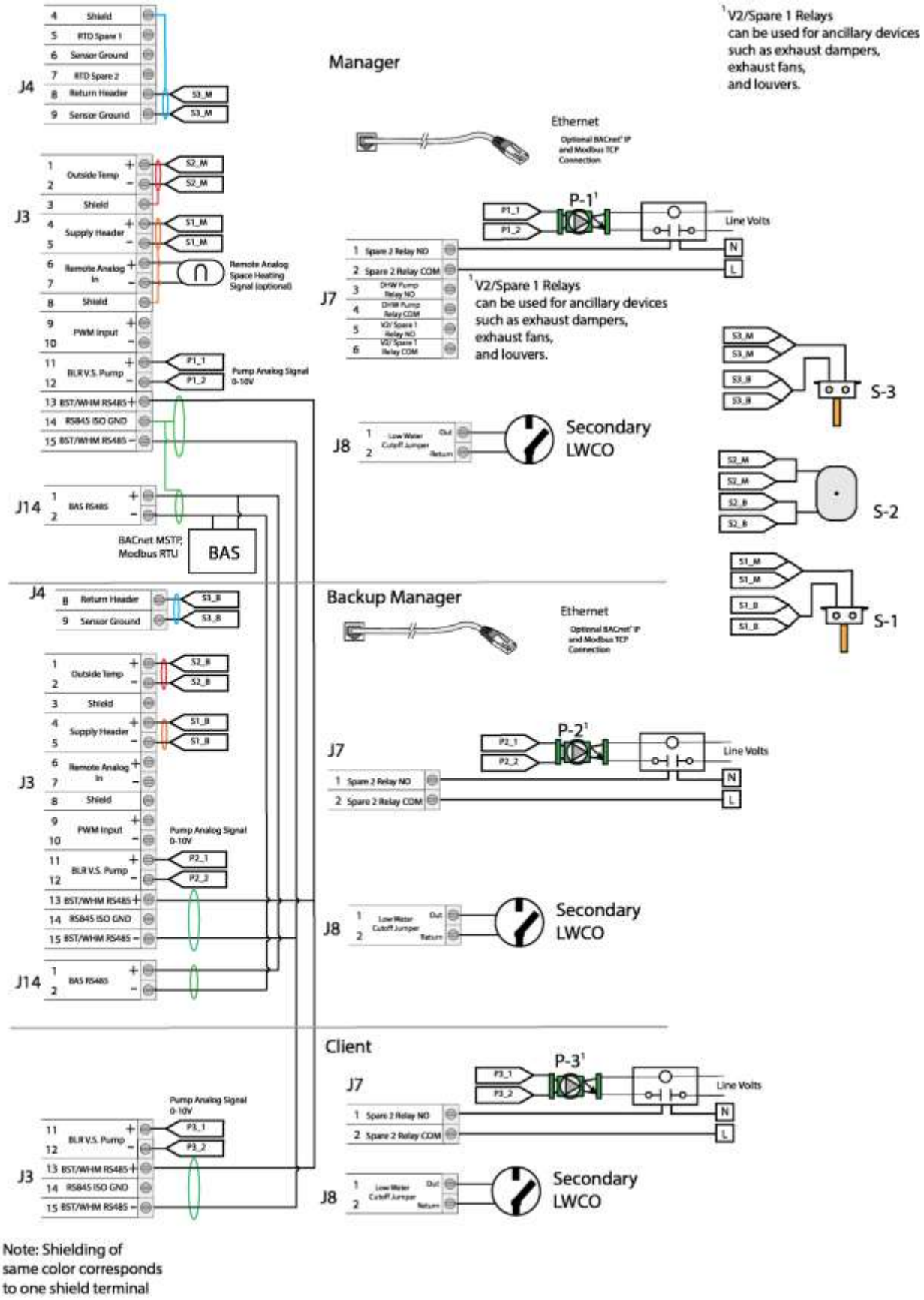


Diagram 4-2b: Space Heating (Primary-Secondary) Wiring

4.3 Combination Plant with One Swing Valve and 2-port Buffer Tank

Application Description & Features: Combination plant consists of Benchmark boilers, operated via Boiler Sequencing Technology (BST) to provide space heating. Supply temperature is maintained via constant setpoint, outdoor air reset or remote setpoint command (from building automation system or remote analog signal). Domestic hot water is generated using AERCO SmartPlate EV water heaters; DHW boiler sensor is used for controlling domestic boiler loop temperature. Swing boiler is assigned to serve the water heater by default and assist in space heating when domestic hot water load is satisfied. Swing valve separates boilers serving domestic hot water from space heating. DHW boiler pump runs continuously to provide boiler water to the water heaters. 2-port buffer tank is utilized to dampen out fast domestic load transitions and minimize boiler cycling. Application utilizes AERCO supplied header sensor, sequencing valves and outdoor air sensor; return header sensor is optional.

- The AERCO Edge Controller sequences the boiler plant for maximum system efficiency by running as many boilers as available, each operating at its most efficient firing rate.
- The swing boiler serves the domestic hot water by default and may be used to implement "N+1" sizing method for space heating.
- Sequencing valves isolate standby boilers from the system, reducing the system's minimum flow requirement.
- Edge[ii] controller supports integration with BAS via BACnet MSTP, BACnet IP, Modbus RTU and Modbus TCP.

Essential System Settings

Parameter	Setting
Application	SH+DHW-1-Vlv
SH Operating Mode	Constant Setpoint, Outdoor Air Reset or Remote Setpoint
DHW Operating Mode	Constant Setpoint
DHW Setup	2 Port Tank
DHW Pump Control Type	Constant On
CASCADE CONFIGURATION-Hdr Temp Sensor	Direct
CASCADE CONFIGURATION-Outdoor Air Temp Sensor *(If SH Operating Mode=Outdoor Air Reset)*	Direct
VALVE CONFIGURATION-Select Output	Cascade Valve
VALVE CONFIGURATION-Valve Feedback	Enabled
Unit Address for B-1 *(in this piping diagram)*	1
Unit Address for B-2 *(in this piping diagram)*	2
Unit Address for B-3 *(in this piping diagram)*	3
Unit 1 Designation	SH
Unit 2 Designation	SH
Unit 3 Designation	Swing
Default Swing Boiler Load	Swing Default DHW

Legend:

S-1 = Header Sensor

S-2 = Outdoor Air Sensor

S-3 = Return Sensor
P-1a, P-1b = System Pump(s)
V-1, V-2, V-3 = Sequencing Valves
P-2 = Combination System Pump

DHW = DHW Boiler Sensor
SV = Swing Valve

Load	Swing Valve	Swing Boiler B-3 DHW Priority	Combination System Pump
SH ≤ 100% DHW ≤ 100%	Close	DHW	ON
SH ≤ 100% DHW = None	Close	Standby	ON
SH = 100% DHW = None	Open	Space Heating	ON

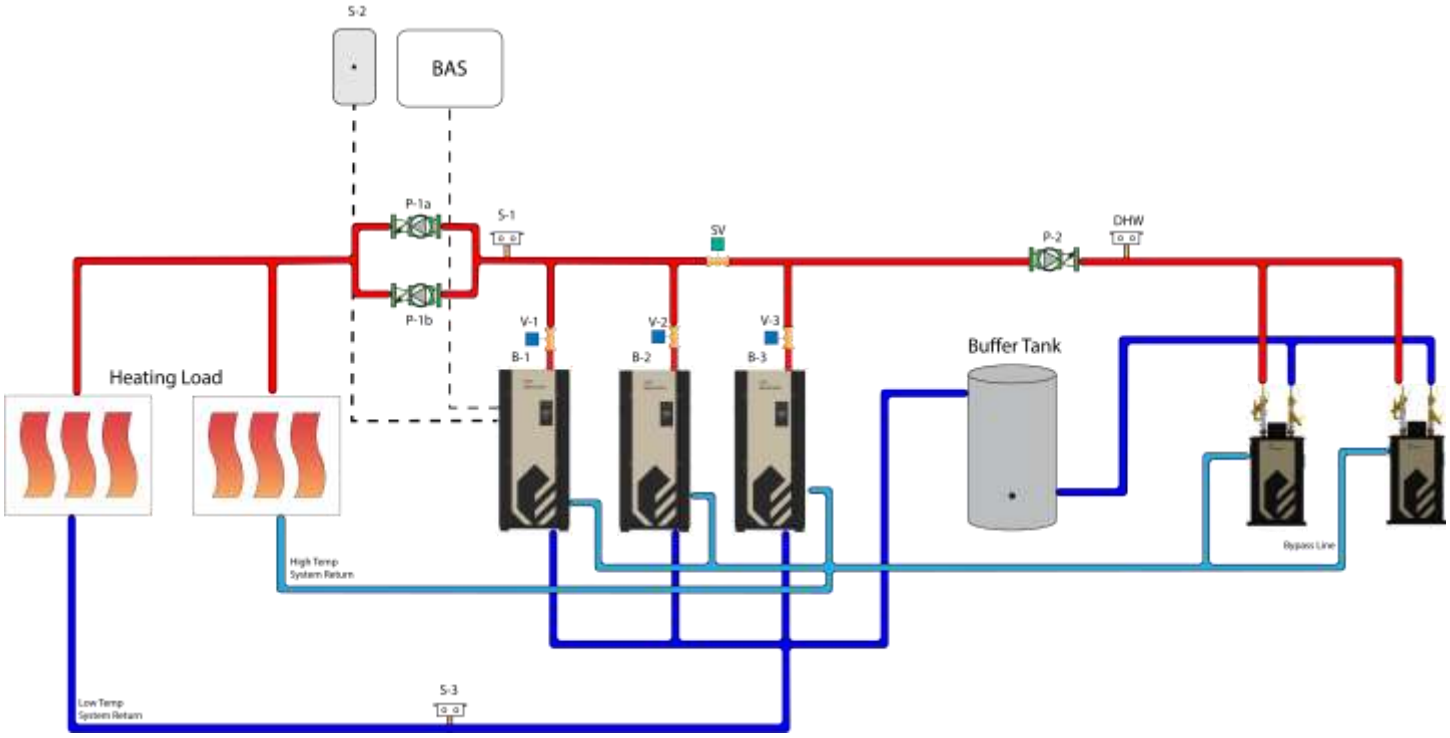


Diagram 4-3a: Combination Plant with One Swing Valve and 2-Port Buffer Tank Piping

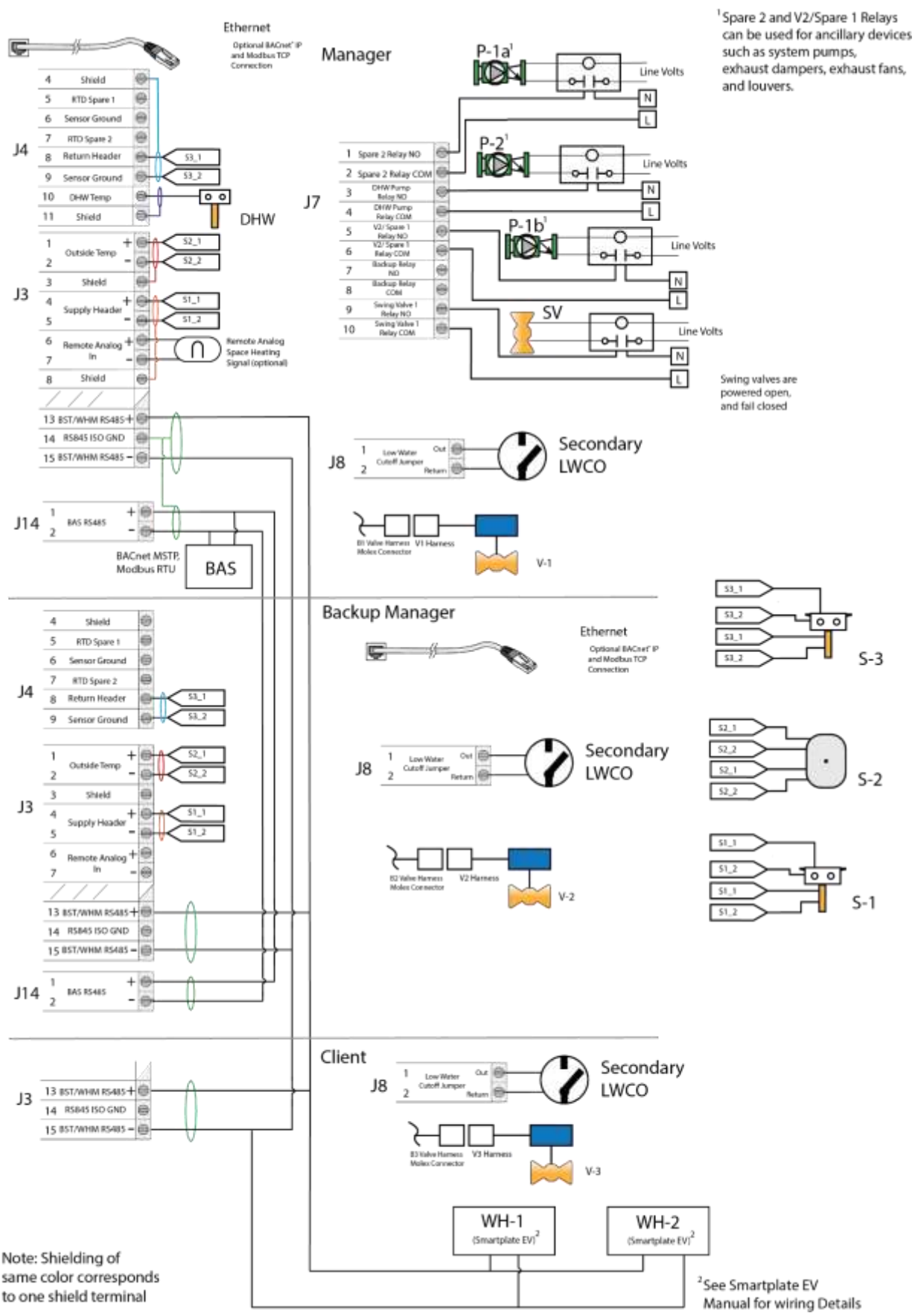


Diagram 4-3b: Combination Plant with One Swing Valve and 2-Port Buffer Tank Wiring

4.4 Combination Plant with One Swing Valve and 4-port Buffer Tank

Application Description & Features: Combination boiler plant serves space heating and domestic hot water generation through AERCO SmartPlate EV water heaters. Benchmark boilers are operated via Boiler Sequencing Technology (BST) to provide space heating. Space heating supply temperature is maintained as constant setpoint, via outdoor air reset or from remote setpoint command (from building automation system or via remote analog signal). Swing boiler is assigned to serve the water heater by default and assist in space heating when domestic hot water load is satisfied. Swing valve separates boilers serving domestic hot water from space heating. Combination system pump is controlled by the DHW temperature sensor; DHW pump runs continuously to provide boiler water to the water heaters. 4-port buffer tank is utilized to dampen out fast domestic load transitions and minimize boiler cycling. Application utilizes AERCO supplied header sensor, sequencing valves and outdoor air sensor; return header sensor is optional.

- The Edge Controller sequences the boiler plant to obtain maximum system efficiency by running as many boilers as available, each operating at its most efficient firing rate.
- The swing boiler serves the domestic hot water by default and may be used to implement "N+1" sizing method for space heating.
- Sequencing valves isolate standby boilers from the system, reducing the system's minimum flow requirement.
- Edge[ii] controller supports integration with BAS via BACnet MSTP, BACnet IP, Modbus RTU and Modbus TCP.

Essential System Settings:

Parameter	Setting
Application	SH+DHW-1-Vlv
SH Operating Mode	Constant Setpoint, Outdoor Air Reset or Remote Setpoint
DHW Operating Mode	Constant Setpoint
DHW Setup	4 Port Tank
DHW Pump Control Type	Controlled
CASCADE CONFIGURATION-Hdr Temp Sensor	Direct
CASCADE CONFIGURATION-Outdoor Air Temp Sensor *(If SH Operating Mode=Outdoor Air Reset)*	Direct
VALVE CONFIGURATION-Select Output	Cascade Valve
VALVE CONFIGURATION-Valve Feedback	Enabled
Unit Address for B-1 *(in this piping diagram)*	1
Unit Address for B-2 *(in this piping diagram)*	2
Unit Address for B-3 *(in this piping diagram)*	3
Unit 1 Designation	SH
Unit 2 Designation	SH
Unit 3 Designation	Swing
Default Swing Boiler Load	Swing Default SH

Legend:

S-1 = Header Sensor

S-2 = Outdoor Air Sensor

S-3 = Return Sensor
P-1a, P-1b = System Pump(s)
V-1, V-2, V-3 = Sequencing Valves
P-2 = Combination System Pump

P-3 = DHW Pump
DHW = DHW Boiler Sensor
SV = Swing Valve

Load	Swing Valve	Swing Boiler B-3 DHW Priority	Combination System Pump
SH ≤ 100% DHW ≤ 100%	Close	DHW	ON
SH ≤ 100% DHW = None	Close	Standby	OFF
SH = 100% DHW = None	Open	Space Heating	OFF

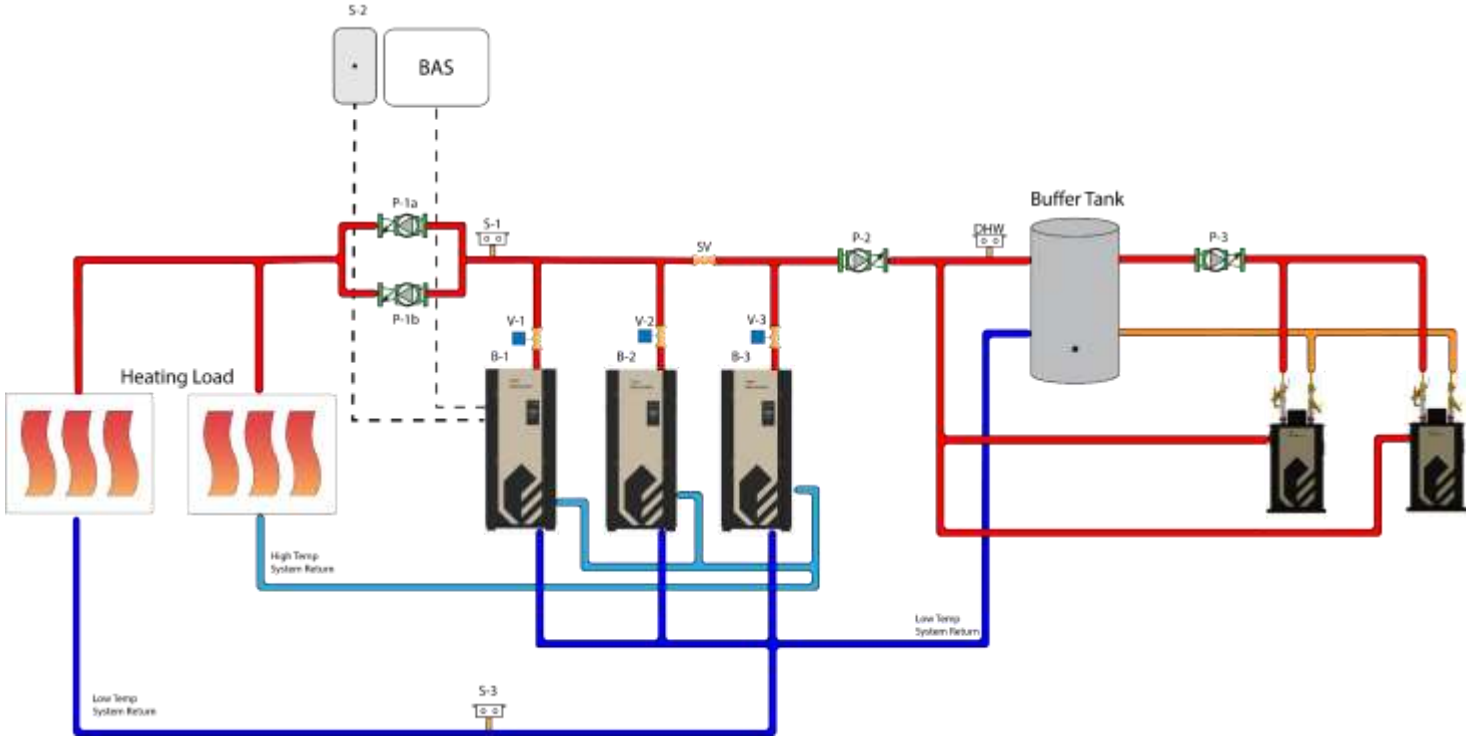


Diagram 4-4a: Combination Plant with One Swing Valve and 4-Port Buffer Tank Piping

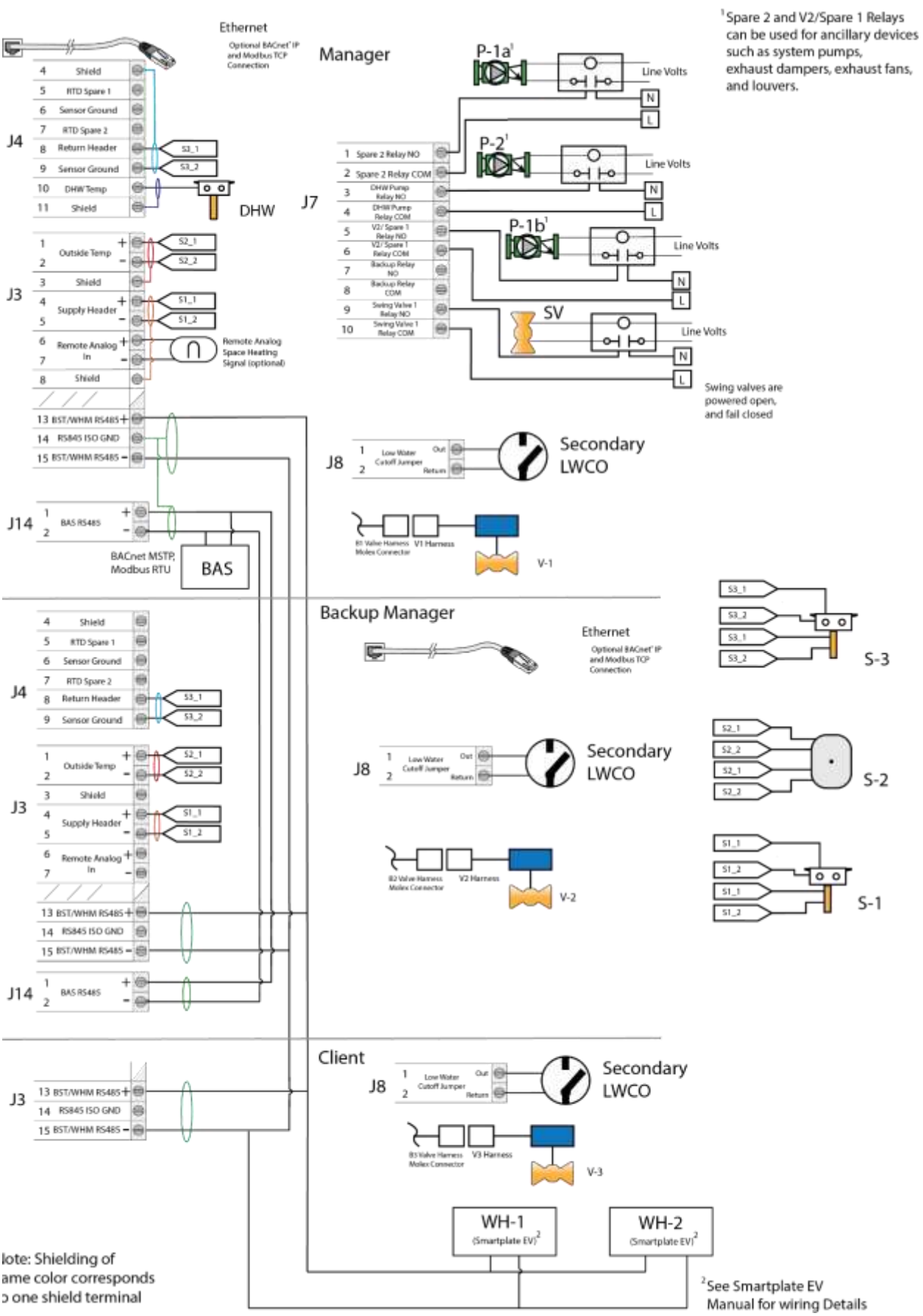


Diagram 4-4b: Combination Plant with One Swing Valve and 4-Port Buffer Tank Wiring

4.5 Combination Plant with 1 Swing Valve + Indirect Storage Tank Water Heater

Application Description & Features: Combination plant consists of AERCO Benchmark boilers, operated via Boiler Sequencing Technology (BST) to provide space heating. Supply temperature is maintained via constant setpoint, outdoor air reset or remote setpoint command (from building automation system or remote analog signal). Domestic hot water is generated using an indirect storage tank water heater. Swing boiler is assigned to serve the water heater by default and assist in space heating when domestic hot water load is satisfied. Swing valve separates boilers serving domestic hot water from space heating. DHW boiler pump is controlled by aquastat to provide boiler water to the indirect storage tank water heater. Application utilizes AERCO supplied header sensor, sequencing valves and outdoor air sensor; return header sensor is optional.

