





**P-K MFD Gas Fired Appliance**  
**Technical Service 1.877.728.5351**



# Safety

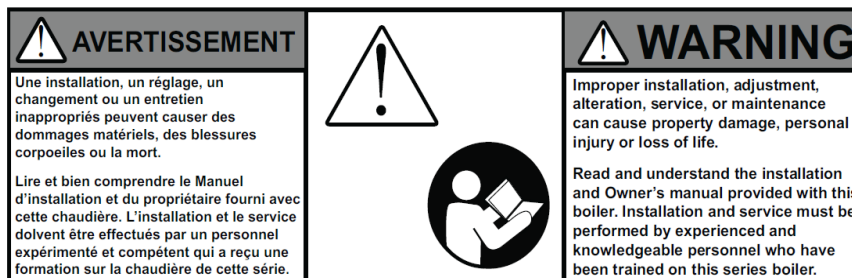
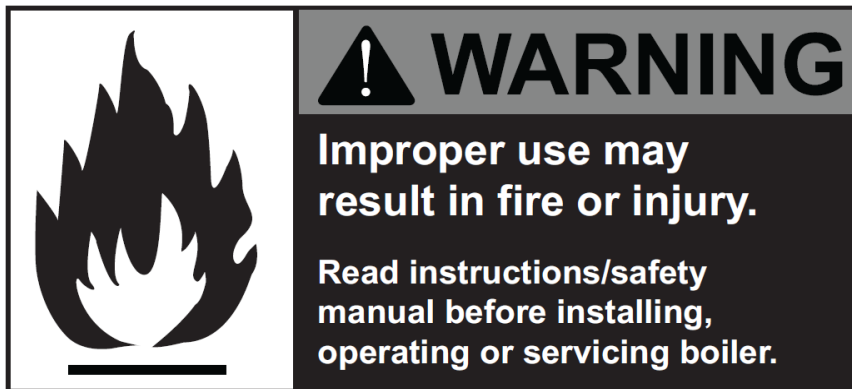
## General

All P-K MODU-FIRE FORCED-DRAFT® Gas-Fired Boilers and Water Heaters must be:

- Installed, operated, and serviced in accordance with the instructions contained in this manual and any other supplemental manuals.
- Installed by qualified personnel in accordance with designs prepared by qualified facility engineers including: structural, mechanical, electrical, and other applicable disciplines.
- Operated and serviced in accordance with a comprehensive safety program determined and established by the customer. Do not attempt to operate or service until such a program has been established.
- Operated and serviced by experienced, qualified, and properly trained personnel in accordance with all applicable codes, laws, and regulations.

## Safety Precautions

Provide a suitable location for the appliance, away from normal personnel traffic, with adequate working space, adequate clearances, proper ventilation and lighting, with a structure sufficiently strong and rigid to support the weight of the appliance, all piping, and accessories.



## NOTICE!

Each safety device must be maintained and checked per the recommended schedule. Refer to [Section 5.2](#).

## SAFETY FEATURES

It is the responsibility of the customer to ensure external safety provisions, such as but not limited to: guards, safety labels, safety controls, interlocks, lockout devices are in place and operable.

## SAFETY LABELS

The following words are used in this manual to denote the degree of seriousness of the individual hazards.

### DANGER

*Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.*

### WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

### CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.


## NOTICE/NOTE - NOTICE

Is the preferred signal word to address practices not related to personal injury. The safety alert symbol is not used with this signal word.



## NOTICE!

The safety labels shown below are affixed to your appliance. Although the labels are of high quality, they may become dislodged or unreadable over time. Contact Patterson-Kelley at **570.476.7261** or toll-free at **877.728.5351** for replacements.