- The Edge controller sequences the boiler plant to obtain maximum system efficiency by running as many boilers as available, each operating at its most efficient firing rate.
- The swing boiler assists in space heating when domestic hot water load is satisfied.
- Sequencing valves isolate standby boilers from the system, reducing the system's minimum flow requirement.
- Edge[ii] controller supports integration with BAS via BACnet MSTP, BACnet IP, Modbus RTU and Modbus TCP.

Essential System Settings:

Parameter	Setting
Application	SH+DHW-1-Vlv
SH Operating Mode	Constant Setpoint, Outdoor Air Reset or Remote Setpoint
DHW Operating Mode	Constant Setpoint
DHW Setup	Indirect Tank
DHW Pump Control Type	Controlled
DHW Aquastat Enable	Enabled
DHW Temp Sensor	Off
CASCADE CONFIGURATION-Hdr Temp Sensor	Direct
CASCADE CONFIGURATION-Outdoor Air Temp Sensor *(If SH Operating Mode=Outdoor Air Reset)*	Direct
VALVE CONFIGURATION-Select Output	Cascade Valve
Unit Address for B-1 *(in this piping diagram)*	1
Unit Address for B-2 *(in this piping diagram)*	2
Unit Address for B-3 *(in this piping diagram)*	3
Unit 1 Designation	SH
Unit 2 Designation	SH
Unit 3 Designation	Swing
Default Swing Boiler Load	Swing Default DHW

Legend:

S-1 = Header Sensor

S-2 = Outdoor Air Sensor

S-3 = Return Sensor
P-1a, P-1b = System Pump(s)
V-1, V-2, V-3 = Sequencing Valves
P-2 = Combination System Pump
SV = Swing Valve

Load	Swing Valve	Swing Boiler B-3 DHW Priority	Combination System Pump
SH ≤ 100% DHW ≤ 100%	Close	DHW	ON
SH ≤ 100% DHW = None	Close	Standby	OFF
SH = 100% DHW = None	Open	Space Heating	OFF

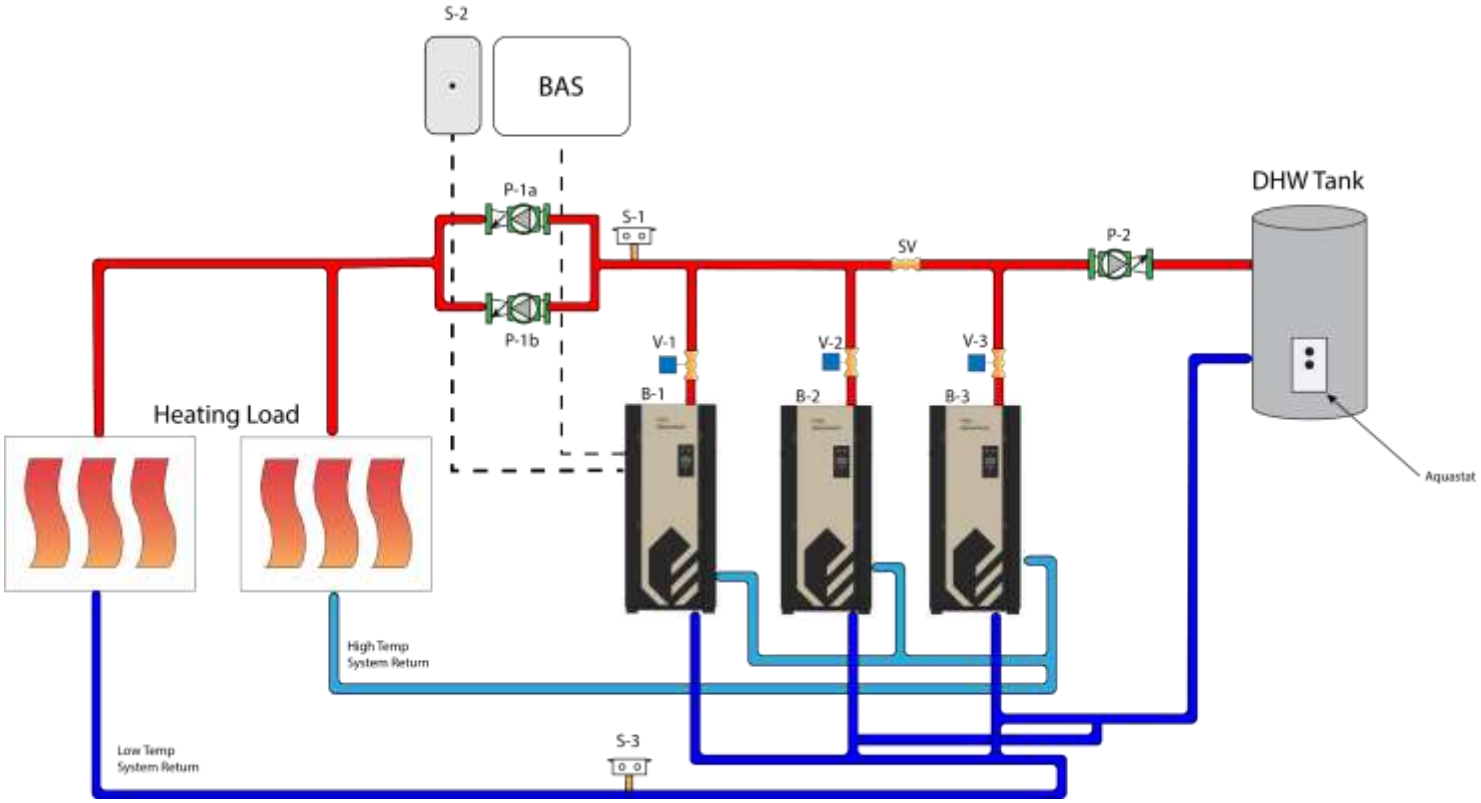


Diagram 4-5a: Combination Plant with One Swing Valve and Domestic Hot Water System Piping

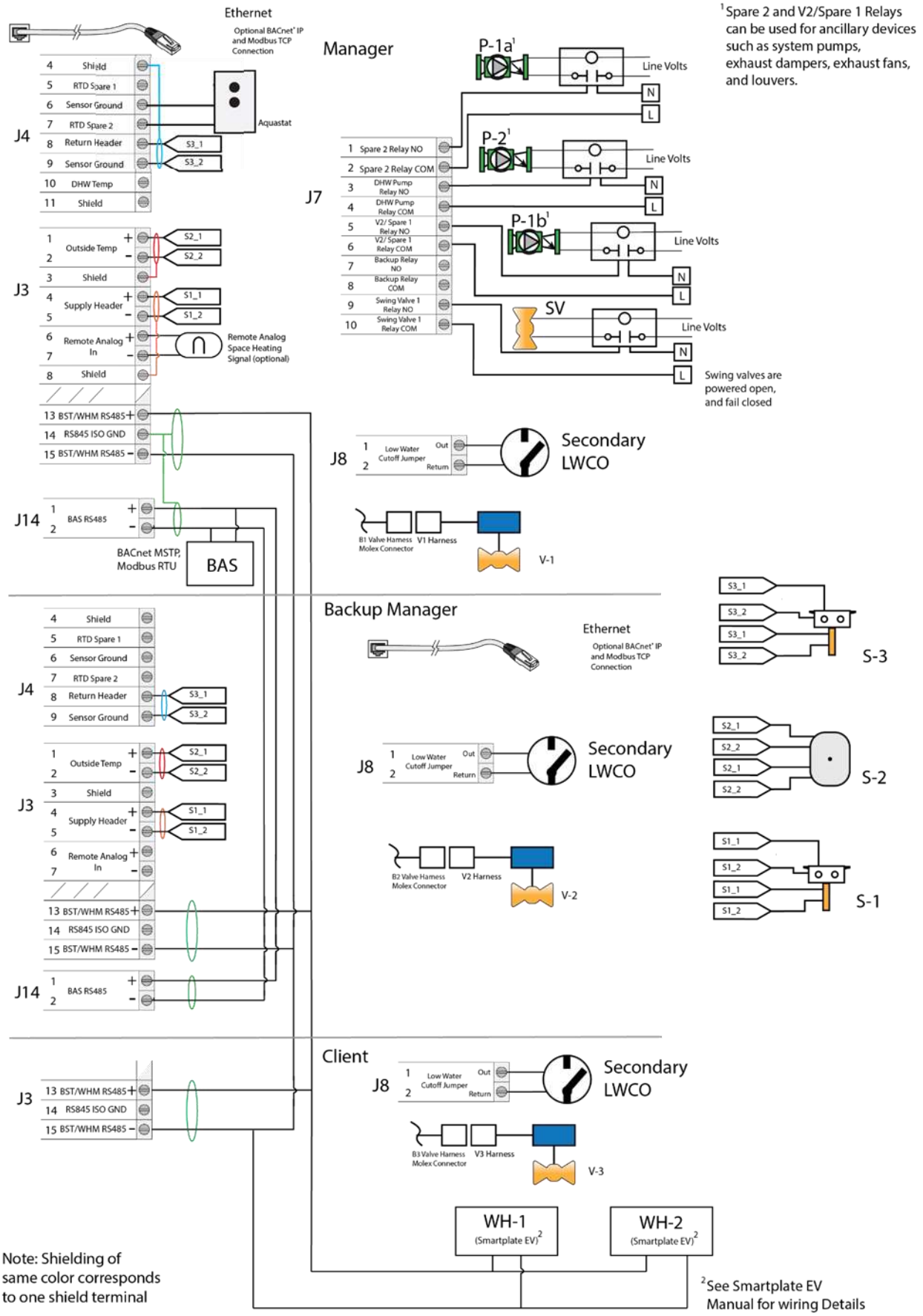


Diagram 4-5b: Combination Plant with One Swing Valve and Domestic Hot Water System Wiring

4.6 Combination Plant with Two Swing Valves and 2-port Buffer Tank

Application Description & Features: Combination plant consists of AERCO Benchmark boilers, operated via Boiler Sequencing Technology (BST) to provide space heating. Supply temperature is maintained via constant setpoint, outdoor air reset or remote setpoint command (from building automation system or remote analog signal). Domestic hot water is generated using AERCO SmartPlate EV water heaters; DHW boiler sensor is used for controlling domestic boiler loop temperature. A boiler is dedicated to serve the domestic hot water load. Swing boiler is assigned to serve space heating by default and assist the domestic hot water load. Swing valves separate the heating, swing and domestic boilers. DHW boiler pump runs continuously to provide boiler water to the water heaters. 2-port buffer tank is utilized to dampen out fast domestic load transitions and minimize boiler cycling. Application utilizes AERCO supplied header sensor, sequencing valves and outdoor air sensor; return header sensor is optional.

- The Edge Controller sequences the boiler plant to obtain maximum system efficiency by running as many boilers as available, each operating at its most efficient firing rate.
- The swing boiler provides redundancy to domestic hot water boiler
- Sequencing valves isolate standby boilers from the system, reducing the system's minimum flow requirement.
- Edge[ii] controller supports integration with BAS via BACnet MSTP, BACnet IP, Modbus RTU and Modbus TCP.

Essential System Settings:

Parameter	Setting
Application	SH+DHW-2-Vlv
SH Operating Mode	Constant Setpoint, Outdoor Air Reset or Remote Setpoint
DHW Operating Mode	Constant Setpoint
DHW Setup	2 Port Tank
DHW Pump Control Type	Constant On
CASCADE CONFIGURATION-Hdr Temp Sensor	Direct
CASCADE CONFIGURATION-Outdoor Air Temp Sensor *(If SH Operating Mode=Outdoor Air Reset)*	Direct
VALVE CONFIGURATION-Select Output	Cascade Valve
VALVE CONFIGURATION-Valve Feedback	Enabled
Unit Address for B-1 *(in this piping diagram)*	1
Unit Address for B-2 *(in this piping diagram)*	2
Unit Address for B-3 *(in this piping diagram)*	3
Unit 1 Designation	SH
Unit 2 Designation	Swing
Unit 3 Designation	DHW
Default Swing Boiler Load	Swing Default SH

Legend:

S-1 = Header Sensor

S-2 = Outdoor Air Sensor

S-3 = Return Sensor

P-1a, P-1b = System Pump(s)
V-1, V-2, V-3 = Sequencing Valves
P-2 = Combination System Pump

DHW = DHW Boiler Sensor
SV-1 = Swing Valve #1
SV-2 = Swing Valve #2

Load	Swing Valve #1	Swing Valve #2	Swing Boiler	DHW Boiler	Combination System Pump
SH ≤ 100% DHW ≤ 100%	Close	Open	Space Heating	DHW	ON
SH < 100% DHW = None	Close	Open	Space Heating	Standby	ON
SH = 100% DHW = None	Open	Open	Space Heating	Space Heating	ON
SH < 100% DHW > 90%, (10 min)	Open	Close	DHW	DHW	ON

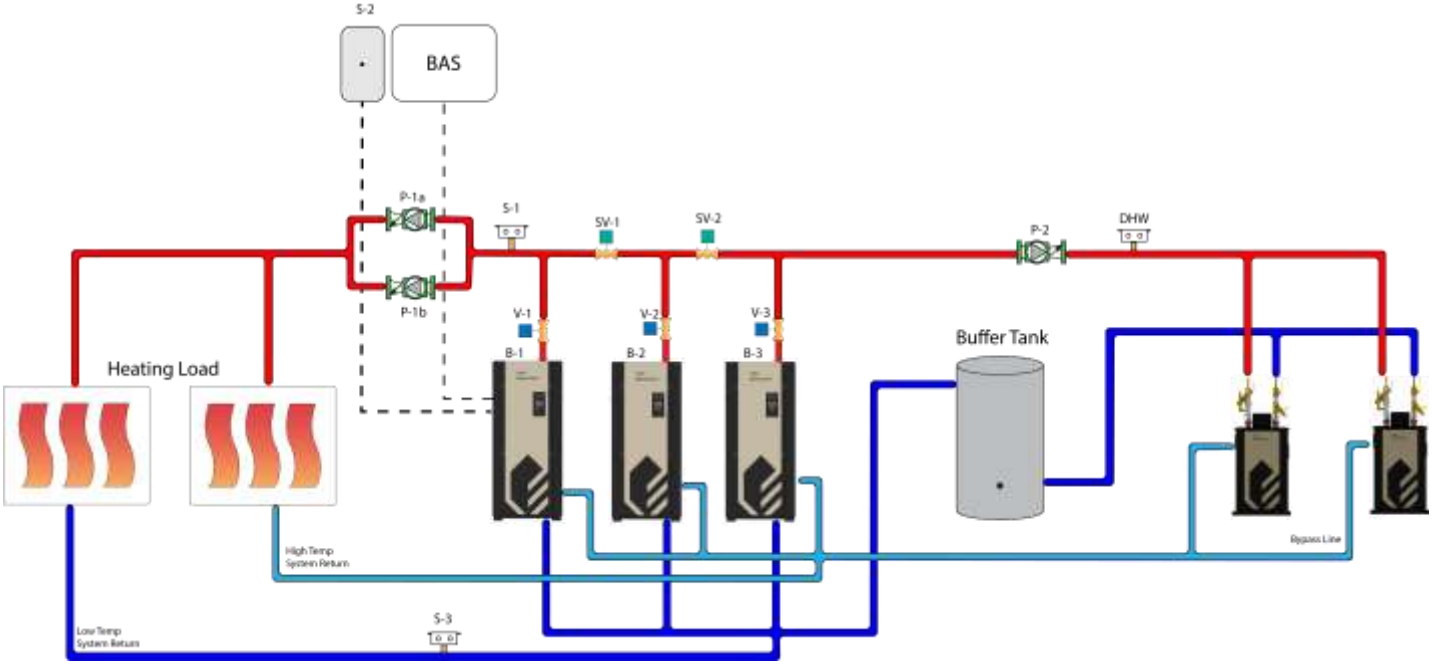


Diagram 4-6a: Combination Plant with Two Swing Valves and 2-Port Buffer Tank Piping

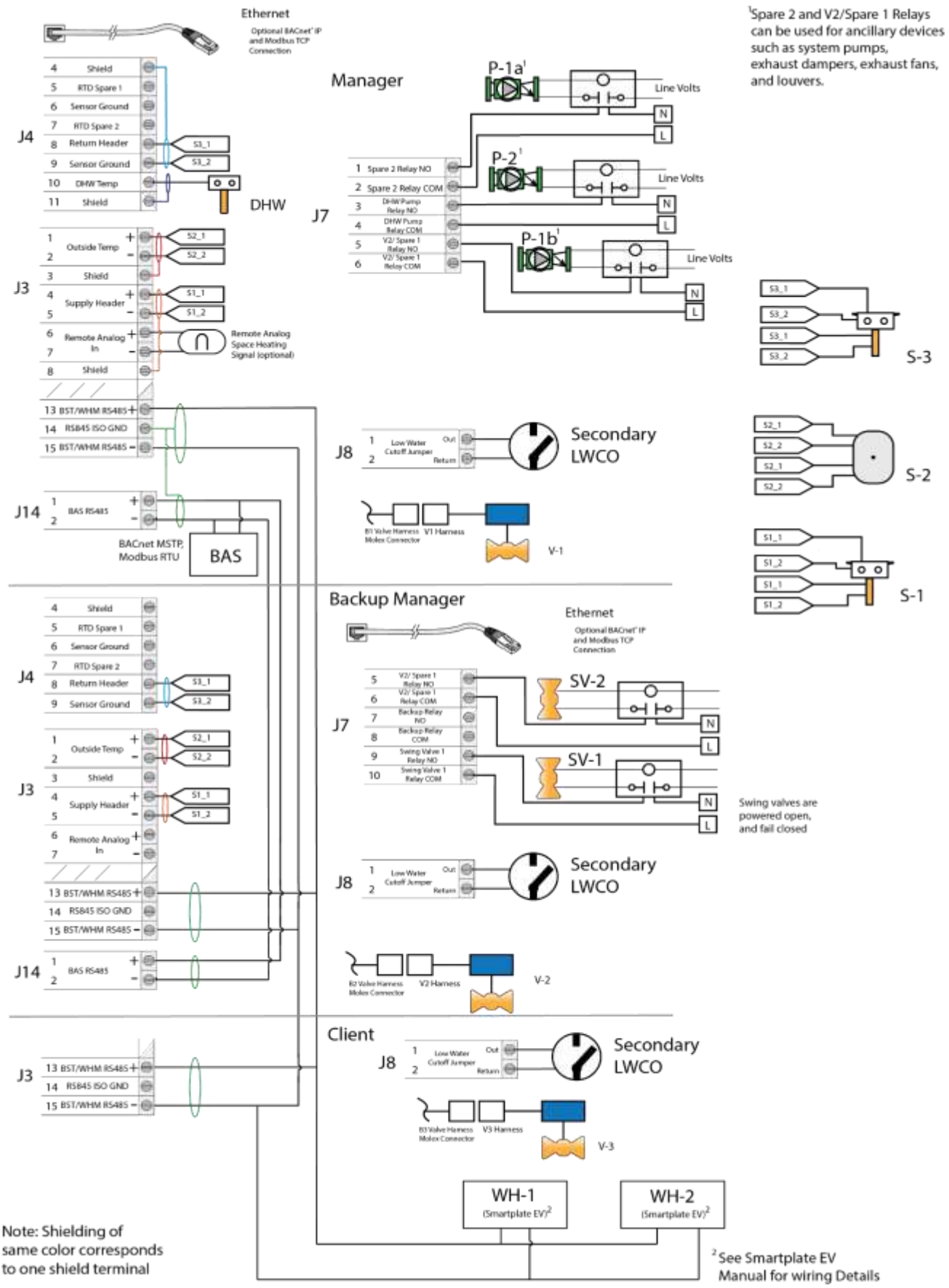


Diagram 4-6b: Combination Plant with Two Swing Valves and 2-Port Buffer Tank Wiring

4.7 Combination Plant with Two Swing Valves and 4-port Buffer Tank

Application Description & Features: Combination plant consists of AERCO Benchmark boilers, operated via Boiler Sequencing Technology (BST) to provide space heating. Supply temperature is maintained via constant setpoint, outdoor air reset or remote setpoint command (from building automation system or remote analog signal). Domestic hot water is generated using AERCO SmartPlate EV water heaters. A boiler is dedicated to serve the domestic hot water load. Swing boiler is assigned to serve space heating by default and assist the domestic hot water load. Swing valves separate the heating, swing and domestic boilers. DHW boiler sensor is used for controlling domestic boiler loop temperature and the combination system pump. DHW boiler pump is enabled externally and runs continuously to provide boiler water to the water heaters. 4-port buffer tank is utilized to dampen out fast domestic load transitions and minimize boiler cycling. Application utilizes AERCO supplied header sensor, sequencing valves and outdoor air sensor; return header sensor is optional.

- The Edge Controller sequences the boiler plant to obtain maximum system efficiency by running as many boilers as available, each operating at its most efficient firing rate.
- The swing boiler provides redundancy to domestic hot water boiler.
- Sequencing valves isolate standby boilers from the system, reducing the system's minimum flow requirement.
- Edge[ii] controller supports integration with BAS via BACnet MSTP, BACnet IP, Modbus RTU and Modbus TCP.

Essential System Settings:

Parameter	Setting
Application	SH+DHW-2-Vlv
SH Operating Mode	Constant Setpoint, Outdoor Air Reset or Remote Setpoint
DHW Operating Mode	Constant Setpoint
DHW Setup	4 Port Tank
DHW Pump Control Type	Controlled
CASCADE CONFIGURATION-Hdr Temp Sensor	Direct
CASCADE CONFIGURATION-Outdoor Air Temp Sensor *(If SH Operating Mode=Outdoor Air Reset)*	Direct
VALVE CONFIGURATION-Select Output	Cascade Valve
VALVE CONFIGURATION-Valve Feedback	Enabled
Unit Address for B-1 *(in this piping diagram)*	1
Unit Address for B-2 *(in this piping diagram)*	2
Unit Address for B-3 *(in this piping diagram)*	3
Unit 1 Designation	SH
Unit 2 Designation	Swing
Unit 3 Designation	DHW
Default Swing Boiler Load	Swing Default SH

Load	Swing Valve #1	Swing Valve #2	Swing Boiler	DHW Boiler	Combination System Pump
SH ≤ 100% DHW ≤ 100%	Close	Open	Space Heating	DHW	ON
SH < 100% DHW = None	Close	Open	Space Heating	Standby	OFF
SH = 100% DHW = None	Open	Open	Space Heating	Space Heating	OFF
SH < 100% DHW > 90%, (10 min)	Open	Close	DHW	DHW	ON

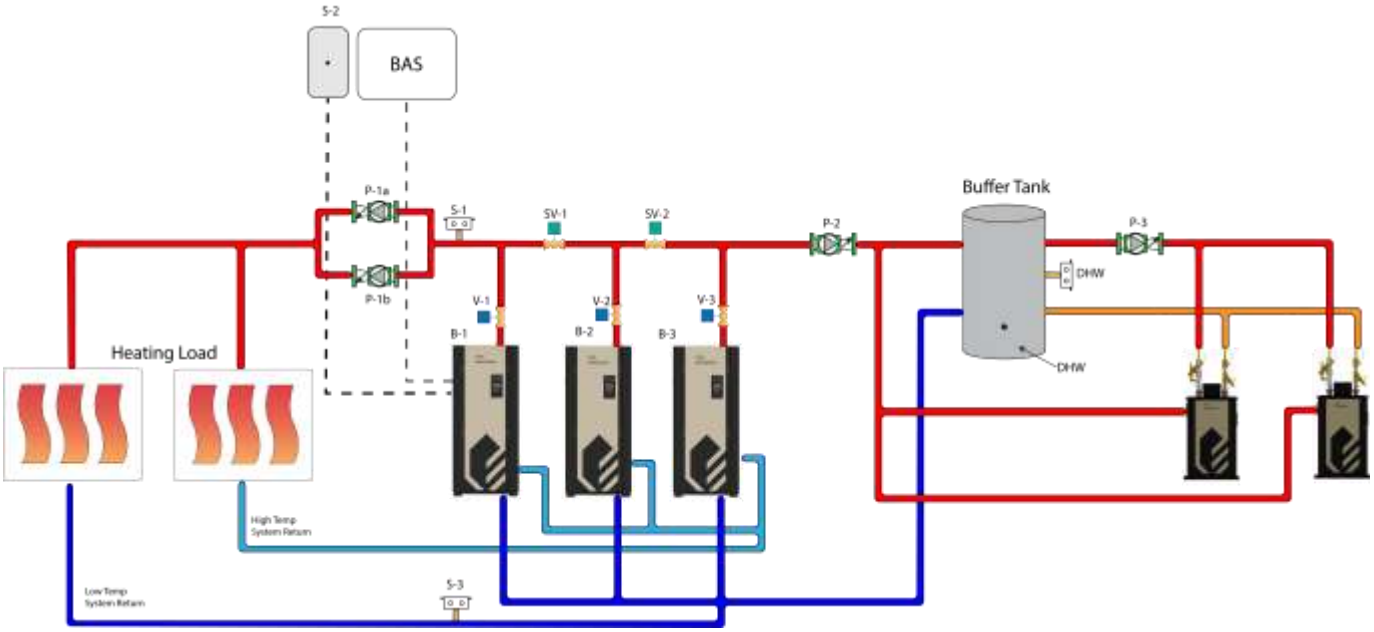


Diagram 4-7a: Combination Plant with Two Swing Valves and 4-Port Buffer Tank Piping

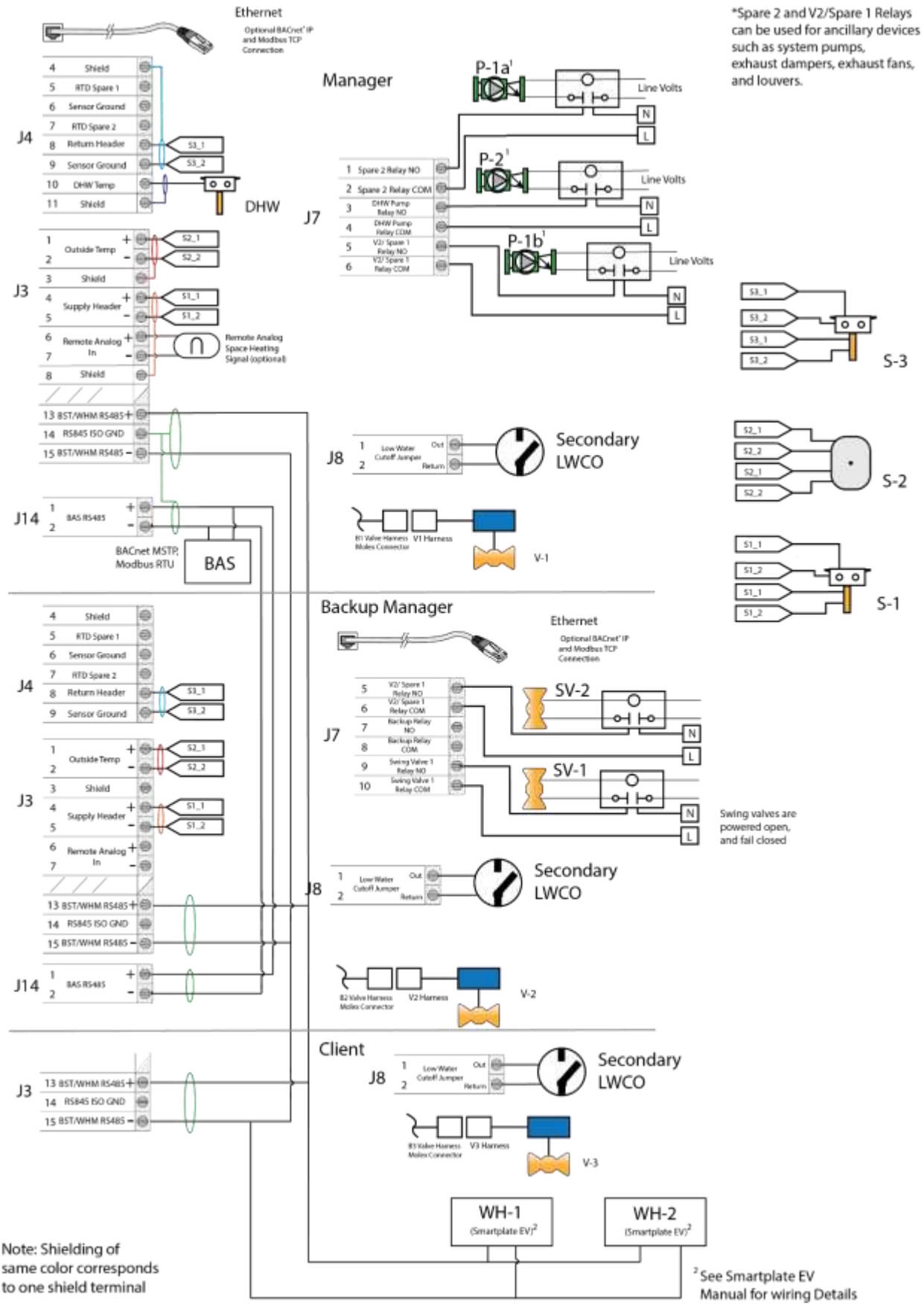


Diagram 4-7b: Combination Plant with Two Swing Valves and 4-Port Buffer Tank Wiring

4.8 Combination Plant with Two Swing Valves and 4-port Buffer Tank (Primary-Secondary Piping)

Application Description & Features: Boiler plant is piped in primary-secondary method with individual boiler pumps. Combination boiler plant serves space heating and domestic hot water generation through AERCO SmartPlate EV water heaters. Benchmark boilers are operated via Boiler Sequencing Technology (BST) to provide space heating. Space heating supply temperature is maintained via constant setpoint, outdoor air reset or from remote setpoint command (from building automation system or remote analog signal). A boiler is dedicated to serve the domestic hot water load. Swing boiler is assigned to serve space heating and assist the domestic hot water load. Swing valves separate the heating, swing and domestic boilers. DHW boiler pump runs continuously to provide boiler water to the water heaters. 4-port buffer tank is utilized to dampen out fast domestic load transitions and minimize boiler cycling. Application utilizes AERCO supplied header sensor, sequencing valves and outdoor air sensor; return header sensor is optional (required if VSP Pump Mode=Return Temp).

- The AERCO Edge Controller sequences the boiler plant for maximum system efficiency by running as many boilers as available, each operating at its most efficient firing rate.
- The swing boiler provides redundancy to domestic hot water boiler.
- Use of variable speed boiler pumps prevents hot water recirculation at the low loss header, resulting to increased efficiency.
- Edge[ii] controller supports integration with BAS via BACnet MSTP, BACnet IP, Modbus RTU and Modbus TCP.

Note: For more information on variable speed pump control modes, consult Edge [ii] Controls Manual OMM-0139.

Essential System Settings:

Parameter	Setting
Application	SH+DHW-2-Vlv
SH Operating Mode	Constant Setpoint, Outdoor Air Reset or Remote Setpoint
DHW Operating Mode	Constant Setpoint
DHW Setup	4 Port Tank
DHW Pump Control Type	Constant On
CASCADE CONFIGURATION-Hdr Temp Sensor	Direct
CASCADE CONFIGURATION-Outdoor Air Temp Sensor *(If SH Operating Mode=Outdoor Air Reset)*	Direct
VSP Pump Mode	Return Temp (Return Sensor Required) or Fire Rate
VSP Piping Configuration	1 Pump Per Blr
Unit Address for B-1 *(in this piping diagram)*	1
Unit Address for B-2 *(in this piping diagram)*	2
Unit Address for B-3 *(in this piping diagram)*	3
Unit 1 Designation	SH
Unit 2 Designation	Swing
Unit 3 Designation	DHW
Default Swing Boiler Load	Swing Default SH

Legend:
S-1 = Header Sensor

S-2 = Outdoor Air Sensor
S-3 = Return Sensor
P-1, P-2, P-3 = Boiler Pumps
V-1, V-2, V-3 = Sequencing Valves
P-4 = DHW Pump

DHW = DHW Boiler Sensor
SV-1 = Swing Valve #1
SV-2 = Swing Valve #2

Load	Swing Valve #1	Swing Valve #2	Swing Boiler	DHW Boiler	DHW Pump
SH ≤ 100% DHW ≤ 100%	Close	Open	Space Heating	DHW	ON
SH < 100% DHW = None	Close	Open	Space Heating	Standby	ON
SH = 100% DHW = None	Open	Open	Space Heating	Space Heating	ON
SH < 100% DHW > 90%, (10 min)	Open	Close	DHW	DHW	ON

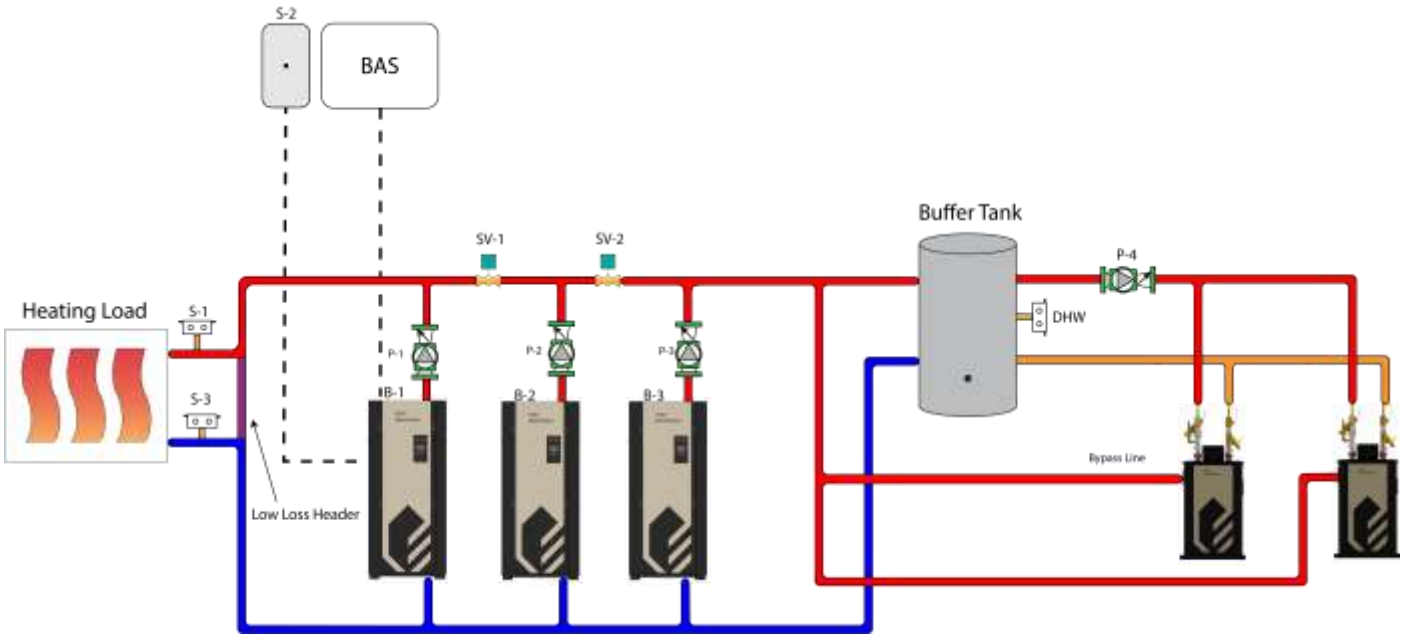


Diagram 4-8a: Combination Plant with Two Swing Valves and 4-Port Buffer Tank (Primary-Secondary) Piping

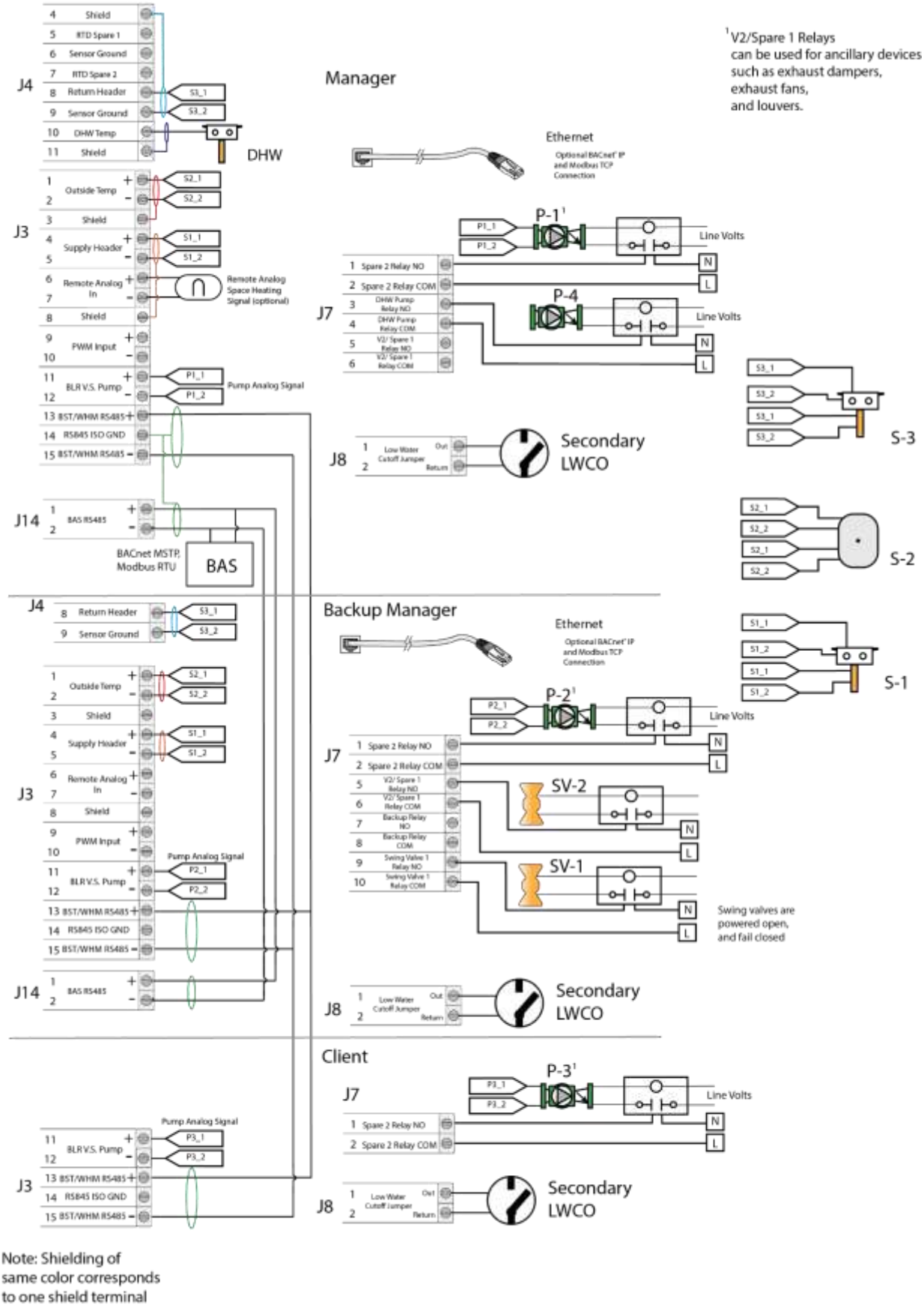


Diagram 4-8b: Combination Plant with Two Swing Valves and 4-Port Buffer Tank (Primary-Secondary) Wiring

4.9 Combination Plant with 2 Swing Valves + Domestic Hot Water Tank

Application Description & Features: Combination plant consists of AERCO Benchmark boilers, operated via Boiler Sequencing Technology (BST) to provide space heating. Supply temperature is maintained via constant setpoint, outdoor air reset or remote setpoint command (from building automation system or remote analog signal). Domestic hot water is generated using an indirect storage tank water heater. A boiler is dedicated to serve the domestic hot water load. Swing boiler is assigned to serve space heating by default and assist the domestic hot water load. Swing valves separate the heating, swing and domestic boilers. DHW boiler pump is controlled by an aquastat to provide boiler water to the indirect storage tank water heater. Application utilizes AERCO supplied header sensor, sequencing valves and outdoor air sensor; return header sensor is optional.

- The AERCO Edge Controller sequences the boiler plant for maximum system efficiency by running as many boilers as available, each operating at its most efficient firing rate.
- The swing boiler provides redundancy to domestic hot water boiler.
- Sequencing valves isolate standby boilers from the system, reducing the system's minimum flow requirement.
- Edge[ii] controller supports integration with BAS via BACnet MSTP, BACnet IP, Modbus RTU and Modbus TCP.

Essential System Settings:

Parameter	Setting
Application	SH+DHW-2-Vlv
SH Operating Mode	Constant Setpoint, Outdoor Air Reset or Remote Setpoint
DHW Operating Mode	Constant Setpoint
DHW Setup	Indirect Tank
DHW Pump Control Type	Controlled
DHW Aquastat Enable	Enabled
DHW Temp Sensor	Off
CASCADE CONFIGURATION-Hdr Temp Sensor	Direct
CASCADE CONFIGURATION-Outdoor Air Temp Sensor *(If SH Operating Mode=Outdoor Air Reset)*	Direct
VALVE CONFIGURATION-Select Output	Cascade Valve
Unit Address for B-1 (in this piping diagram)	1
Unit Address for B-2 (in this piping diagram)	2
Unit Address for B-3 (in this piping diagram)	3
Unit 1 Designation	SH
Unit 2 Designation	Swing
Unit 3 Designation	DHW
Default Swing Boiler Load	Swing Default SH

Legend:

S-1 = Header Sensor

S-2 = Outdoor Air Sensor

S-3 = Return Sensor

P-1a, P-1b = System Pump(s)
V-1, V-2, V-3 = Sequencing Valves
P-2 = Combination System Pump
SV-1 = Swing Valve #1

SV-2 = Swing Valve #2

Load	Swing Valve #1	Swing Valve #2	Swing Boiler	DHW Boiler	Combination System Pump
SH ≤ 100% DHW ≤ 100%	Close	Open	Space Heating	DHW	ON
SH < 100% DHW = None	Close	Open	Space Heating	Standby	OFF
SH = 100% DHW = None	Open	Open	Space Heating	Space Heating	OFF
SH < 100% DHW > 90%, (10 min)	Open	Close	DHW	DHW	ON

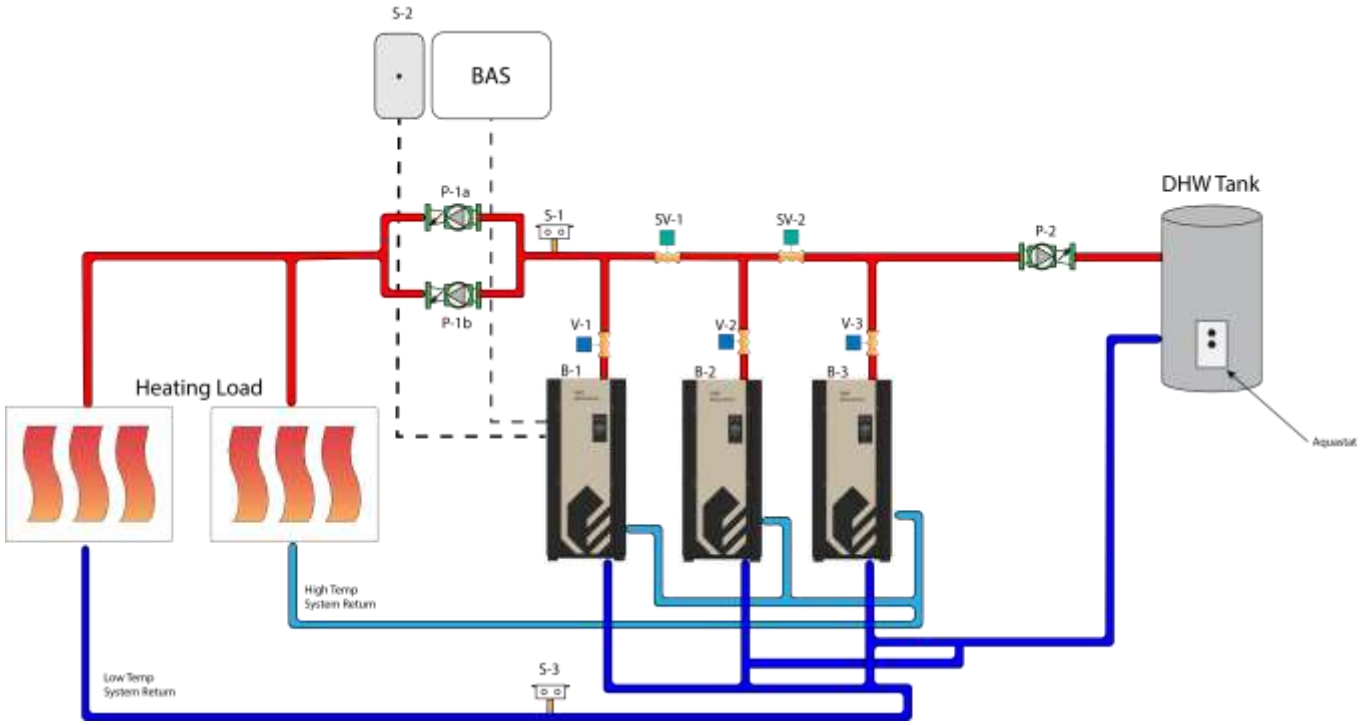


Diagram 4-9a: Combination Plant with Two Swing Valves and Domestic Hot Water Tank Piping