<b>AVERTISSEMENT</b> Une installation, un réglage, un changement ou un entretien inappropriés peuvent causer des dommages matériels, des blessures corporelles ou la mort. Lire et bien comprendre le Manuel d'installation et du propriétaire fourni avec cette chaudière. L'installation et le service doivent être effectués par un personnel expérimenté et compétent qui a reçu une formation sur la chaudière de cette série.	 	<b>WARNING</b> Improper installation, adjustment, alteration, service, or maintenance can cause property damage, personal injury or loss of life. Read and understand the installation and Owner's manual provided with this boiler. Installation and service must be performed by experienced and knowledgeable personnel who have been trained on this series boiler.
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<b>ATTENTION</b> Risque de brûlures. Certains composants sont très chauds. Allouer un temps de refroidissement après l'arrêt et ne pas toucher pendant le fonctionnement.		<b>CAUTION</b> Burn hazard. Some components are hot to the touch. Allow time to cool after shutdown and do not touch during operation.
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<b>AVERTISSEMENT</b> Risque électrique. Un contact causera un choc électrique et des blessures. Suivre les procédures de verrouillage/signalisation lors de l'entretien.	 	<b>WARNING</b> Electrical Hazard. Contact may cause electrical shock and injury. Follow lockout/tagout procedure when servicing.
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	<b>WARNING</b> Improper use may result in fire or injury. Read instructions/safety manual before installing, operating or servicing boiler.
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<b>WARNING</b> Gas may lose its odor. Proper gas sensing equipment and procedures should be used for leak checks. Failure to detect gas leaks could result in injury or death.
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## Training

Proper training is the best protection against accidents. It is **essential** to read, understand, and follow the recommendations of this manual before installing, operating, or servicing this equipment. Failure to do so could result in fire or explosion and serious injury, death, and/or property damage.

Operating and service personnel must be thoroughly familiar with the basic construction of the MODU-FIRE Forced-Draft gas-fired boilers and water heaters, the use and locations of the controls, the operation of the equipment, adjustment of their various mechanisms, and all applicable safety precautions. If any of the provisions of this manual are not fully and completely understood, contact Patterson-Kelley Technical Service at **570.476.7261** or toll free at **877.728.5351**.

## Hazard Warnings

### Electrical Hazards



**Shock Hazard!** Properly lockout/tagout the electrical service and all other energy sources before working on or near the appliance.

**Shock Hazard!** Do not spray water directly on this appliance or any electrical components.

**Electrical Hazard!** Do not alter wiring connections.

### Crush Hazards



**Lifting Hazards!** Use properly rated lifting equipment to lift and position the appliance. The load is unbalanced. Test the balance before lifting off the floor. Do not allow personnel beneath the lifted load. Refer to the approximate weights in the table below.

750 & 1000	1500	2000	2500 & 3000
750 Lbs.	920 Lbs.	935 Lbs.	1200 Lbs.

### Bump Hazard from Overhead Ductwork and Piping



**Injury Hazard!** Install components with adequate vertical clearance.

## Pressure Hazards



**Pressure Hazard!** Hot fluids. Install isolation valves on appliance water inlet and outlet. Make sure isolation valves are closed before servicing the appliance.

**Pressure Hazard!** Hot fluids. Annually test safety relief valve(s) for proper operation. Do not operate the appliance with faulty relief valve(s). Contact the water supplier or local plumbing inspector on how to correct this situation. Do not plug the relief valve.



## Slip, Fall Hazards



General Warning

**Tripping Hazard!** Do not install piping on floor surfaces. Maintain a clear path around the appliance.

**Slip and Fall Hazard!** Use a drip pan to catch water while draining the appliance. Maintain dry floor surfaces.

**Slip and Fall Hazard!** Do not locate intake or exhaust terminations above a walkway; dripping of condensate can cause icing of the walking surface. Refer to [Section 2.5.5](#).

**Fall Hazard!** Do not stand on the appliance.

## Chemical Hazards



General Warning

**Chemical Hazards from Cleaning Products.** Use caution when cleaning the system. The use of professional assistance is recommended. Use safe procedures for the disposal of all cleaning solutions.



## Burn, Fire and Explosion Hazards



General Warning

**Burn, fire, and explosion hazards!** Installation must be in strict conformance to all applicable codes and standards including NFPA 54, ANSI Z223.1 and CAN/CSA B.149. Install all required vent lines for gas devices. Refer to [Section 3.4](#) and [Section 3.5](#).

**Hazard from Incorrect Fuels!** Possible fire, explosion, overheating, and damage. Do not use any fuels except the design fuels for the unit.

**Overfire Hazards!** High pressure in gas supply could result in overfiring of this or other devices supplied from the same source.