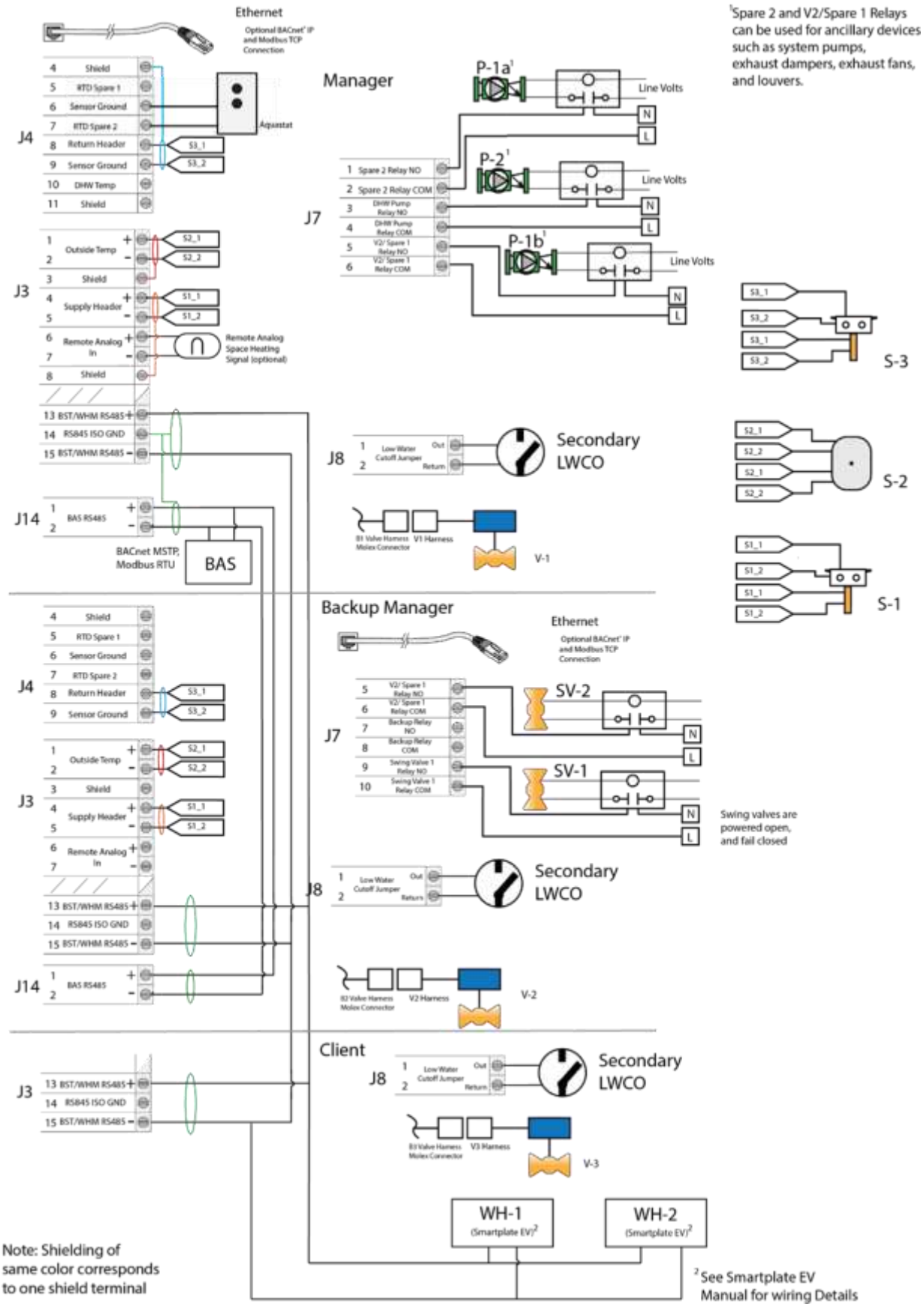


Diagram 4-9b: Combination Plant with Two Swing Valves and Domestic Hot Water Tank Wiring

4.10 Combination System w/ 2-Port Buffer Tank & Domestic Summer Pump Mode

Application Description & Features: AERCO Benchmark boilers are operated via Boiler Sequencing Technology (BST) to provide space heating and domestic hot water generation through AERCO SmartPlate EV water heaters. Space heating supply temperature is maintained as constant setpoint, via outdoor air reset or from remote setpoint command (from building automation system or via remote analog signal). DHW boiler/summer pump runs continuously to provide boiler water to the water heaters. 2-port buffer tank is utilized to dampen out fast domestic load transitions and minimize boiler cycling. Application utilizes AERCO supplied header sensor, sequencing valves and outdoor air sensor; return header sensor is optional.

- The AERCO Edge Controller sequences the boiler plant for maximum system efficiency by running as many boilers as available, each operating at its most efficient firing rate.
- Sequencing valves isolate standby boilers from the system, reducing the system's minimum flow requirement.
- Edge[ii] controller supports integration with BAS via BACnet MSTP, BACnet IP, Modbus RTU and Modbus TCP.

Essential System Settings:

Parameter	Setting
Application	SH+DHW-Stpt Prty
SH Operating Mode	Constant Setpoint, Outdoor Air Reset or Remote Setpoint
DHW Operating Mode	Constant Setpoint
DHW Pump Control Type	Constant On
CASCADE CONFIGURATION-Hdr Temp Sensor	Direct
CASCADE CONFIGURATION-Outdoor Air Temp Sensor *(If SH Operating Mode=Outdoor Air Reset)*	Direct
VALVE CONFIGURATION-Select Output	Cascade Valve
VALVE CONFIGURATION-Valve Feedback	Enabled

Legend:
S-1 = Header Sensor

S-2 = Outdoor Air Sensor
S-3 = Return Sensor
P-1a, P-1b = System Pump(s)
V-1, V-2, V-3 = Sequencing Valves

P-2 = DHW Pump
DHW = DHW Boiler Sensor

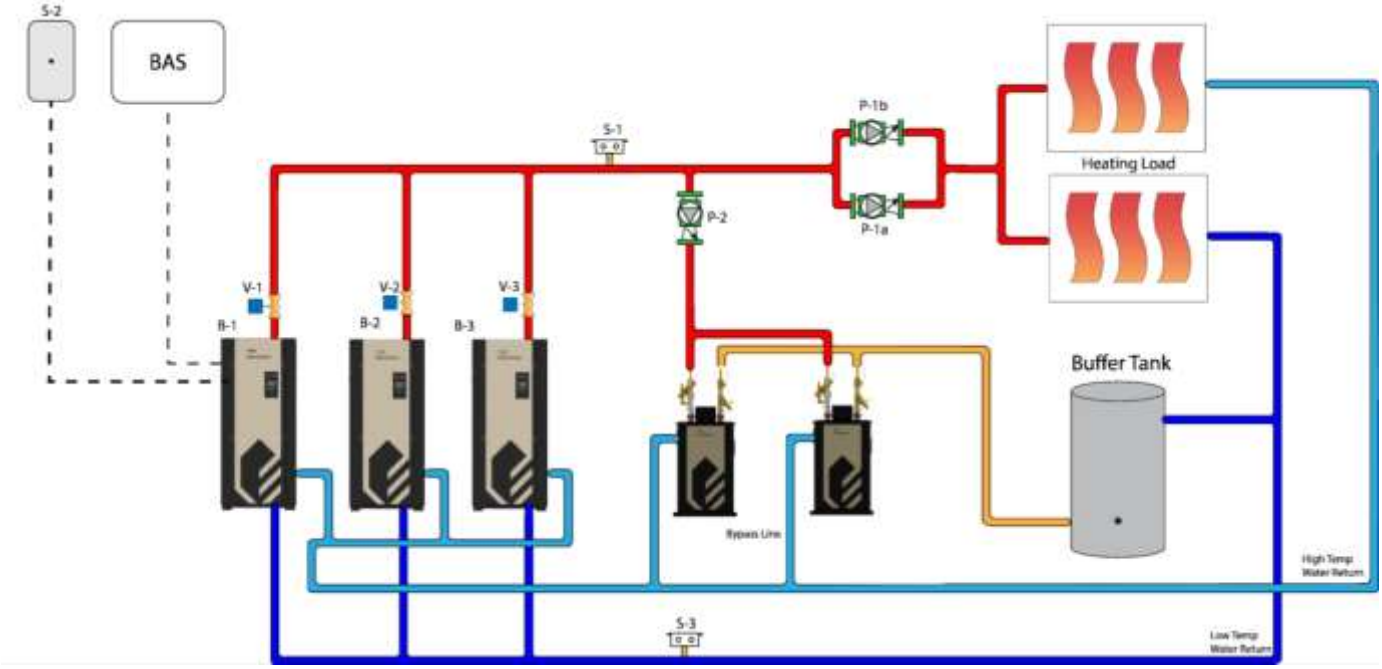


Diagram 4-10a: Combination System with 2-Port Buffer Tank and Domestic Summer Pump Mode Piping

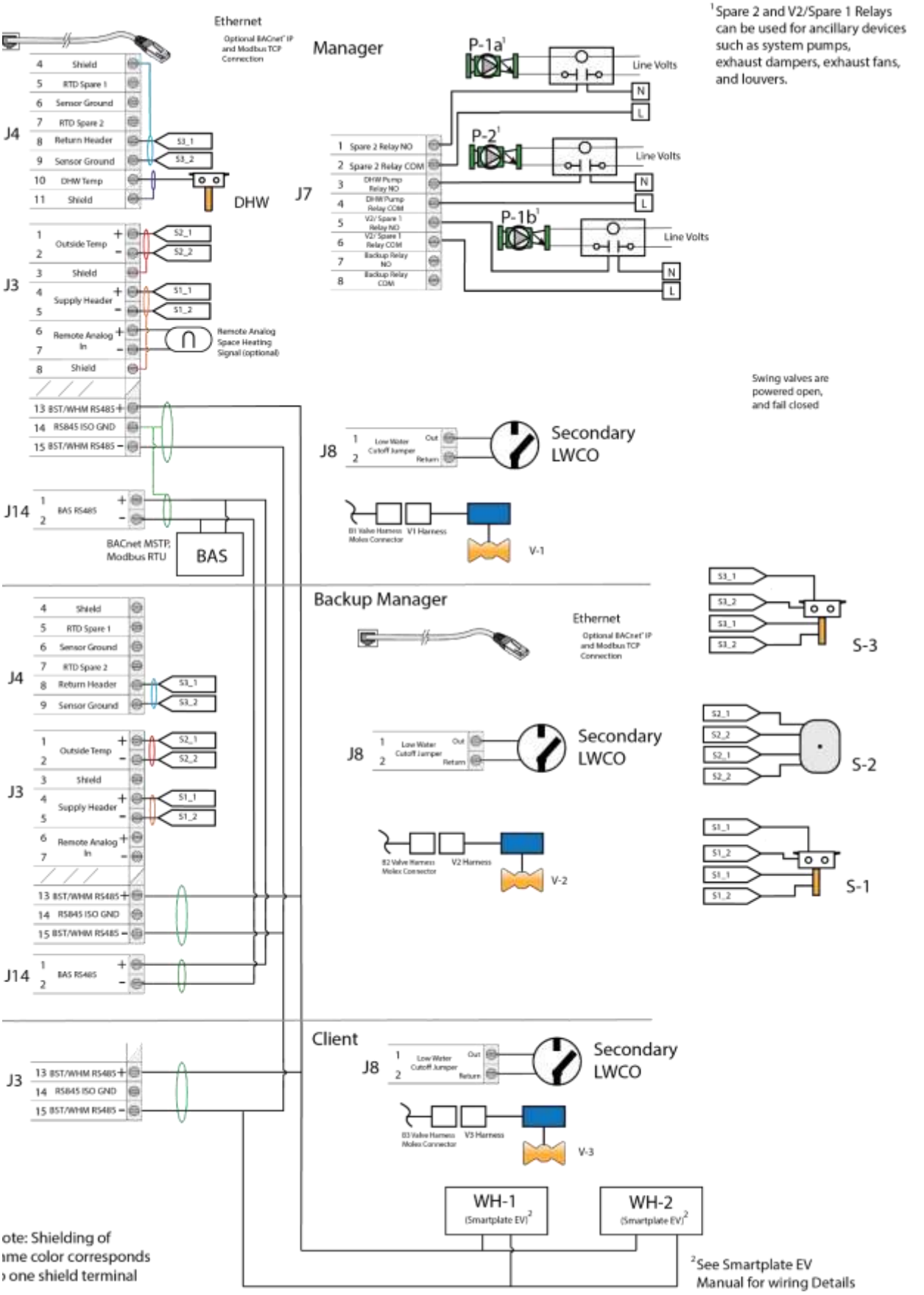


Diagram 4-10b: Space Heating with Temperature Boost and 2-Port Buffer Tank Wiring

4.11 Space Heating with Temperature Boost and 4-port Buffer Tank

Application Description & Features: AERCO Benchmark boilers are operated via Boiler Sequencing Technology (BST) to provide space heating and domestic hot water generation through AERCO SmartPlate EV water heaters. Space heating supply temperature is maintained as constant setpoint, via outdoor air reset or from remote setpoint command (from building automation system or via remote analog signal). Domestic hot water generation setpoint is a priority: temperature setpoint is boosted when header temperature falls below DHW setpoint. DHW pump is controlled by the DHW temperature sensor to provide boiler water to the water heaters. 4-port buffer tank is utilized to dampen out fast domestic load transitions and minimize boiler cycling. Application utilizes AERCO supplied header sensor, sequencing valves and outdoor air sensor; return header sensor is optional.

- The AERCO Edge Controller sequences the boiler plant for maximum system efficiency by running as many boilers as available, each operating at its most efficient firing rate.
- Sequencing valves isolate standby boilers from the system, reducing the system's minimum flow requirement.
- Edge[ii] controller supports integration with BAS via BACnet MSTP, BACnet IP, Modbus RTU and Modbus TCP.

Essential System Settings:

Parameter	Setting
Application	SH+DHW-Stpt Prty
SH Operating Mode	Constant Setpoint, Outdoor Air Reset or Remote Setpoint
DHW Operating Mode	Constant Setpoint
DHW Pump Control Type	Controlled
CASCADE CONFIGURATION-Hdr Temp Sensor	Direct
CASCADE CONFIGURATION-Outdoor Air Temp Sensor *(If SH Operating Mode=Outdoor Air Reset)*	Direct
VALVE CONFIGURATION-Select Output	Cascade Valve
VALVE CONFIGURATION-Valve Feedback	Enabled

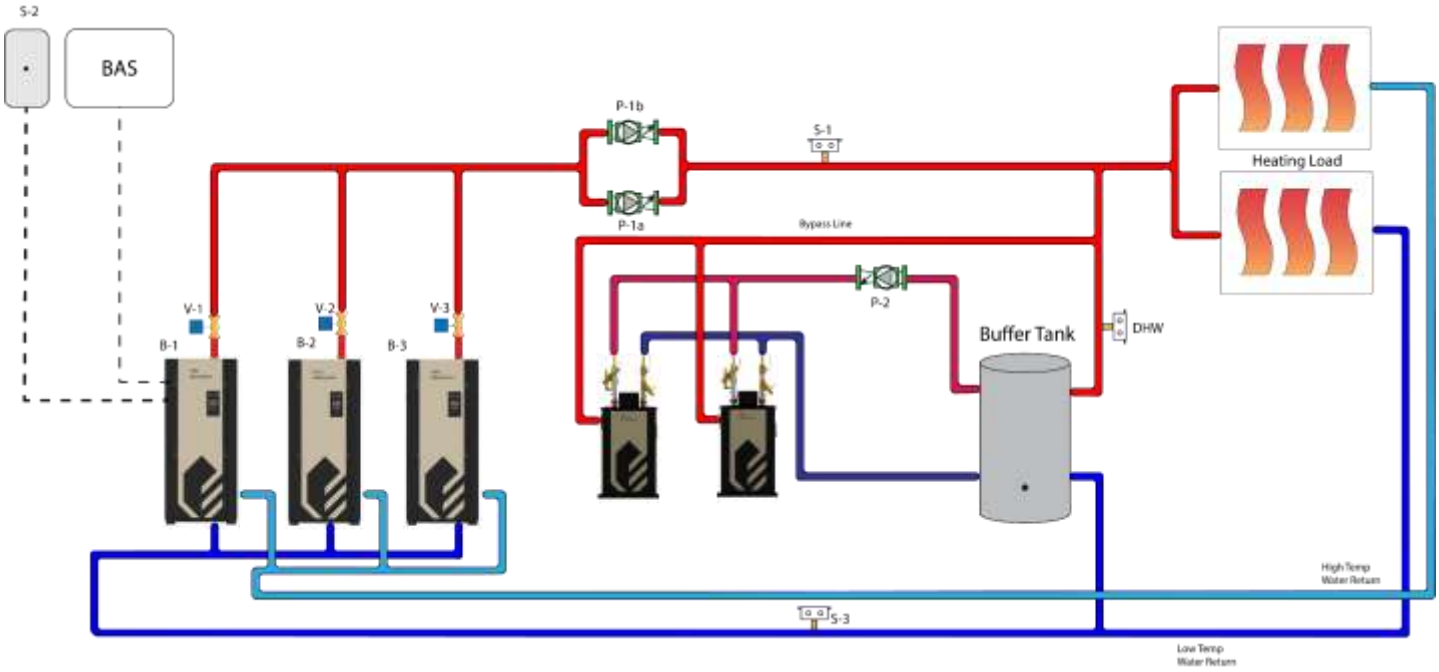


Diagram 4-11a: Space Heating with Temperature Boost and 4-Port Buffer Tank Piping

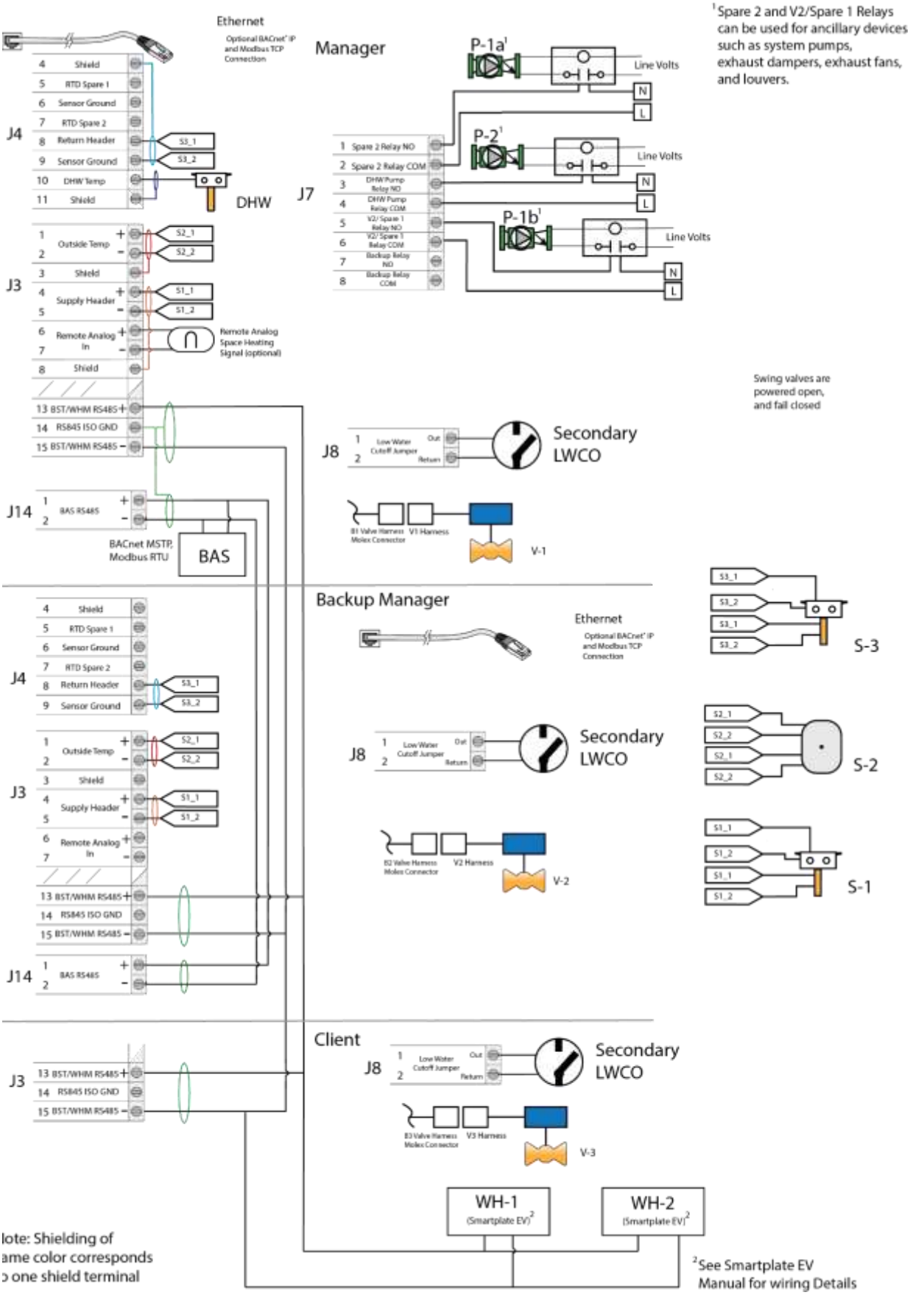


Diagram 4-11b: Space Heating with Temperature Boost and 4-Port Buffer Tank Wiring

4.12 Space Heating with Temperature Boost and Indirect Storage Tank Water Heater

Application Description & Features: AERCO Benchmark boilers are operated via Boiler Sequencing Technology (BST) to provide space heating and domestic hot water generation through a indirect storage tank water heater. Space heating supply temperature is maintained as constant setpoint, via outdoor air reset or from remote setpoint command (from building automation system or via remote analog signal). Domestic hot water generation setpoint is a priority: temperature setpoint is boosted when header temperature falls below DHW setpoint. DHW boiler pump is controlled by an aquastat to provide boiler water to the indirect storage tank water heater. Application utilizes AERCO supplied header sensor, sequencing valves and outdoor air sensor; return header sensor is optional.

- The AERCO Edge Controller sequences the boiler plant for maximum system efficiency by running as many boilers as available, each operating at its most efficient firing rate.
- Sequencing valves isolate standby boilers from the system, reducing the system's minimum flow requirement.
- Edge[ii] controller supports integration with BAS via BACnet MSTP, BACnet IP, Modbus RTU and Modbus TCP.

Essential System Settings:

Parameter	Setting
Application	SH+DHW-Stpt Prty
SH Operating Mode	Constant Setpoint, Outdoor Air Reset or Remote Setpoint
DHW Operating Mode	Constant Setpoint
DHW Pump Control Type	Controlled
DHW Aquastat Enable	Enabled
CASCADE CONFIGURATION-Hdr Temp Sensor	Direct
CASCADE CONFIGURATION-Outdoor Air Temp Sensor *(If SH Operating Mode=Outdoor Air Reset)*	Direct
VALVE CONFIGURATION-Select Output	Cascade Valve
VALVE CONFIGURATION-Valve Feedback	Enabled

Legend:

S-1 = Header Sensor

S-2 = Outdoor Air Sensor

S-3 = Return Sensor

P-1a, P-1b = System Pump(s)

V-1, V-2, V-3 = Sequencing Valves

P-2 = DHW Pump

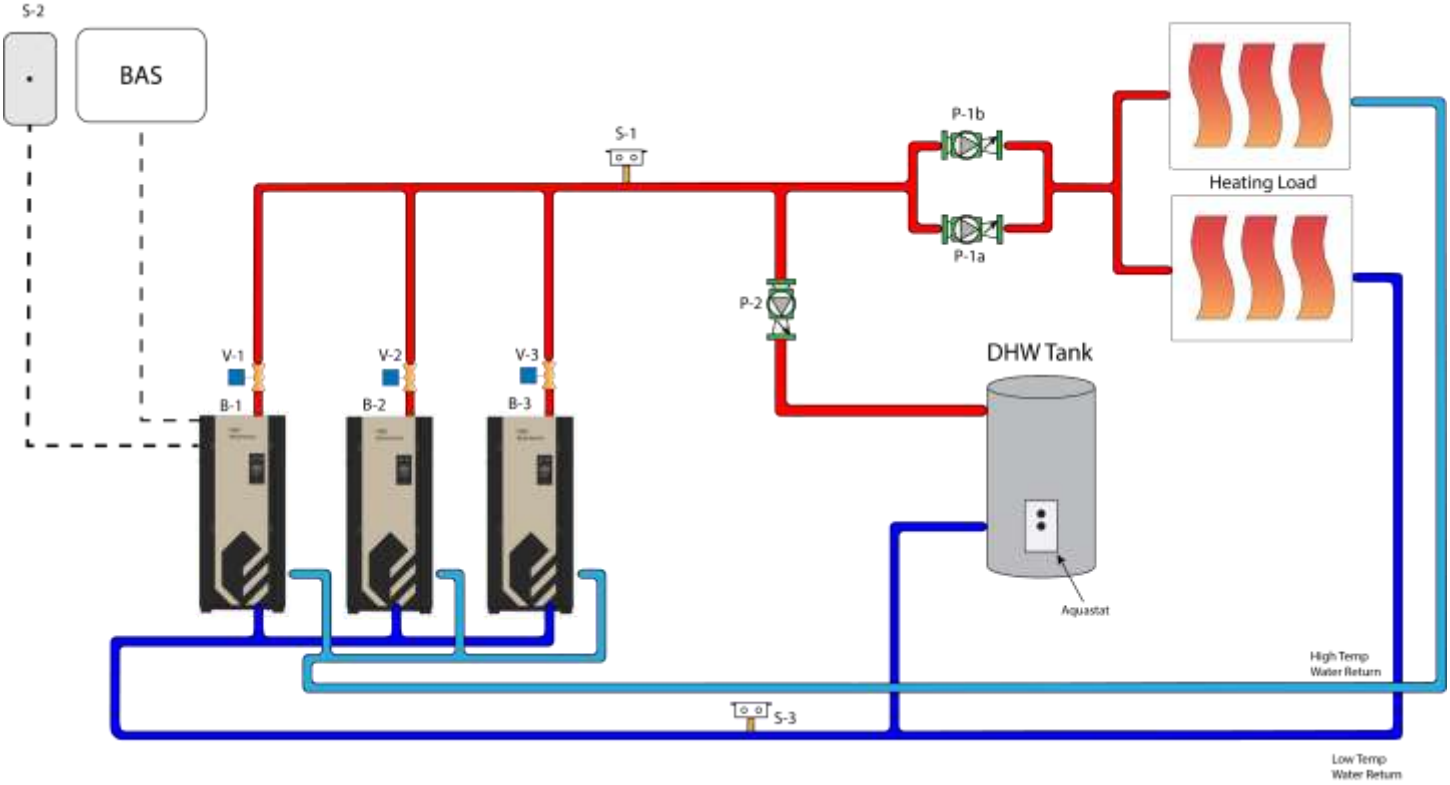


Diagram 4-12a: Space Heating with Temperature Boost and Domestic Hot Water Piping

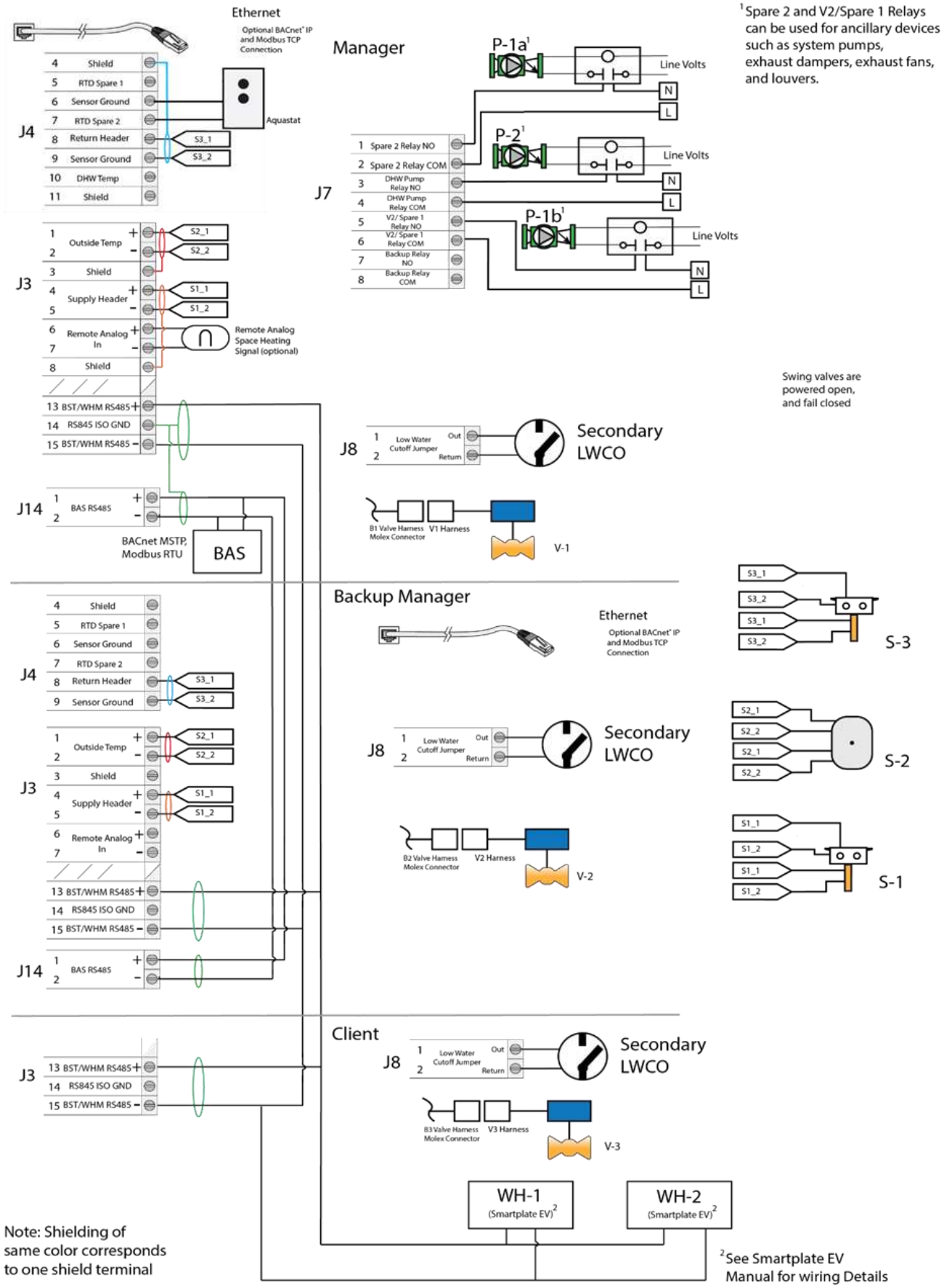


Diagram 4-12b: Space Heating with Temperature Boost and Domestic Hot Water Wiring

5. INPUT/OUTPUT REFERENCE DIAGRAM

Wiring connections for temperature sensors, control signals, interlocks and auxiliary equipment are made on the Input/Output board. See Benchmark Edge [ii] Installation Manual OMM-0136 for details.

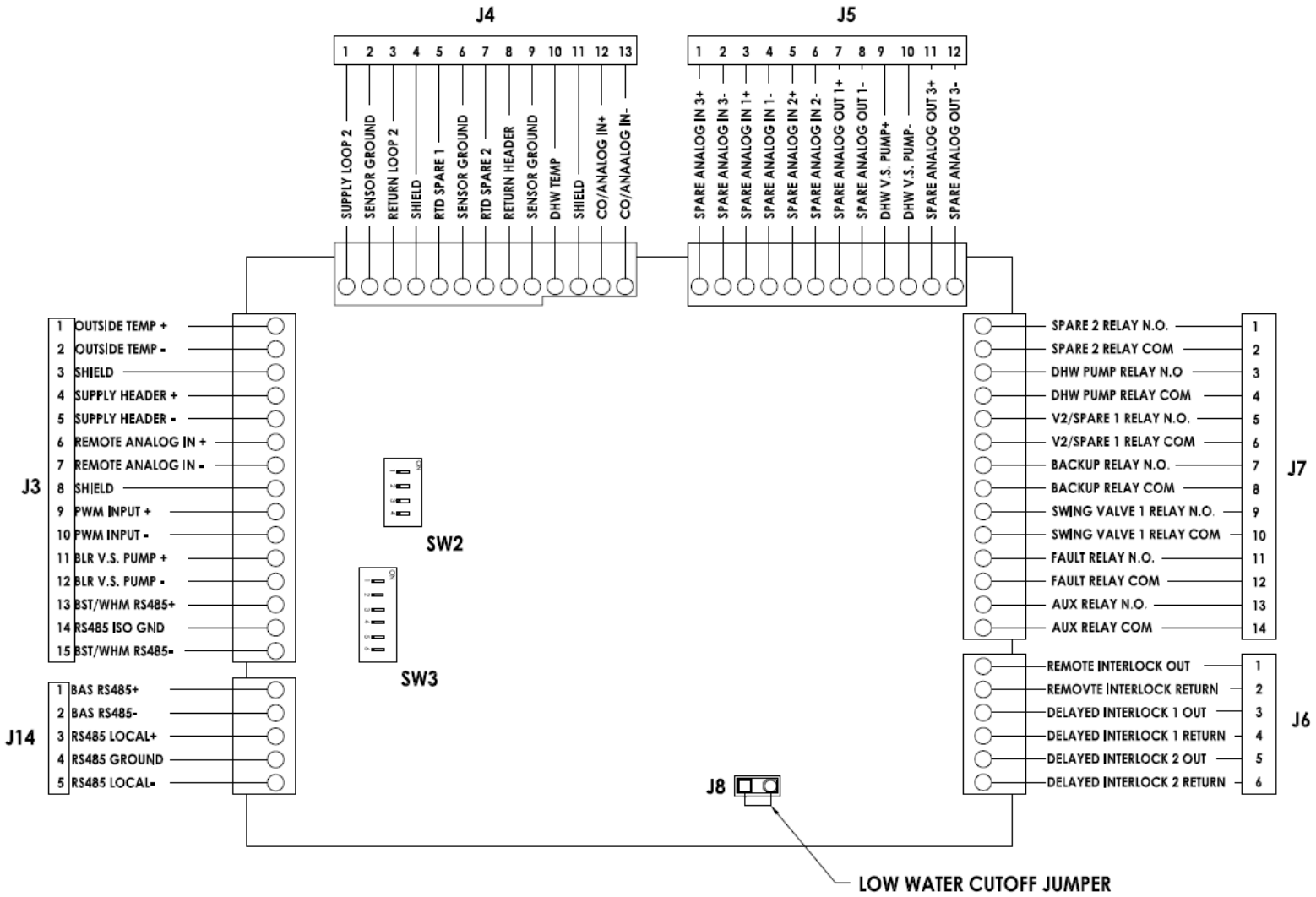
The following relays are rated 120VAC, 3A Resistive (1 A Inductive):

- Spare 2 Relay
- DHW Pump Relay
- V2/Spare 1 Relay
- Backup Relay
- Swing Valve 1 Relay

The following relays are rated 120VAC, 10A Resistive (3A Inductive):

- Fault Relay
- Aux Relay

NOTE: Remote Interlock BST/Cascade Shutdown:
For remote interlock plant shutdown, connect to terminals 5 and 6 of J4 of the Manager boiler. Remote interlock use must be set to "System Shutdown" or "SH Shutdown" and enabled for remote interlock plant shutdown to function.



Technical Data Sheet

Butterfly Motorized Valve (AM/GM/GK/DKRX Actuator) 24V

Valves are supplied by Belimo to AERCO's specification.

- 50 psi bubble tight shut-off
- Long stem design allows for 2" insulation
- Valve face-to-face dimensions comply with API 609 & MSS-SP-67
- Completely assembled and tested, ready for installation

Application

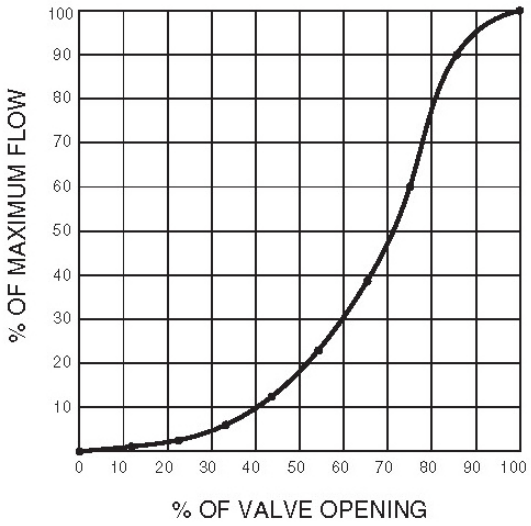
These valves are designed to meet the needs of HVAC and commercial applications requiring bubble tight shut-off for liquids. Typical applications include chiller isolation, cooling tower isolation, change-over systems, large air handler coil control, bypass and process control applications. The large Cv values provide for an economical control valve solution for larger flow applications.

Jobsite Note

Valves should be stored in a weather protected area prior to construction. Complete installation recommendations can be found in Belimo's Installationand Maintenance Instructions for F6/F7 HD/ HDU Butterfly Valves.

Valve Technical Data	
Service	chilled, hot water, 60% glycol
Flow Characteristic	modified equal percentage
Action	90° rotation
Type of End Fitting	for use with ANSI Class 125/150 flanges
Materials	
Body	ductile iron ASTM A536
Body finish	epoxy powder coated
Disc	304 stainless steel
Seat	EPDM
Shaft	416 stainless steel
O-ring	EPDM
Upper bushing	RPTFE
Middle bushings	RPTFE
Lower bushing	RPTFE
Media Temperature Range	-22°F to 250°F [-30°C to 120°C]
Operation Ambient Temperature Range	-22°F to 122°F [-30°C to 50°C]
Body Pressure Rating	ASME/ANSI Class 125/150 (200 psi at -30°F to 275°F)
Range ability	10:1 (for 30° to 70° range)
Maximum Velocity	12 FPS

Flow Pattern



Application Notes

1. Valves are rated at 50 psi differential pressure in the closed position.
2. Valves are furnished with lugs tapped for use with ANSI Class 125/150 flanges. Installation flanges and hardware are not included.
3. 2-way assemblies are furnished assembled and tested, ready for installation.

Actuator Technical Data	
Power Supply	24VAC ±20% 50/60Hz 24VDC ±10%
Power consumption AMX GMX GKX DKRX	Running (Holding) 3.5 W (1.3 W) 4.5 W (1.5 W) 12 W (3 W) 12 W (3W)
Transformer sizing AMX GMX GKX/DKRX	 6 VA Class 2 power source 7 VA Class 2 power source 21 VA Class 2 power source
Electrical connection	18 GA plenum rated cable ½" conduit connector protected NEMA 2 (IP54) 3 ft [1m] DKRX = Screw Terminal (for 22 to 12 AWG wire) 92084-8/9/10 include Molex Connector 39-01-2061
Overload protection	electronic throughout 0 to 95 rotation (DKRX:90º)
Operation range Y	2 to 10 VDC, 4 to 20mA (default) variable (VDC,floating point, on/off)
Input impedance	100kΩ (0.1 mA), 500Ω 1500Ω (fl oating point, on/off)
Feedback output U	2 to 10VDC, 0.5mA max, VDC variable
Angle of rotation	max. 95º (DKRX 90º), adjustable with mechanical stop electronically variable
Torque AMX GMX GKX DKRX	 180 in-lb [20 Nm] 360 in-lb [40 Nm] 360 in-lb [40 Nm] 720 in-lb [80 Nm]
Direction of rotation	reversible with cw/ccw switch
Fail-safe position (GKX/DKRX Models)	adjustable with dial or tool 0 to 100% in 10% increments
Position indication	reflective visual indicator (snap-on)
Manual override	external push button
Running time normal operation fail-safe (GKX/DKRX Models)	90 seconds (default) , AMX variable (90 to 350 sec), GMX variable (75 to 300 sec), GKX variable (90 to 150 sec), DKRX=(75 to 290 sec) 35 seconds
Humidity	5 to 95% RH non-condensing
Ambient temperature	-22ºF to +122ºF [-30ºC to +50ºC]
Storage temperature	-40ºF to +176ºF [-40ºC to +80ºC]
Housing	NEMA2, IP54, UL enclosure type 2
Housing material	UL94-5VA(AMX/GMX/GKX); DKRX = Polycarbonate
Agency list	cULus acc. to UL 60730-1A/-2-14 (ALL MODELS) CAN/CSA E60730-1:02 (AMX/GMX/GKX); CAN/CSA E60730-1 (DKRX) Certified to IEC/EN 60730-1 and IEC/EN 60730-2-14" (DKRX) acc. to 2004/108/EEC and 2006/95/EC (AMX/GMX/GKX)
Noise level	max 45dB(A)
Servicing	maintenance free
Quality standard	ISO 9001

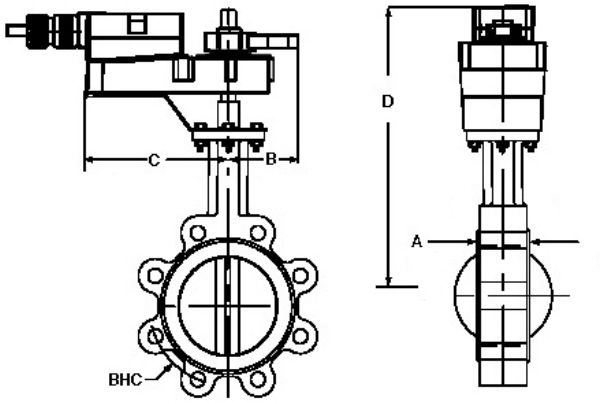
Specifications *C-More/Edge [i] BST enabled **Edge [ii]Controller Applications

AERCO P/N	Size	Valve Model	Actuator Model	Cv	Max GPM	COP	Weight (lbs)
92084-3	3"	F680HDU	AMX24-MFT	302	264	50	13
92084-4	4"	F6100HDU	GMX24-MFT	600	470	50	24
92084-5 92084-8* 92084-11**	3"	F680HDU	GKX24-MFT	302	264	50	15
92084-6 92084-9* 92084-12**	4"	F6100HDU	GKX24-MFT	600	470	50	25
92084-7 92084-10* 92084-13**	6"	F6150HDU	DKRX24-MFT-T	1579	1058	50	45

Actuator Operation

The actuator is electronically protected against overload. The AMX, GMX, and GKX series actuators provide 95º (DKRX:90º) of rotation and a visual indicator shows the position of the actuator. When reaching the damper or actuator end position the actuator automatically stops. The gear can be manually disengaged by pressing the button located on the actuator cover. The AMX, GMX, GKX, and DKRX actuators use a brushless DC motor, which is controlled by an Application Specific Integrated Circuit (ASIC). The ASIC monitors and controls the actuators rotation and provides a digital rotation sensing (DRS) function to prevent damage to the actuator in a stall condition. Power consumption is reduced in a holding mode. The GKX 24-MFT, and DKRX24-MFT actuator provides electrical power off operation for reliable fail safe application. Auxiliary switches or feedback potentiometers are provided and fastened directly onto the actuator body for signaling and switching functions. Complete wiring diagrams can be found in AERCO's Technical Instructions Document TID-0028.

Dimensions



Dimensions (inches)							
AERCO P/N	A	B	C	D (Max)	BHC	No. of Holes	Lug Bolt
92084-3	1.78	7	7	16	6	4	5/8-11UNC
92084-4	1.92	9	9	21	7.5	8	5/8-11UNC
92084-5/8	1.69	9	9	21.03	6	4	5/8-11UNC
92084-6/9	1.92	9	9	21.53	7.5	8	5/8-11UNC
92084-7/10	2.19	7.34	6.77	21.52	9.50	8	3/4-10UNC

Dimenson "A" is compressed, add .125" for relaxed state.

Dimension "D" allows for actuator removal without the need to remove the valve from the pipe.

Max GPM = Maximum US galllons of water per minute, at room temperature , that will flow through the fully open valve without exceeding design velocity limits.

COP = Close-Off Pressure stated in psi. This is the maximum differential pressure the valve will close-off against while maintaining a bubble tight seal.

Proposal/Submittal Information				
Size	AERCO P/N	System Data		
		GPM	Pressure (psig)	Temp (F)

A WATTS Brand

Heating and Hot Water Solutions

AERCO International, Inc. • 100 Oritani Drive • Blauvelt, NY 10913
USA: T: (845) 580-8000 • Toll Free: (800) 526-0288 • AERCO.com

Benchmark & Benchmark Platinum Boiler Relief Valves

Model	PSI	Relief Valve	Alternative
BMK 750	30	Apollo 610 Series	
	50	Apollo 620 Series	
	60	Watts 740	
	75	Apollo 600 Series	
	100	Watts 174A	
	125	Watts 174A	
	150	Watts 174A	
	160	Apollo 610 Series	
BMK 750	30	Apollo 610 Series	
	50	Apollo 620 Series	
	60	Watts 740	
	75	Apollo 600 Series	
	100	Watts 174A	
	125	Watts 174A	
	150	Watts 174A	
	160	Apollo 610 Series	
BMK1500	30	Watts 174A	
	50	Watts 740	
	60	Watts 740	
	75	Watts 740	
	100	Watts 174A	
	125	Watts 174A	
	150	Watts 174A	
	160	Apollo 610 Series	
BMK2000	30	Watts 740	Apollo 610 Series
	50	Watts 174A	Apollo 610 Series
	60	Watts 174A	
	75	Watts 174A	Apollo 610 Series
	100	Watts 174A	Apollo 610 Series
	125	Watts 174A	
	150	Watts 174A	Apollo 610 Series
	160	Apollo 610 Series	
BMK2500	30	Apollo 600 Series	
	50	Watts 740	
	60	Watts 740	
	75	Watts 174A	
	100	Watts 174A	
	125	Watts 174A	
	150	Watts 174A	
	160	Apollo 610 Series	
BMK3000	30	Apollo 600 Series	
	50	Watts 740	
	60	Watts 740	
	75	Watts 174A	
	100	Watts 174A	
	125	Watts 174A	
	150	Watts 174A	
	160	Apollo 610 Series	
BMK5000	30	Apollo 600 Series	
	35	Watts 740	
	50	Watts 740	
	60	Watts 740	
	75	Watts 174A	
	100	Watts 174A	
	125	Watts 174A	
	150	Watts 174A	
BMK6000	30	Apollo 600 Series	
	35	Watts 740	
	50	Watts 740	
	60	Watts 740	
	75	Watts 174A	
	100	Watts 174A	
	125	Watts 174A	
	150	Watts 174A	

For Hot Water Boiler Applications

Job Name _____

Job Location _____

Engineer _____

Approval _____

Contractor _____

Approval _____

Contractor's P.O. No. _____

Representative _____

Series 174A, 374, 740

ASME Water Pressure Relief Valves

For Pressure Protection of Hot Water Heating Boilers

Sizes: ¾" – 2" (20 - 50mm)

Series 174A
Bronze body safety relief valves for pressure protection only of all types of hot water heating boiler equipment. Pressure range 30 to 150psi (2.1 - 10 bar) with corresponding high ratings from 650,000 to 14,370,000 BTU/hr. Female inlet and outlet connections. Sizes ¾" - 2" (20 - 50mm).