**Fire and Explosion Hazards!** Close the main gas shutoff before servicing the appliance.

**Fire and Explosion Hazards!** Do not store or use gasoline or other flammable vapors or liquids in the vicinity of this or any other gas fired appliance.



Hot Surface

**Burn hazard!** Possible hot surfaces. Do not touch gas vent during firing operation. Use only factory recommended vent components.

**Burn Hazard!** Pipes, vents, and appliance components could be hot. Do not touch piping or stack surfaces during operation or immediately after shutdown of the appliance.

**Burn Hazard!** Hot flue! Use caution when servicing or draining the appliance.

**Fire and Explosion Hazards!** Use caution when servicing burner. Propane (LPG) is heavier than air and may linger in the combustion chamber, vent lines, or elsewhere.

**Gas Leak Hazard!** Make sure the burner is installed correctly and blower/transition is securely fastened following any maintenance performed on them. These connections may leak gas if assembled incorrectly.

**Gas Leak Hazard!** All threaded gas connections must be made using a pipe compound that is resistant to liquefied petroleum gas. Do not use Teflon™ tape on threaded gas piping.

**Gas Leak Hazard!** Check entire gas train for leaks after installation. If there is a smell of gas, shut down the appliance and obtain immediate assistance from trained service personnel and/or your local fire department.

**Overfire Hazard!** Possible fire and explosion from excess gas pressure. Make sure that gas inlet pressure does not exceed 14 inches W.C.

**Overfire Hazard!** Possible fire and explosion. Possible malfunction of regulators and/or gas safety shut off/control valves. Maintain all gas train components in good condition. Do not alter wiring connections. Annual inspection by factory-trained personnel for proper set-up and operation is recommended.

**Overfire and Underfire Hazards!** Possible fire, explosion, overheating, and component failure. Do not attempt to adjust firing rate of the appliance. The firing rate must be adjusted only by factory-trained personnel.



## Table of Contents

<b>1</b>	<b>INTRODUCTION .....</b>	<b>VIII</b>
1.1	REFERENCE TABLE –MODU-FIRE FORCED DRAFT “MFD” MODELS .....	1
1.2	PURPOSE OF THIS DOCUMENT .....	2
1.3	COMMON ABBREVIATIONS .....	2
<b>2</b>	<b>SITE PREPARATION .....</b>	<b>3</b>
2.1	INITIAL INSPECTION UPON RECEIVING .....	3
2.2	STORAGE PRIOR TO INSTALLATION.....	3
2.3	COMPLIANCE WITH CODES.....	4
2.3.1	MFD Series: Boiler Specific Certifications.....	4
2.3.2	MFD Series: Water Heater Specific Certifications.....	4
2.3.3	Installation Codes .....	5
2.4	LOCATION SETUP .....	6
2.4.1	Foundation .....	6
2.4.2	Clearances .....	7
2.5	INLET AIR AND EXHAUST VENTING CONSIDERATIONS .....	8
2.5.1	Applicable Codes and Standards.....	8
2.5.2	Combustion Air Inlet Planning (United States and Canada Considerations) .....	8
2.5.3	Category II/IV Flue Gas Exhaust Vent Planning (MFD Boilers & Water Heaters) .....	9
2.5.4	Venting Materials for Flue/Exhaust Systems .....	10
2.5.5	Required Clearances .....	11
2.6	GAS PIPING CONSIDERATIONS .....	13
2.7	WATER QUALITY STANDARD .....	13
<b>3</b>	<b>INSTALLATION.....</b>	<b>14</b>
3.1	OVERVIEW.....	14
3.2	APPLIANCE CONNECTIONS.....	14
3.2.1	Appliance Connections (750 & 1000 Sizes) .....	15
3.2.2	Appliance Connections (1500 & 2000 Sizes) .....	16
3.2.3	Appliance Connections (N2500-MFD & N3000-MFD) .....	17
3.3	ELECTRICAL CONNECTIONS .....	18
3.3.1	Power Requirements .....	18
3.3.2	High Voltage (TB2) Terminal Block (208-240VAC) .....	19
3.3.3	Low Voltage (TB1) Terminal Block (120VAC -or- 208-240VAC) .....	21
3.4	COMBUSTION AIR .....	23
3.4.1	Air Inlet Requirements – United States .....	23
3.4.2	Air Inlet Requirements - Canada.....	24
3.4.3	MFD Combustion Air Requirements .....	25
3.4.4	Direct Vent / Sealed Combustion Installations .....	26
3.4.5	Motorized Combustion Air Dampers .....	28
3.5	FLUE GAS/ EXHAUST VENTING.....	30
3.5.1	Category II or IV Vent Installation (MFD Boilers and Water Heaters Only) .....	31
3.5.2	MFD Boilers & Water Heaters: Acceptable Category II/IV Vent Configurations.....	33
3.5.3	Venting for Multiple Appliances .....	35
3.6	REMOVING AN EXISTING BOILER OR WATER HEATER .....	36
3.7	PIPING.....	37
3.7.1	Gas Piping Overview .....	37
3.7.2	Natural Gas Piping .....	38
3.7.3	Propane Gas Piping .....	38