Series 374A
Iron body with forged brass inlet, 550,000 BTU/hr rating. ¾" (20mm) only.

Series 740
Iron body with expanded outlets for hot water space heating boilers. Pressure range 30 to 75psi (2 to 5 bar) with corresponding high ratings from 925,000 to 10,700,000 BTU/hr.

Series 174A


Series 740

Features

- Seat located above drain; water can't be trapped and sediment can't foul seat.
- Non-mechanical seat-to-disc alignment will not stick or freeze.
- Water seal of high temperature resisting material isolates spring working parts from water during relief.*

Specifications

Boiler Relief Valves
An ASME Section IV certified pressure relief valve shall be installed on each boiler as noted. The valve shall have a BTU rating in excess of the BTU rating of the boiler's heating output. Each hot water space heating boiler shall be equipped with a pressure relief valve set to relieve below the maximum boiler working pressure. The valve shall feature a raised seat and non-mechanical disc alignment. Working parts and spring shall be isolated from any discharge by a high temperature resistant material.* Valve shall be a Watts Series 174A, 374A or 740.

NOTICE

The information contained herein is not intended to replace the full product installation and safety information available or the experience of a trained product installer. You are required to thoroughly read all installation instructions and product safety information before beginning the installation of this product.

* Does not apply to 374A

Operation

As thermal expansion conditions develop, pressure builds up to the setting of the relief valve. This will cause discharging of small quantity of water.

Should operating controls fail, permitting runaway firing, the boiler water may reach steam temperatures. The valve will then open to discharge steam at the rate or faster than the boiler can generate it, thus restoring system pressure to a safer level.

NOTICE

The discharge line must be the same size as the valve outlet, and must pitch downward from the valve to a safe place for disposal.

Valve lever must be tripped at least once a year to ensure that waterways are clear. This device is designed for emergency safety relief and shall not be used as an operating control.

⚠ WARNING

It is illegal to use this product in any plumbing system providing water for human consumption, such as drinking or dishwashing, in the United States. Before installing standard material product, consult your local water authority, building and plumbing codes.

WATTS®

Materials

Series 174A
- Bronze body construction
- Nonmetallic disc-to-metal seating

Series 740
- Iron body construction
- Nonmetallic disc-to-metal seating

Pressure – Temperature

Series 174A
Pressure range: 30psi to 150psi (2 to 10 bar) with corresponding high BTU/hr ratings from 650,000 to 14,370,000 BTU/hr. Maximum Temperature: 250 ºF (121 ºC)

Series. 374A
Pressure range: rated up to 550,000 BTU/hr at a 30psi (2 bar) setting. (Other settings available)

Series 740
Pressure range: 30psi to 75psi (2 to 5 bar) with corresponding high ratings from 925,000 to 10,700,000 BTU/hr. Maximum Temperature: 250 ºF (121 ºC)

Standards

ASME

Tested and rated by the National Board of Boiler and Pressure Vessel Inspectors to the requirements of ASME. Meets Military Spec. MIL-V-18634B, Type I, Class 3A, Style A (Bronze Body), Style B (Iron Body).

Dimensions – Weights

SERIES 174A									
	Size (Dn)			Height		Length		Weight	
Model	in.	mm	Model	in.	mm	in	mm	lbs.	kg.
374A	¾ x ¾	20 x 20	–	3½	90	2½	64	1.2	0.5
174A	¾ x ¾	20 x 20	M3	4½	116	2¾	67	1.2	0.5
174A	1 x 1	25 x 25	M1	5¾	144	3	76	1.9	0.9
174A	1¼ x 1¼	32 x 32	M1	8½	213	4¼	109	4.6	2.1
174A	1½ x 1½	40 x 40	M	9¼	232	4¾	122	6.9	3.1
174A	2 x 2	50 x 50	M	11½	290	6½	162	14.4	6.5
SERIES 740									
740	¾ x 1	20 x 25	M1	5⅝	143	3	76	1.88	9
740	1 x 1¼	25 x 32	M	7¼	184	3½	89	3.13	1.4
740	1¼ x 1½	32 x 40	M	8¾	222	4⅝	117	6.13	2.8
740	1½ x 2	40 x 50	M	9¼	235	5¼	133	7.50	3.4
740	2 x 2½	50 x 65	M	11⅝	295	6¾	171	16.50	7.5

Capacity*

BTU/hr Steam Pressure Discharge Capacities
As tested and rated by the National Board of Boiler and Pressure Vessel Inspectors

SERIES 174A						
Set Pressure		¾" x ¾"	1" x 1"	1¼" x 1¼"	1½" x 1½"	2" x 2"
		20 x 20mm	25 x 25mm	32 x 32mm	40 x 40mm	50 x 50mm
psi	bar	Model M3	Model M1	Model M1	Model M	Model M
30	2.07	650,000	1,005,000	1,682,000	2,020,000	3,815,000
33	2.27	695,000	1,075,000	1,788,000	2,150,000	4,080,000
35	2.41	725,000	1,125,000	1,877,000	2,250,000	4,250,000
36	2.48	740,000	1,145,000	1,916,000	2,310,000	4,344,000
40	2.76	800,000	1,240,000	2,071,000	2,490,000	4,690,000
45	3.1	875,000	1,355,000	2,265,000	2,720,000	5,130,000
50	3.45	950,000	1,470,000	2,459,000	2,950,000	5,575,000
55	3.79	1,025,000	1,590,000	2,653,000	3,190,000	6,010,000
60	4.13	1,100,000	1,702,000	2,847,000	3,425,000	6,450,000
65	4.58	1,170,000	1,820,000	3,041,000	3,660,000	6,890,000
70	4.82	1,245,000	1,935,000	3,325,000	3,890,000	7,330,000
75	5.17	1,320,000	2,055,000	3,429,000	4,125,000	7,770,000
80	5.51	1,400,000	2,166,000	3,605,000	4,360,000	8,215,000
85	5.86	1,470,000	2,285,000	3,817,000	4,590,000	8,650,000
90	6.6	1,545,000	2,400,000	4,011,000	4,825,000	9,090,000
95	6.55	1,620,000	2,520,000	4,205,000	5,060,000	9,530,000
100	6.89	1,695,000	2,635,000	4,399,000	5,290,000	9,970,000
105	7.23	1,770,000	2,750,000	4,593,000	5,525,000	10,410,000
110	7.58	1,845,000	2,865,000	4,787,000	5,760,000	10,850,000
115	7.92	1,920,000	2,980,000	4,981,000	5,990,000	11,290,000
120	8.27	1,995,000	3,100,000	5,175,000	6,225,000	11,730,000
125	8.61	2,070,000	3,215,000	5,370,000	6,460,000	12,170,000
130	8.96	2,145,000	3,330,000	5,564,000	6,690,000	12,610,000
135	9.3	2,220,000	3,445,000	5,758,000	6,925,000	13,050,000
140	9.65	2,295,000	3,565,000	5,952,000	7,160,000	13,490,000
145	9.99	2,370,000	3,680,000	6,146,000	7,390,000	13,390,000
150	10.34	2,445,000	3,795,000	6,340,000	7,630,000	14,370,000
SERIES 740						
Set Pressure		¾" x 1"	1" x 1¼"	1¼" x 1½"	1½" x 2"	2" x 2½"
		20 x 25mm	25 x 32mm	32 x 40mm	40 x 50mm	50 x 65mm
psi	bar	Model M1	Model M	Model M	Model M	Model M
30	2.07	925,000	1,300,000	2,105,000	2,900,000	5,250,000
33	2.27	989,000	1,390,000	2,250,000	3,100,000	5,613,000
35	2.41	1,032,000	1,450,000	2,345,000	3,235,000	5,855,000
36	2.48	1,053,000	1,480,000	2,395,000	3,300,000	5,975,000
40	2.76	1,139,000	1,600,000	2,590,000	3,569,000	6,461,000
45	3.10	1,245,000	1,750,000	2,830,000	3,903,000	7,067,000
50	3.45	1,352,000	1,899,000	3,075,000	4,237,000	7,672,000
55	3.79	1,459,000	2,049,000	3,315,000	4,572,000	8,277,000
60	4.13	1,566,000	2,200,000	3,560,000	4,907,000	8,883,000
65	4.58	1,672,000	2,349,000	3,800,000	5,241,000	9,488,000
70	4.82	1,779,000	2,499,000	4,045,000	5,575,000	10,093,000
75	5.17	1,886,000	2,649,000	4,285,000	5,909,000	10,700,000

A Watts Water Technologies Company

USA: Tel: (978) 689-6066 • Fax: (978) 975-8350 • Watts.com
Canada: Tel: (905) 332-4090 • Fax: (905) 332-7068 • Watts.ca
Latin America: Tel: (52) 81-1001-8600 • Fax: (52) 81-8000-7091 • Watts.com

For Commercial Water Heater Applications

Job Name _____ Contractor _____

Job Location _____ Approval _____

Engineer _____ Contractor's P.O. No. _____

Approval _____ Representative _____

LEAD FREE*

Series LF40, LF140, LFN240, and LF340

Automatic Re-seating T&P Relief Valves

The combined 2-in-1 Temperature & Pressure Relief Valve provides the least expensive and proven means for protection against both excessive temperature and pressure emergency conditions.

Fully automatic temperature and pressure relief protection for domestic hot water supply tanks and heaters based on the latest ANSI Z21.22 Listing requirements for temperature discharge capacity. The LF40, LF140, LFN240, and LF340 feature Lead Free* construction to comply with Lead Free* installation requirements.

LF40XL with test lever and extension thermostat for installation in hot water outlet within the allowable distance from the top of the tank based on latest ANSI Z21.22. Sizes ¾" and 1".

LF40L with test lever and short thermostat for installation directly in available tank tappings. Sizes ¾" and 1".

Series LF140, LFN240 and LF340 have the same basic body construction and advanced design features as the Series LF40 except for discharge capacity and size of inlet and outlet connections. For complete specifications (including specifications for the Series LF40) see other side. Sizes 1", 1¼", 1½" and 2".

Series LF40L and LF40XL

Series LF140

Series LFN240X

Series LF340

Features

- Lead Free cast body
- Non-mechanical seat-to-disc alignment
- Tamper-resistant bonnet screws
- Series ¾" LF40, LF140 and 1" LF40 feature a unique thermostat with a special thermo-bonded coating
- Series 1" LF140 are furnished with stainless steel thermostat tube
- Series LFN240, LF340 and LF342 are furnished with stainless steel thermostat tube

Specifications

Temperature & Pressure Relief Valves

Each hot water storage heater shall be equipped with an automatic temperature and pressure relief valve to protect the heater from excessive pressure and excessive temperature. The device shall be certified as meeting the requirements of ASME low pressure heating boiler code and ANSI Z21.22. The BTU discharge capacity of the device shall be in excess of the BTU input rating of the heater. The device shall be constructed using Lead Free* materials. Lead Free* automatic re-seating T&P relief valves shall comply with state codes and standards, where applicable, requiring reduced lead content. The T&P valve shall be a Watts Series LF40, LF140, LFN240 or LF340.

⚠ WARNING

Following installation, the valve lever MUST be operated AT LEAST ONCE A YEAR by the water heater owner to ensure that the waterways are clear. Certain naturally occurring mineral deposits may adhere to the valve, blocking waterways, rendering it inoperative. When the lever is operated, Hot water will discharge if the waterways are clear. Precautions must be taken to avoid personal injury from contact with hot water and to avoid property damage.

NOTICE

The information contained herein is not intended to replace the full product installation and safety information available or the experience of a trained product installer. You are required to thoroughly read all installation instructions and product safety information before beginning the installation of this product.

NOTICE

Inquire with governing authorities for local installation requirements

***The wetted surface of this product contacted by consumable water contains less than 0.25% of lead by weight.**

WATTS®

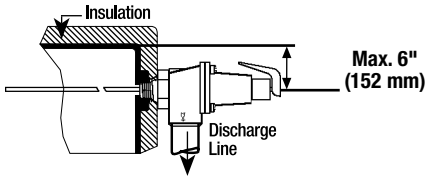
Direct Side Tapping

FOR EXTERNAL FLUE HEATERS

Use extra length extension thermostat to extend into water storage tank.

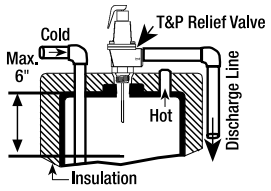
FOR INTERNAL FLUE HEATERS

Use short or standard length thermostat. Vertical discharge line must be installed with its direction downward.



For Heaters with Direct Top Tapping

Use standard or extra length extension thermostat.



Standards

ASME Rated, ANSI Z21.22, Design certified and listed by CSA, National Board of B&PVI to Section IV of the ASME B&PV code and meet current FHA requirements and ANSI Z21.22 in addition to Military Spec. MIL-V-136-12D, Type I.

Pressure – Temperature

Temperature relief: 210°F (99°C)

Pressure range: 75 – 150psi (5.2 – 10.3 bar)

Standard setting: 75, 100, 125 and 150psi (5.2, 6.9, 8.6 and 10.3 bar)

General Recommendations†

For gas, electric or oil-fired storage water heaters between 180,000 to 205,000 BTU/Hr. rating: **Use ¾" Series LF40, LF140 tested under ANSI Z21.22 with ratings as certified and listed by CSA.**

For gas or oil-fired storage water heaters between 205,000 and 730,000 BTU/Hr. rating and for compliance with applicable water heater labeling requirements: **Use 1" LF40, LF140, LFN240 Series tested under ANSI Z21.22 with ratings as certified and listed by CSA.**

For installations of gas or oil-fired hot water supply boilers over 730,000 BTU/Hr. output heating domestic water and for steam coil storage water heaters: **Use Series LF340, LF342 tested under ANSI Z21.22 with rating as certified and listed by CSA.**

MODEL	INLET X OUTLET	THERMOSTAT LENGTH (BELOW INLET THREAD)	DIMENSIONS HEIGHT (LESS THERMOSTAT)	DIMENSIONS WIDTH	WEIGHT	CSA TEMP. STEAM	**ASME PRESSURE STEAM RATING BTU/HR			
	in.	*in.*	*in.*	*in.*	*lbs.*	*Rating BTU/HR*	*@75psi set pres.*	*@100psi set pres.*	*@125psi set pres.*	*@150psi set pres.*
LF40L-3	¾ M x ¾ F	3	5⅝	2⅝	1¾	180,000	778,000	998,000	1,218,000	1,438,000
LF40XL-5	¾ M x ¾ F	5	5⅝	2⅝	1¾	205,000	778,000	998,000	1,218,000	1,438,000
LF40XL-8	¾ M x ¾ F	8	5⅝	2⅝	1¾	205,000	778,000	998,000	1,218,000	1,438,000
LF140S-3	¾ F x ¾ F	3	5⅝	2⅝	1¾	180,000	778,000	998,000	1,218,000	1,438,000
LF140X-5	¾ F x ¾ F	5	5⅝	2⅝	1¾	205,000	778,000	998,000	1,218,000	1,438,000
LF140X-8	¾ F x ¾ F	8	5⅝	2⅝	1¾	205,000	778,000	998,000	1,218,000	1,438,000
LF40L-2	1M x 1F	2	6¼	2¾	2¼	450,000	1,155,000	1,481,000	1,808,000	2,135,000
LF40XL-4	1M x 1F	4	6¼	2¾	2¼	500,000	1,155,000	1,481,000	1,808,000	2,135,000
LF40XL-7	1M x 1F	7	6¼	2¾	2¼	500,000	1,155,000	1,481,000	1,808,000	2,135,000
*LF140S-3	1F x 1F	3	5¾	3	2¼	570,000	1,670,000	2,140,000	2,610,000	3,085,000
*LF140X-6	1F x 1F	6	5¾	3	2¼	670,000	1,670,000	2,140,000	2,610,000	3,085,000
*LF140X-9	1F x 1F	9	5¾	3	2¼	670,000	1,670,000	2,140,000	2,610,000	3,085,000
*LFN240X-6	1F x 1F	6	6¼	3¼	2¾	730,000	2,195,000	2,817,000	3,438,000	4,059,000
*LFN240X-9	1F x 1F	9	6¼	3¼	2¾	730,000	2,195,000	2,817,000	3,438,000	4,059,000
*LFN241X-5	1¼ M x 1F	5	7⅜	3¼	2¾	730,000	2,195,000	2,817,000	3,438,000	4,059,000
*LFN241X-8	1¼ M x 1F	8	7⅜	3¼	2¾	730,000	2,195,000	2,817,000	3,438,000	4,059,000
*LF340-3	1½ F x 1½ F	3	9¾	4½	7	1,150,000	3,450,000	4,426,000	5,403,000	6,379,000
*LF340X-8	1½ F x 1½ F	8	9¾	4½	8	1,150,000	3,450,000	4,426,000	5,403,000	6,379,000
*LF342-3	2 M x 1½ F	3	9¾	4½	7	1,150,000	3,450,000	4,426,000	5,403,000	6,379,000
*LF342X-8	2 M x 1½ F	8	9¾	4½	8	1,150,000	3,450,000	4,426,000	5,403,000	6,379,000

*Furnished with stainless steel thermostat tube. M = Male F = Female

**ASME capacities are steam pressure ratings and do not reflect the CSA temperature relieving capacity of the valves for selection purposes.

†LFLL40XL and LFLLL40XL valves with extended inlet shanks should be used for water heaters that have extra thick insulation, Ask for ES-LFLL/LLL40XL.

⚠ WARNING

Temperature and Pressure Relief Valves should be inspected AT LEAST ONCE EVERY TWO TO FOUR YEARS, and replaced, if necessary, by a licensed plumbing contractor or qualified service technician, to ensure that the product has not been affected by corrosive water conditions and to ensure that the valve and discharge line have not been altered or tampered with illegally. Certain naturally occurring conditions may corrode the valve or its components over time, rendering the valve inoperative. Such conditions can only be detected if the valve and its components are physically removed and inspected. Do not attempt to conduct an inspection on your own. Contact your plumbing contractor for a reinspection to ensure continuing safety.

USA: T: (978) 689-6066 • F: (978) 975-8350 • Watts.com
Canada: T: (905) 332-4090 • F: (905) 332-7068 • Watts.ca
Latin America: T: (52) 81-1001-8600 • Watts.com

"Apollo"® Valves
SUBMITTAL SHEET

RVW60

ASME Hot Water Safety Relief Valve - 10600 Series

Job Name:	
Job Location:	
Engineer:	
Contractor:	
Tag:	
PO#:	
Rep:	
Wholesale Dist.:	

DESCRIPTION

ASME Section IV capacity certified bronze safety relief valve for protection of hot water heating boilers, systems and similar equipment. It can be pre-set to any pressure ranging from 15 to 160 psig (1 to 11 bar) at 250°F (121°C) max.

FEATURES

- Sizes: 3/4" – 2" (20 – 50mm)
- ASME Section IV Certified Capacity
- Corrosion Resistant Construction
- Diaphragm Isolated Spring Chamber
- Extremely High Capacity
- **Made in the USA**

APPROVALS

- ASME Section IV Heating Boilers
- Canadian Registration Number 0G8547.5C
- Pressure Equipment Directive 2014/68/EU (PED)

STANDARD MATERIALS LIST

BODY/CAP	ASTM B584 Bronze
SPRING	Alloy Steel, Plated
SEAT	Silicone

PART NUMBER MATRIX

10	XX	X	X	X
SERIES NO.	MODEL	INLET SIZE	SET PRESSURE	OPTION
10	60 - STANDARD OUTLET	4 - 3/4"	PSIG (15-160)	CE - CE
	61 - OVERSIZE OUTLET	5 - 1"	SEE TABLE	
		6 - 1-1/4"		
		7 - 1-1/2"		
		8 - 2"		

PSIG SUFFIX

SUFFIX	SET PRESSURE	SUFFIX	SET PRESSURE
01	15	17	85
02	20	18	90
03	22	19	95
04	25	20	100
05	30	21	105
06	35	22	110
07	40	23	115
08	43	24	120
09	45	25	125
10	50	30	130
11	55	31	135
12	60	32	140
13	65	33	145
14	70	34	150
15	75	35	155
16	80	36	160

CAPACITY, BTU/HR

ASME HV Rating - 90% of Actual Capacity at 10% Overpressure

RVW60 (10600) STANDARD DISCHARGE PORT					
PSIG	**3/4" 10604**	**1" 10605**	**1-1/4" 10606**	**1-1/2" 10607**	**2" 10608**
15	541,000	876,000	1,515,000	2,061,000	3,397,000
30	827,000	1,339,000	2,316,000	3,151,000	5,193,000
50	1,209,000	1,956,000	3,384,000	4,604,000	7,589,000
100	2,162,000	3,500,000	6,055,000	8,238,000	13,577,000
125	2,639,000	4,272,000	7,390,000	10,054,000	16,571,000
150	3,116,000	5,044,000	8,725,000	11,871,000	19,565,000

RVW61 (10610) HIGH CAPACITY DISCHARGE PORT					
PSIG	**3/4" 10614**	**1" 10615**	**1-1/4" 10616**	**1-1/2" 10617**	**2" 10618**
15	635,000	1,027,000	1,777,000	2,417,000	3,984,000
30	970,000	1,570,000	2,716,000	3,696,000	6,091,000
50	1,418,000	2,295,000	3,969,000	5,400,000	8,900,000
100	2,536,000	4,105,000	7,101,000	9,661,000	15,924,000
125	3,096,000	5,011,000	8,668,000	11,792,000	19,435,000
150	3,655,000	5,916,000	10,234,000	13,923,000	22,947,000

AVAILABLE CONFIGURATIONS

SERIES NUMBER	SIZE (IN.) FNPT X FNPT	HEIGHT (IN.) (MM)	WIDTH (IN.) (MM)	WEIGHT (LB.) (KG.)
10604 10614	3/4 x 3/4 3/4 x 1	5.3 (133)	3.2 (81)	2.3 (1.1)
10605 10615	1 x 1 1 x 1-1/4	6.7 (170)	4.0 (102)	4.0 (1.8)
10606 10616	1-1/4 x 1-1/4 1-1/4 x 1-1/2	8.4 (213)	5.1 (129)	7.7 (3.5)
10607 10617	1-1/2 x 1-1/2 1-1/2 x 2	10.8 (274)	5.9 (150)	11.25 (5.1)
10608 10618	2 x 2 2 x 2-1/2	14.0 (356)	7.2 (183)	23.5 (10.6)

(704) 841-6000
apollovalves.com

aalberts integrated piping systems

Model RVW62

ASME HOT WATER SAFETY RELIEF VALVE

(10-620/630 Series)

Job Name:	Contractor:
Job Location:	P.O. Number:
Engineer:	Representative:
Tag:	Wholesale Distributor:

DESCRIPTION

The Apollo® RVW62 is an ASME Section IV capacity certified bronze safety relief valve for protection of hot water heating boilers, swimming pool heaters and similar equipment. It can be pre-set to any pressure ranging between 30 to 150 psig (2.1 to 10.3 bar) and 250°F (121°C).

FEATURES

- ASME Section IV (HV) Certified Capacity
- 30-150 psig (2.1 to 10.3 bar) Set Pressure Range
- Corrosion Resistant Construction
- Diaphragm Isolated Spring Chamber
- Male or Female NPT Inlet
- MADE IN THE USA

MATERIALS

Body: ASTM B 584 Bronze
Bonnet: ASTM B584 Bronze
Diaphragm: Reinforced EPDM
Spring: Stainless Steel
Seat: Silicone

OPTIONS

☐ ¾" Male NPT inlet (RVW62)

☐ ¾" Female NPT inlet (RVW62F)

☐ Set Pressure (psig) (30-150)

APPROVALS

HV NB

ASME Section IV – Heating Boilers
Canadian Registration Number 0G8547.5C

CAPACITY

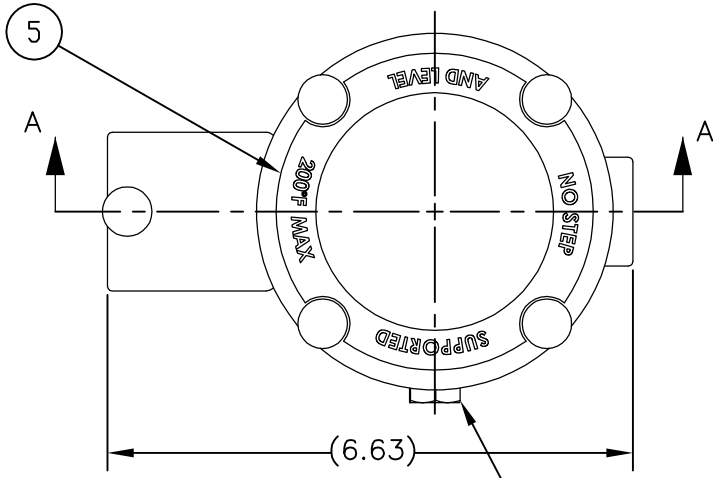
ASME HV Rating – 90% of actual capacity at 10% overpressure

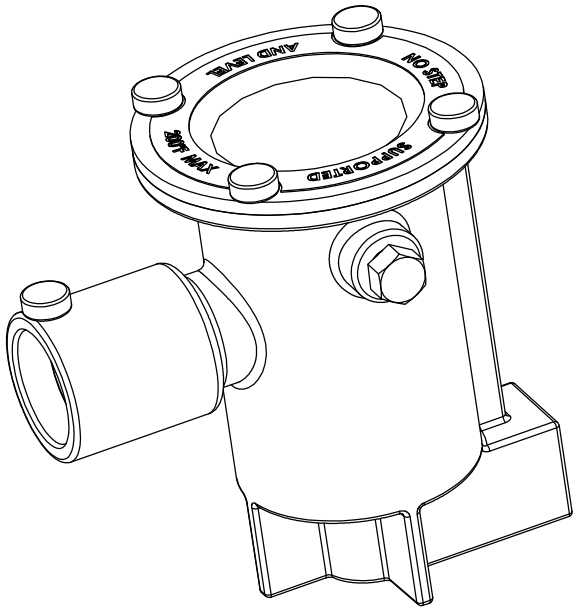
Set Pressure		Capacity
Psig	Bar	BTU/HR
30	2.07	689,000
50	3.45	1,007,000
75	5.17	1,405,000
100	6.90	1,802,000
125	8.62	2,199,000
150	10.34	2,597,000

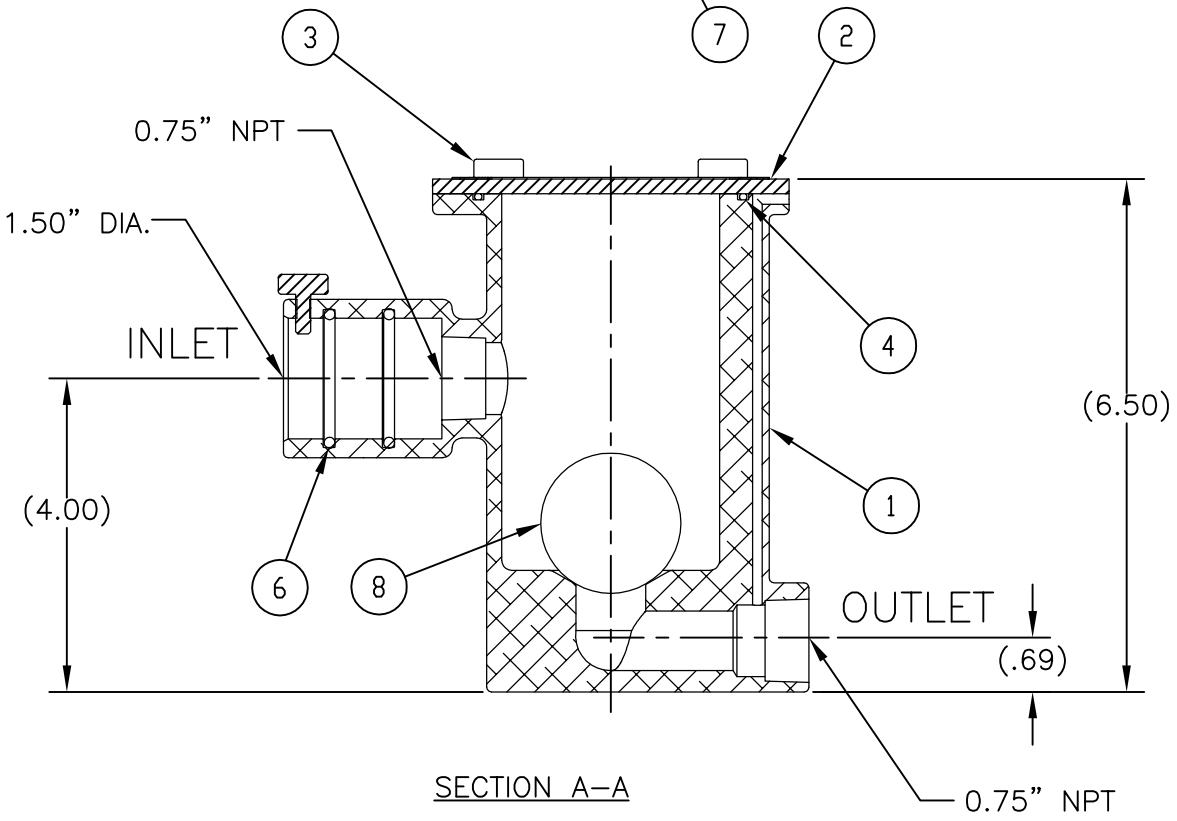
DIMENSIONS

Series (Model)	SIZE	Height		Width		Weight	
	In x Out	in.	mm	in.	mm	lbs	kgs
10624 (RVW62)	3/4M x 3/4F	4.6	117	2.35	60	1.0	.48
10634 (RVW62F)	3/4F x 3/4F	4.5	114	2.35	60	1.0	.48

Conbraco Industries, Inc. 701 Matthews Mint Hill Rd. Matthews NC 28105 USA ; www.apollovalves.com ; 704-841-6000







SECTION A–A

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
8	59222	BALL, CONDENSATE POLYPROPYLENE	1
7	9–22	PIPE PLUG, 1/4" NPT, STEEL	1
6	88009	O–RING #2–222 SILICONE	2
5	72118	LABEL, CONDENSATE TRAP	1
4	84017	O–RING #2–152	1
3	54024	THUMBSCREW # 10–32 X .50 LG	5
2	36085	CAP, CONDENSATE TRAP	1
1	44080	TRAP, CONDENSATE	1

AERCO INTERNATIONAL, INC.
Blauvelt, NY 10913

CONDENSATE TRAP ASSEMBLY POLY BALL (P/N 24441)

DWN.BY K.S. DATE 030615
SCALE ____ SIZE A
CHKD. ____ APPD. ____
REV.DATE ____

AP–A–1006

REV. A

For Commercial and Industrial Applications

Job Name _____ Contractor _____

Job Location _____ Approval _____

Engineer _____ Contractor's P.O. No. _____

Approval _____ Representative _____

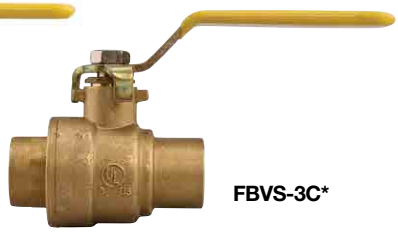
Series FBV-3C, FBVS-3C

2-Piece, Full Port, Brass Ball Valves

Sizes: ¼" – 4" (8 – 100mm)

Series FBV-3C 2-piece, full port, brass ball valves are used in commercial and industrial applications for a full range of liquids and gases. They feature a bottom-loaded blowout proof stem, virgin PTFE seats, thrust washer, and adjustable stem packing gland, stem packing nut, chrome plated brass ball, brass adapter, and steel handle.

FBV-3C



FBVS-3C*

Features

- CSA approved threaded valves only ¼" – 3" (15 – 80mm)
- UL/FM approved threaded valves ¼" – 2" (8 – 50mm)
- UL Listed solder valves ½" – 2" (15 – 50mm)
- Fluorocarbon elastomer stem O-ring prevents stem leaks
- Adjustable stem packing gland
- PTFE stem packing seal, thrust washer, and seats
- Bottom loaded blowout proof stem
- Machined chrome plated brass ball
- Valves comply to MSS-SP-110 standard
- Recommended for open/close applications

Models

FBV-3C: ¼" – 4" (8 – 100mm) with threaded connections
FBVS-3C: ½" – 3" (15 – 80mm) with solder connections

Pressure – Temperature

Water Temperature Range: -40ºF to 400ºF (-40ºC to 204ºC)

Pressure Ratings

FBV-3C : ¼" – 2" (8 – 50mm)
600psi (41 bar) WOG, non-shock
150psi (10.3 bar) WSP

2½" – 4" (65 – 100mm)
400psi (27.5 bar) WOG, non-shock
125psi (8.6 bar) WSP

FBVS-3C : ½" – 2" (15 – 50mm)
600psi (41 bar) WOG, non-shock
150psi (10.3 bar) WSP

2½" – 3" (65 – 80mm)
400psi (27.5 bar) WOG, non-shock
125psi (8.6 bar) WSP

*This valve is designed to be soft soldered into lines without disassembly, using a low temperature solder to 420°F (216°C). Higher temperature solders may damage the seat material.

NOTICE

Apply heat with the flame directed **AWAY** from the center of the valve body. Excessive heat can harm the seats. After soldering, the packing nut may have to be tightened.

Approvals

¼" – 2" (8 – 50mm) FBV-3C UL/FM approved
½" – 2" (15 – 50mm) FBVS-3C UL Listed

approved

Gas Approvals (Threaded Valves Only)

¼" – ⅜" (8 – 10mm)
ASME B16.33, CSA
ASME B16.44
½ psig, 5psig, (14, 34 kPa) @ -40ºF to 125ºF (-40ºC to 52ºC)

½" – 2" (15 – 50mm) ASME B16.33, CSA
ASME B16.44
½ psig, 5psig, and 125psig (14, 34 and 862 kPa) @ -40ºF to 125ºF (-40ºC to 52ºC)

2½" – 3" (65 – 80mm)
ASME B16.38, CSA
ASME B16.44
½ psig, 5psig, and 125psig (14, 34 and 862 kPa) @ -40ºF to 125ºF (-40ºC to 52ºC)

Specifications

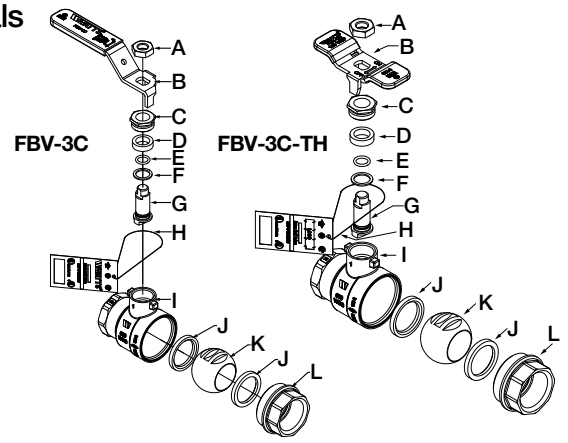
Approved valves shall be 2-piece full port design constructed of a forged brass body and end adapter. Seats and stem packing shall be virgin PTFE. Stem shall be bottom loaded, blowout proof design with fluorocarbon elastomer O-ring to prevent stem leaks. Valve shall have chrome plated brass ball and adjustable packing gland. Threaded valves ¼" – 3" (shall be CSA approved to ½, 5, and 125psig (14, 34 and 862 kPa), ¼" – 2" UL/FM approved. Solder valves to be UL listed. Valve sizes ¼" – 2" (8 – 80mm) shall be rated to 600psi (41 bar) WOG non-shock and 150psi (10.3 bar) WSP. Valve sizes 2½" – 4" (65 – 100mm) threaded, shall be rated to 400psi (27.5 bar) WOG non-shock and 125psi (8.6 bar) WSP. Valve sizes 2½" – 3" (65 – 88mm) solder shall be rated to 400psi (27.5 bar) WOG non-shock and 125psi (8.6 bar) WSP. Valve shall be a Watts Series FBV-3C (threaded) or FBVS-3C (solder).

NOTICE

The information contained herein is not intended to replace the full product installation and safety information available or the experience of a trained product installer. You are required to thoroughly read all installation instructions and product safety information before beginning the installation of this product.

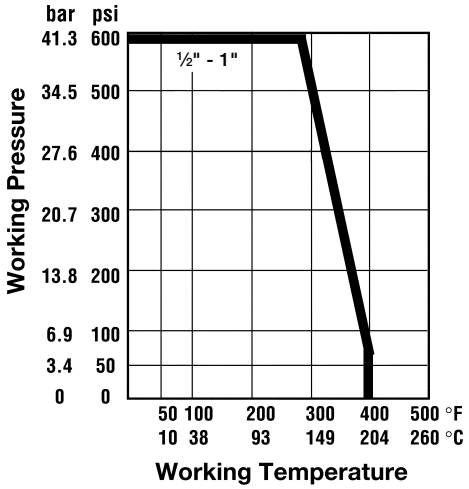
WATTS®

Materials



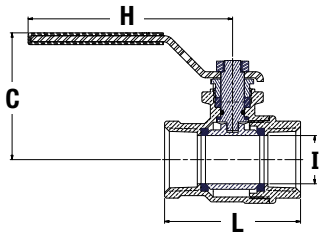
A.	Handle Nut	Zinc plated carbon steel
B.	Handle Assembly	Zinc plated carbon steel with vinyl insulator
C.	Packing Nut	Brass
D.	Stem Packing	Virgin PTFE
E.	O-ring	Fluorocarbon elastomer (FKM)
F.	Thrust Washer	Virgin PTFE
G.	Stem	Machined Brass
H.	Tag	Cardboard, Mylar coated both sides
I.	Body	Forged Brass
J.	Seats	Virgin PTFE
K.	Ball	Chrome plated brass
L.	Adapter	Forged Brass

Temperature – Pressure

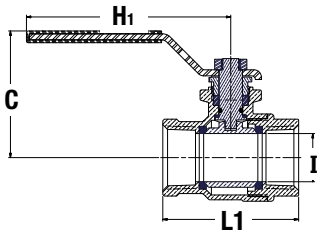


***See applicable note on reverse side for solder end valves with regards to pressure/ temperature rating.**

Dimensions – Weights



FBV-3C



FBVS-3C

SIZE (DN)		DIMENSIONS												WEIGHT	
		C		H		H1		I		L		L1			
in.	*mm*	*in.*	*mm*	*in.*	*mm*	*in.*	*mm*	*in.*	*mm*	*in.*	*mm*	*in.*	*mm*	*lbs.*	*kg.*
¼	8	1 13/16	46	3 7/16	87	-	-	½	12.9	1¾	45	-	-	0.4	0.2
⅜	10	1 13/16	46	3 7/16	87	-	-	½	12.9	1¾	45	-	-	0.4	0.2
½	15	1 13/16	46	3 7/16	87	3 7/16	87	½	12.9	1 15/16	50	2 1/16	52	0.4	0.2
¾	20	2¼	57	4	101	4	101	¾	19.2	2 5/16	59	2 11/16	68	0.8	0.3
1	25	2⅝	67	4¼	108	4¼	108	1	25.5	2 13/16	72	3¼	83	1.2	0.5
1¼	32	2 13/16	71	4¼	108	4¼	108	1¼	31.9	3 3/16	81	3 11/16	94	1.8	0.8
1½	40	3 3/16	80	5¼	134	5 5/16	135	1¼	38.0	3½	88	4¼	108	2.6	1.2
2	50	3½	89	6	153	6	153	2	50.9	4⅛	105	5 5/16	135	3.7	1.7
2½	65	4 1/16	104	7⅜	187	7⅜	188	2½	63.6	5 5/16	134	6¼	158	7.1	3.2
3	80	4½	114	7¾	197	7¾	197	3	76.3	6 1/16	154	7⅜	185	11.3	4.7
4	100	5⅜	136	9⅝	245	-	-	4	101.6	7 7/16	189	-	-	17.7	8.0

USA: T: (978) 689-6066 • F: (978) 975-8350 • Watts.com
Canada: T: (905) 332-4090 • F: (905) 332-7068 • Watts.ca
Latin America: T: (52) 81-1001-8600 • F: (52) 81-8000-7091 • Watts.com

BENCHMARK LIMITED WARRANTY

The following warranty applies to all Benchmark boilers sold by AERCO International, Inc. This document supersedes the warranty page in all Benchmark Operation and Maintenance Manuals (OMMs).

THERMAL SHOCK WARRANTY

The Benchmark pressure vessel is warranted against failure due to Thermal Shock for 20 years from date of shipment provided the boiler is installed, controlled, operated and maintained in accordance with the Operation and Maintenance Manual. This warranty does not cover damage due to corrosion, scaling, sooting and/or improper installation, operation and maintenance. Thermal Shock is defined as a pressure vessel failure determined, by AERCO International, to be caused by uneven expansion of the materials of construction during a single, rapidly applied thermal load.

SHIPMENT DATE	THERMAL SHOCK WARRANTY PERIOD
11/01/2016 - 04/04/2021	10 year
04/05/2021 - Present	20 year

PRESSURE VESSEL/HEAT EXCHANGER

The pressure vessel/heat exchanger shall carry the following limited warranty from the date of shipment against any condensate corrosion, thermal stress failure, mechanical defects or workmanship:

SHIPMENT DATE	COMPONENT	WARRANTY	PRORATED DISCOUNT (from original list price)
All units shipped prior to 12/31/2004	Pressure vessel/ Heat exchanger	7 year, prorated	5th Year – 100% 6th year – 70% 7th Year – 40%
01/01/2005 – 12/31/2007	Pressure vessel/ Heat exchanger	7 year, non-prorated	
01/01/2008 – 04/09/2012	Pressure vessel/ Heat exchanger	10 year, prorated	1st year through 7th – 100% 8th year – 70% 9th year – 40% 10th year – 25%
04/10/2012 – Present	Pressure vessel/ Heat exchanger	10 year, non-prorated	

Operation of the boiler using contaminated air will void the warranty. The pressure vessel/heat exchanger shall not be warranted from failure due to scaling, liming, corrosion, or erosion due to water or installation conditions. AERCO will repair, rebuild or exchange, at its option the pressure vessel/heat exchanger.

EDGE OR C-MORE CONTROL PANEL: 2 YEARS FROM SHIPMENT

AERCO labeled control panels are conditionally warranted against failure for (2) two years from shipment.

BURNER: 5 YEARS FROM SHIPMENT

Warranted against failure for (5) five years from shipment.

OTHER COMPONENTS: 18 MONTHS FROM SHIPMENT

All other components, with the exception of the igniter and flame detector, are conditionally warranted against any failure for 18 months from shipment.

The warranty set forth herein is in lieu of and not in addition to any other express or implied warranties in any documents, or under any law. No salesman or other representative of **AERCO** has any authority to expand warranties beyond the face of the this warranty and purchaser shall not rely on any oral statement except as stated in this warranty. **AERCO MAKES NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTIES.**
AERCO disclaims all responsibility for any special, incidental or consequential damages. Any claim relating to the product must be filed with AERCO not later than 14 days after the event-giving rise to such claim. Any claims relating to this product shall be limited to the sale price of the product at the time of sale. The sale of the product is specifically conditioned upon acceptance of these terms.

CONDITIONS OF WARRANTY:

Under no circumstances will AERCO pay for, or be responsible for, overtime pay (nights, weekends, or holidays) for the owner's convenience or desires. Labor cost covered by this warranty is limited to installations with normal access to the equipment. All additional cost resulting from uncommonly restrictive ingress or egress requiring intricate rigging and/or unusual building or machinery alterations will be the owner's responsibility.

Should an **AERCO** gas-fired (natural gas, propane, or natural gas/propane dual fuel) boiler fail for any of the above reasons within the specified time period from the date of original shipment(s), **AERCO** shall at its option modify, repair or exchange the defective item. **AERCO** shall have the option of having the item returned, FOB its factory, or to make field replacements at the point of installation. AERCO shall be entitled to inspect the product prior to repair or replacement. **In no event shall AERCO be held liable for replacement labor charges (except as provided under the First Year Limited Service Policy below)** or for freight or handling charges.

AERCO shall accept no responsibility if such item has been improperly installed, operated, or maintained – as defined in the applicable **AERCO** O&M manual, or if the buyer has permitted any unauthorized modification, adjustment, and/or repairs to the item. The use of replacement parts not manufactured or sold by **AERCO** will void any warranty, express or limited.

AERCO shall accept no responsibility if such item has been damaged due to contaminated combustion air containing but not limited to sheetrock particles, plaster board particles, dirt, dust, lint, and corrosive chemicals such as chlorine gas, halogenated hydrocarbons, and Freon.

In order to process a warranty claim a formal purchase order number is required prior to shipment of any warranty item. In addition, the returned item must include a Returned Goods Authorization (RGA) label, attached to the shipping carton, which identifies the item's return address, register number and factory authorized RGA number.

Warranty coverage for all components and equipment mentioned this warranty are not valid unless the boiler is started up by a factory certified SST (Service, Start-Up and Troubleshooting) Technician and an **AERCO** start- up sheet is completed.

This warranty coverage is only applicable within the United States, Canada and Mexico. All other geographical areas carry a limited warranty of 18 months from date of shipment or 12 months from startup, whichever comes first.

FIRST-YEAR LIMITED SERVICE POLICY

Applicable to United States and Canadian installations only

For one year from the start of this service policy, AERCO will, if the heat exchanger or a component part fails due to a defect in material or workmanship, replace or repair the defective component and return the product to operating condition.

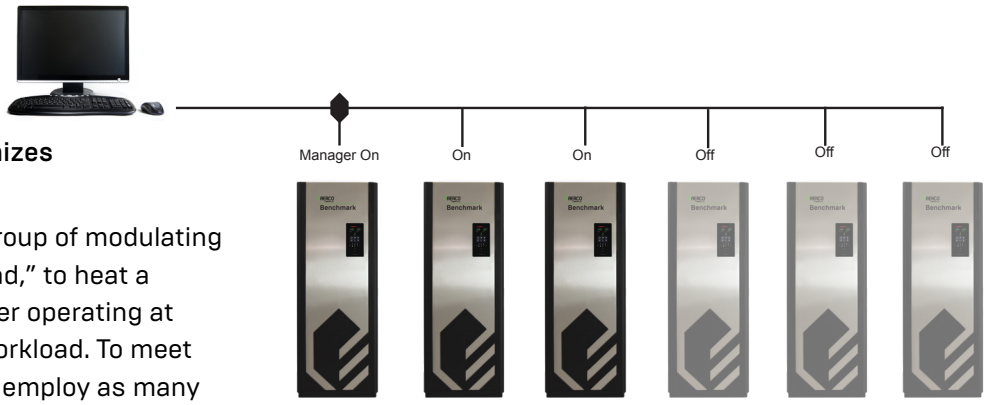
Conditions and Exceptions (all installations):
1. All general conditions, as stipulated in the Limited Warranty, will apply to this one-year cost-free service policy.
2. The installation must be accessible for service, must comply with all applicable federal, state, and local regulations, and must be in accordance with AERCO's installation and maintenance manual.
3. Normal maintenance and repair will be the responsibility of the owner.
4. This policy is valid during the first installation only.

Conditions and Exceptions (Alaska, Hawaii and Canadian installations):
1. Labor cost covered by this service policy is limited to installations with normal access to the equipment, and travel distance not to exceed 150 miles from the nearest factory authorized service agency.

The First Year Limited Service Policy is effective as of the date of shipment.

Technical Data Sheet

Edge™ Controller With Boiler Sequencing Technology (BST)



Load Sharing Strategy Maximizes Energy Efficiency

It requires less energy for a group of modulating boilers, each firing at "part load," to heat a building, than for a single boiler operating at "full fire" to carry the entire workload. To meet building demand, the BST will employ as many boilers as available, each operating at its most efficient firing rate. Importantly, because the BST reacts in real-time to, up to 16 boilers, changes in the number of boilers available, users can take a unit offline for maintenance at any time or bring on back-up boilers for extremely cold conditions without changes to the BST. And as individual boilers are added or deleted, the energy delivered is automatically adjusted to prevent fluctuations in the header temperature of the plant.

Typical Staging Example Demonstrates "Part Load" Efficiency

The first boiler unit comes online and will gradually increase its air-fuel valve position to meet demand. When it reaches 50% – a second unit is called into service.

The two boilers will split the load – each firing at 30% air-fuel valve position to meet demand. If additional heat is required, a third unit is called into service.

Three boilers, each firing at 30% air-fuel valve position, satisfies the demand more efficiently than either two units at 50% or one unit at 100%. This same principle applies to much larger plants.

Features

- Increase system turndown to maximize operating efficiency
- Control Up to 16 Boilers
- Automatic load matching precisely meets demand changes
- "Bumpless" energy transfer
- Multiple configuration options
- User-friendly software makes programming easy
- Full system information VFD display on manager unit
- Controls external 24V AC/DC motorized modulating valve
- Easy integration to BAS or EMS via BACnet or Modbus
- Single point BAS or EMS data gathering for up to 20 BAS system operating parameters and 18 operating parameters of each boiler
- Available standard on all AERCO Benchmark Platinum boilers. No additional panel necessary.
- Can incorporate different unit capacities for optimized efficiency.
- Utilizes a header and/or outdoor sensors directly connected to the BST manager unit, optional Modbus header sensors, or remote network sensors.

Control System Supports Efficient Boiler Plant Operation

The AERCO Edge with Boiler Sequencing is a flexible controller designed to maximize energy savings in modular boiler plants. The BST can stage and coordinate the operations of up to 16 boilers and is uniquely designed to maximize uptime reliability and the operating efficiency of condensing equipment capable of unmatched modulation. For boiler plants greater than 16 boilers, the AERCO Control System (ACS) panel is required.

Able to regulate overall plant output with precise accuracy, a boiler plant with ±4ºF header temperature variation is assured under normal load conditions. It offers sequential or parallel operation flexibility, and user programmable modes of operation that can be changed in the field. The Edge automatically rotates the lead unit to help equalize boiler runtime or number of cycles.

Fully Compatible with BAS or EMS Systems via BACnet or Modbus

For facilities that have taken a building-wide approach to energy efficiency, the Edge supports easy integration with Building Automation Software (BAS) or Energy Management Software (EMS) programs via BACnet MSTP, BACnet IP, Modbus RTU & Modbus TCP. A standards-based integrated protocols used throughout the buildings controls market, BACnet or Modbus integration will enable facility managers to monitor all operations from any building control platform. BAS or EMS can poll 20 System Operating Parameters, and 18 unit Operating Parameters per boiler through a single connection, including (for greater detail consult Edge Communication Manual GF-214).

BST System Parameters

- BST mode
- BST setpoint
- BST auto master
- BST Unit outlet temp
- BST num units enabled
- BST units faulted
- ManagerUnit Address
- BST header temp
- BST outdoor temp
- BST fire rate output
- BST Unit Ignited
- BST Active Setpoint
- Next turn on fire rate
- BST setpoint mode

Boiler Parameters

- Comm addr
- Unit Status
- Fault status
- Outlet temp
- Inlet temp
- Exhaust temp
- Air temp
- Flame strength
- Fire rate out
- Boiler Isolation Valve State
- Network remote setpoint
- Run cycles
- Run hours
- O_2 Level

Configuration Options	Typical Applications
Indoor/Outdoor Reset A change in the outside air condition results in a Process Application proportionate change in header temperature – a function of the adjustable reset ratio (0.3 – 3.0).	Indoor/Outdoor Reset Hydronic Heating Process Application
Constant Setpoint Delivers fixed supply water temperature at set points of 50ºF-220ºF (dependent upon boiler maximum temperature limit).	Water Source Heat Pump Domestic Water Generation Supplemental Heat Recovery Equipment Swimming Pool Heating
0-5V/0-20 mA Signal Header temperature responds linearly to an external 4-20mA control signal.	Computer Controlled Building Management Industrial Process Greenhouse Application
Network Communications Enables EMS or BAS system to drive boiler plant setting for header set point temperature via Modbus connection to BST. Also provides communication link between the boiler and the BST to allow direct communication. This enables the EMS/BAS to query and capture faults of BST and 20 BST System operating parameters as well as 18 operating parameters of each individual boiler.	Computer Controlled Building Management EMS Data Logging & Trend Analysis

NOTE: Supply Header Temperature Sensor Is Sold Separately (See Benchmark and Edge Control Panel O&M)

Robust Features Simplify Control

- **Application Flexibility** – Different configuration options meet the needs of any closed loop system and can be changed in the field.
- **Time Delay Between Boiler Start** – An adjustable time delay between boiler starts allows for a smooth energy input without spikes in electrical, gas or venting conditions.
- **Automatic Allowance for Maintenance** – By continuously monitoring the number of boilers available for operation, the system will automatically operate the next boiler needed to meet demand if a unit malfunctions or is taken off-line for maintenance.
- **Adjustable Offset** – The BST includes a 7-day programmable clock to support night setback and/or daily setback periods. The BST will shift from the original set point to a higher or lower temperature.
- **Two Interlock Circuits** – Monitor pumps, combustion air dampers, or other equipment using two interlock circuits that must be completed before plant operations begin.
- **Power Off Memory** – By using non-volatile memory, programs are retained through a shut down of more than two years. No batteries required.
- **Simple Installation** – The Edge control system operates on boiler unit's standard power supply. Twisted pair, shielded wire connections between the Manager boiler unit and client individual boilers is required to support communications. An RS-485 interface is required to link an BAS communication wiring supports a distance of up to 4,000 feet between BAS and boilers.
- **Flexible & Expandable** – The BST can support up to 16 AERCO boilers – which can be fully integrated with any EMS or BAS software via BACnet or Modbus. AERCO also offers Gateway product for LON and Johnson Controls N2.
- **"Bumpless" Energy Transfer** – When staging boilers sequentially, the BST can bring additional units online at an adjustable percentage of input selected by the user.
- **Accuracy** – The BST uses PID (Proportional & Integral + Derivative) and Dynamic Up/Dynamic Down Modulation control algorithm to provide a dynamic response to all changes in plant operation. Header temperatures, as well as percentage boiler input, are precisely controlled with virtually no overshoot or short cycling of equipment. A header temperature of ±4ºF is assured during continual plant operation.
- **Lead and Lag Boiler** – The BST will select the Lead and Lag boilers by either Unit Size or Run Hours depending on user setting. The Lead and Lag boilers can also be manually selected by the user.
- **Anti-Cycling Features** – These features prolong the system's stay at specific state (firing/off) - reducing the number of cycles while maintaining accurate temperature control.
  - Shutoff Delay Temp
  - Deadband high
  - Low-flow Mode
  - Demand offset
  - Deadband low
- **Low-Flow Mode** – is an innovative and exclusive feature in the AERCO BST control that detects a "low-flow" condition in a multi-boiler system. When the AERCO BST determines that a low-flow condition exists, it will slowly shut down one boiler at a time in an attempt to raise the Fire Rate of the remaining boilers. If the low-flow condition persists and only a single boiler remains ignited, the AERCO BST will use the "Outlet Temperature Sensor" of the remaining ignited boiler to control the temperature. The Outlet Temperature Sensor is mounted in the individual boiler and drastically increases the response time to precisely control temperature. The distant header sensor is ignored in this mode of operation.

- **Setback Setpoint Gradual Decrease** – Whenever boilers are running at a high rate and the Setback-Setpoint feature is activated, the sudden decrease in setpoint will cause the PID to drastically cut back on fire rate. This sudden decrease in fire rate will often cause the boilers to drop below their Stop Levels causing them to turn off, thereby causing excessive cycling and loss of heating capacity while the boilers can re-ignite. The Setback-Setpoint gradual decrease feature will decrease the setpoint, lowered by the activation of the Setback-Setpoint feature, at a slow rate thereby allowing the PID to recover and prevent any boilers from shutting down if not required to do so.
- **Warm-Up and Low-Fire-Delay Fire Rate Hold** – When an extra boiler is ignited to meet demand, the fire rate of all ignited boilers will be held at their present level until the newly ignited boiler has completed Warm-up and Low Fire Delay. When the newly ignited boiler has completed Warm-up and Low Fire Delay, all boiler fire rates will decrease to approx 30% Fire Rate. All boiler fire rates will then rise together to the required fire rate to meet demand.
- **Setpoint Approach Rate control** – To avoid header temperature overshoots, whenever the header temperature nears the setpoint temperature at a rate too quickly to prevent a temperature overshoot, the BST fire rate will temporarily decrease in order to lower the temperature rise momentum. This feature will help avoid temperature overshoots due to variable flow as well as other conditions.
- **Next Turn On Valve Position** – When all ignited boilers reach or exceed the BST Next on VP value, another boiler will be ignited to share the load (if one is available). The default value is 50%.This feature is also useful if a user wishes to always have as few boilers on at any one time. Setting the BST Next on VP value to a high number (Example 100%) will only ignite a new boiler if all currently ignited boilers reach their total BTU capacity (100%).
- **Backup Manager Function** - In the event the manager unit experiences a panel failure or communication loss, the BST system will automatically transfer the manager function to the next manager unit in the system plant. This ensures maximum efficiency and intended plant operation in face of the events mentioned above.

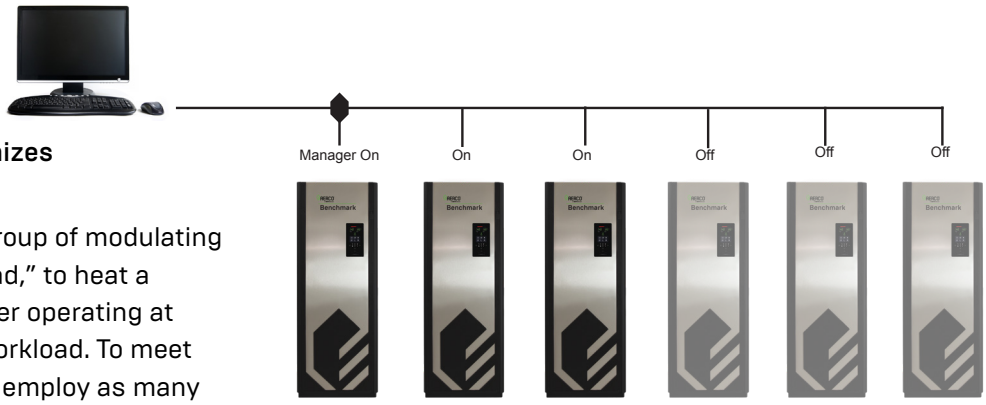
Specifications

Standard Listings & Approvals: UL, CUL

AERCO International, Inc. • 100 Oritani Drive • Blauvelt, NY 10913
USA: T: (845) 580-8000 • Toll Free: (800) 526-0288 • AERCO.com

Technical Data Sheet

Edge™ Controller With Boiler Sequencing Technology (BST)



Load Sharing Strategy Maximizes Energy Efficiency

It requires less energy for a group of modulating boilers, each firing at "part load," to heat a building, than for a single boiler operating at "full fire" to carry the entire workload. To meet building demand, the BST will employ as many boilers as available, each operating at its most efficient firing rate. Importantly, because the BST reacts in real-time to, up to 16 boilers, changes in the number of boilers available, users can take a unit offline for maintenance at any time or bring on back-up boilers for extremely cold conditions without changes to the BST. And as individual boilers are added or deleted, the energy delivered is automatically adjusted to prevent fluctuations in the header temperature of the plant.

Typical Staging Example Demonstrates "Part Load" Efficiency

The first boiler unit comes online and will gradually increase its air-fuel valve position to meet demand. When it reaches 50% – a second unit is called into service.

The two boilers will split the load – each firing at 30% air-fuel valve position to meet demand. If additional heat is required, a third unit is called into service.

Three boilers, each firing at 30% air-fuel valve position, satisfies the demand more efficiently than either two units at 50% or one unit at 100%. This same principle applies to much larger plants.

Features

- Increase system turndown to maximize operating efficiency
- Control Up to 16 Boilers
- Automatic load matching precisely meets demand changes
- "Bumpless" energy transfer
- Multiple configuration options
- User-friendly software makes programming easy
- Full system information VFD display on manager unit
- Controls external 24V AC/DC motorized modulating valve
- Easy integration to BAS or EMS via BACnet or Modbus
- Single point BAS or EMS data gathering for up to 20 BAS system operating parameters and 18 operating parameters of each boiler
- Available standard on all AERCO Benchmark Platinum boilers. No additional panel necessary.
- Can incorporate different unit capacities for optimized efficiency.
- Utilizes a header and/or outdoor sensors directly connected to the BST manager unit, optional Modbus header sensors, or remote network sensors.

Control System Supports Efficient Boiler Plant Operation

The AERCO Edge with Boiler Sequencing is a flexible controller designed to maximize energy savings in modular boiler plants. The BST can stage and coordinate the operations of up to 16 boilers and is uniquely designed to maximize uptime reliability and the operating efficiency of condensing equipment capable of unmatched modulation. For boiler plants greater than 16 boilers, the AERCO Control System (ACS) panel is required.

Able to regulate overall plant output with precise accuracy, a boiler plant with ±4ºF header temperature variation is assured under normal load conditions. It offers sequential or parallel operation flexibility, and user programmable modes of operation that can be changed in the field. The Edge automatically rotates the lead unit to help equalize boiler runtime or number of cycles.

Fully Compatible with BAS or EMS Systems via BACnet or Modbus

For facilities that have taken a building-wide approach to energy efficiency, the Edge supports easy integration with Building Automation Software (BAS) or Energy Management Software (EMS) programs via BACnet MSTP, BACnet IP, Modbus RTU & Modbus TCP. A standards-based integrated protocols used throughout the buildings controls market, BACnet or Modbus integration will enable facility managers to monitor all operations from any building control platform. BAS or EMS can poll 20 System Operating Parameters, and 18 unit Operating Parameters per boiler through a single connection, including (for greater detail consult Edge Communication Manual GF-214).

BST System Parameters

- BST mode
- BST setpoint
- BST auto master
- BST Unit outlet temp
- BST num units enabled
- BST units faulted
- ManagerUnit Address
- BST header temp
- BST outdoor temp
- BST fire rate output
- BST Unit Ignited
- BST Active Setpoint
- Next turn on fire rate
- BST setpoint mode

Boiler Parameters

- Comm addr
- Unit Status
- Fault status
- Outlet temp
- Inlet temp
- Exhaust temp
- Air temp
- Flame strength
- Fire rate out
- Boiler Isolation Valve State
- Network remote setpoint
- Run cycles
- Run hours
- O_2 Level

Configuration Options	Typical Applications
Indoor/Outdoor Reset A change in the outside air condition results in a Process Application proportionate change in header temperature – a function of the adjustable reset ratio (0.3 – 3.0).	Indoor/Outdoor Reset Hydronic Heating Process Application
Constant Setpoint Delivers fixed supply water temperature at set points of 50ºF-220ºF (dependent upon boiler maximum temperature limit).	Water Source Heat Pump Domestic Water Generation Supplemental Heat Recovery Equipment Swimming Pool Heating
0-5V/0-20 mA Signal Header temperature responds linearly to an external 4-20mA control signal.	Computer Controlled Building Management Industrial Process Greenhouse Application
Network Communications Enables EMS or BAS system to drive boiler plant setting for header set point temperature via Modbus connection to BST. Also provides communication link between the boiler and the BST to allow direct communication. This enables the EMS/BAS to query and capture faults of BST and 20 BST System operating parameters as well as 18 operating parameters of each individual boiler.	Computer Controlled Building Management EMS Data Logging & Trend Analysis

NOTE: Supply Header Temperature Sensor Is Sold Separately (See Benchmark and Edge Control Panel O&M)

Robust Features Simplify Control

- **Application Flexibility** – Different configuration options meet the needs of any closed loop system and can be changed in the field.
- **Time Delay Between Boiler Start** – An adjustable time delay between boiler starts allows for a smooth energy input without spikes in electrical, gas or venting conditions.
- **Automatic Allowance for Maintenance** – By continuously monitoring the number of boilers available for operation, the system will automatically operate the next boiler needed to meet demand if a unit malfunctions or is taken off-line for maintenance.
- **Adjustable Offset** – The BST includes a 7-day programmable clock to support night setback and/or daily setback periods. The BST will shift from the original set point to a higher or lower temperature.
- **Two Interlock Circuits** – Monitor pumps, combustion air dampers, or other equipment using two interlock circuits that must be completed before plant operations begin.
- **Power Off Memory** – By using non-volatile memory, programs are retained through a shut down of more than two years. No batteries required.
- **Simple Installation** – The Edge control system operates on boiler unit's standard power supply. Twisted pair, shielded wire connections between the Manager boiler unit and client individual boilers is required to support communications. An RS-485 interface is required to link an BAS communication wiring supports a distance of up to 4,000 feet between BAS and boilers.
- **Flexible & Expandable** – The BST can support up to 16 AERCO boilers – which can be fully integrated with any EMS or BAS software via BACnet or Modbus. AERCO also offers Gateway product for LON and Johnson Controls N2.
- **"Bumpless" Energy Transfer** – When staging boilers sequentially, the BST can bring additional units online at an adjustable percentage of input selected by the user.
- **Accuracy** – The BST uses PID (Proportional & Integral + Derivative) and Dynamic Up/Dynamic Down Modulation control algorithm to provide a dynamic response to all changes in plant operation. Header temperatures, as well as percentage boiler input, are precisely controlled with virtually no overshoot or short cycling of equipment. A header temperature of ±4ºF is assured during continual plant operation.
- **Lead and Lag Boiler** – The BST will select the Lead and Lag boilers by either Unit Size or Run Hours depending on user setting. The Lead and Lag boilers can also be manually selected by the user.
- **Anti-Cycling Features** – These features prolong the system's stay at specific state (firing/off) - reducing the number of cycles while maintaining accurate temperature control.
  - Shutoff Delay Temp
  - Deadband high
  - Low-flow Mode
  - Demand offset
  - Deadband low
- **Low-Flow Mode** – is an innovative and exclusive feature in the AERCO BST control that detects a "low-flow" condition in a multi-boiler system. When the AERCO BST determines that a low-flow condition exists, it will slowly shut down one boiler at a time in an attempt to raise the Fire Rate of the remaining boilers. If the low-flow condition persists and only a single boiler remains ignited, the AERCO BST will use the "Outlet Temperature Sensor" of the remaining ignited boiler to control the temperature. The Outlet Temperature Sensor is mounted in the individual boiler and drastically increases the response time to precisely control temperature. The distant header sensor is ignored in this mode of operation.

- **Setback Setpoint Gradual Decrease** – Whenever boilers are running at a high rate and the Setback-Setpoint feature is activated, the sudden decrease in setpoint will cause the PID to drastically cut back on fire rate. This sudden decrease in fire rate will often cause the boilers to drop below their Stop Levels causing them to turn off, thereby causing excessive cycling and loss of heating capacity while the boilers can re-ignite. The Setback-Setpoint gradual decrease feature will decrease the setpoint, lowered by the activation of the Setback-Setpoint feature, at a slow rate thereby allowing the PID to recover and prevent any boilers from shutting down if not required to do so.
- **Warm-Up and Low-Fire-Delay Fire Rate Hold** – When an extra boiler is ignited to meet demand, the fire rate of all ignited boilers will be held at their present level until the newly ignited boiler has completed Warm-up and Low Fire Delay. When the newly ignited boiler has completed Warm-up and Low Fire Delay, all boiler fire rates will decrease to approx 30% Fire Rate. All boiler fire rates will then rise together to the required fire rate to meet demand.
- **Setpoint Approach Rate control** – To avoid header temperature overshoots, whenever the header temperature nears the setpoint temperature at a rate too quickly to prevent a temperature overshoot, the BST fire rate will temporarily decrease in order to lower the temperature rise momentum. This feature will help avoid temperature overshoots due to variable flow as well as other conditions.
- **Next Turn On Valve Position** – When all ignited boilers reach or exceed the BST Next on VP value, another boiler will be ignited to share the load (if one is available). The default value is 50%.This feature is also useful if a user wishes to always have as few boilers on at any one time. Setting the BST Next on VP value to a high number (Example 100%) will only ignite a new boiler if all currently ignited boilers reach their total BTU capacity (100%).
- **Backup Manager Function** - In the event the manager unit experiences a panel failure or communication loss, the BST system will automatically transfer the manager function to the next manager unit in the system plant. This ensures maximum efficiency and intended plant operation in face of the events mentioned above.

Specifications

Standard Listings & Approvals: UL, CUL

AERCO International, Inc. • 100 Oritani Drive • Blauvelt, NY 10913
USA: T: (845) 580-8000 • Toll Free: (800) 526-0288 • AERCO.com