3.7.4	Pressure Testing the Gas Piping .....	38
3.7.5	Sample Piping Diagram – MFD Series Boilers.....	39
3.7.6	Sample Piping Diagram – MFD Series Water Heaters.....	40
3.7.7	Water Piping Accessories & Connections (for Installer) .....	41
3.8	WATER QUALITY .....	42
3.9	PRE-START CHECKLIST .....	42
3.10	SAFETY CHECKS .....	43
3.10.1	Ignition Safety System Test .....	43
3.10.2	Manual Reset High Temperature Limit Test.....	43
3.10.3	Low Gas Pressure Switch Test.....	43
3.10.4	High Gas Pressure Switch Test .....	44
3.10.5	Low Water Cut-out Test (If Applicable).....	44
3.11	BURNER ADJUSTMENT.....	45
3.11.1	Inlet Gas Test Port.....	45
3.11.2	Manual Control Mode for High and Low Fire Adjustment .....	46
3.11.3	Adjusting High Fire Combustion.....	47
3.11.4	Adjusting Low Fire .....	47
3.11.5	Checking Flame Signal .....	47
3.12	INITIAL NURO CONTROL SETUP & ADJUSTMENT .....	48
3.12.1	Startup.....	48
3.12.2	Home Screen.....	49
3.12.3	Information Screen .....	49
3.12.4	Setup Wizard.....	50
<b>4</b>	<b>OPERATIONS .....</b>	<b>51</b>
4.1	NURO TOUCHSCREEN CONTROL SYSTEM.....	51
4.1.1	Power On/Off Switch .....	51
4.1.2	NURO Touch Screen Interface and Control Panel.....	52
4.1.3	Factory Tests.....	52
4.2	NORMAL LIGHTING AND SHUT-DOWN PROCEDURES .....	53
4.2.1	Normal Lighting Procedures .....	53
4.2.2	Normal Shut Down Procedures.....	53
4.3	EMERGENCY SHUT-OFF .....	53
<b>5</b>	<b>MAINTENANCE .....</b>	<b>54</b>
5.1	PREVENTATIVE MAINTENANCE .....	54
5.1.1	Daily Preventative Maintenance .....	54
5.1.2	Weekly Preventative Maintenance.....	54
5.1.3	Monthly Preventative Maintenance.....	55
5.2	MAINTENANCE AND INSPECTION SCHEDULE .....	56
5.2.1	Semi-Annually .....	56
5.2.2	Annually .....	56
5.3	CLEANING THE BURNER & COMBUSTION CHAMBER .....	57
5.4	AFTER REPAIRS OR MAINTENANCE.....	62
5.5	SEQUENCE OF OPERATIONS .....	62
5.6	TROUBLESHOOTING .....	64
5.6.1	Loss of Power.....	64
5.6.2	Loss of Water Flow .....	64
5.6.3	Low Gas Pressure .....	64
5.6.4	High Gas Pressure .....	64
5.6.5	High Water Temperature.....	64



5.6.6	Low Air .....	65
5.6.7	Flame Failure .....	65
5.6.8	Flame Error .....	65
5.6.9	Flue Problem .....	65
<b>6</b>	<b>PARTS/TECHNICAL SUPPORT .....</b>	<b>66</b>
6.1	TERMINAL BLOCK ASSIGNMENTS AND WIRING DIAGRAMS .....	67
6.1.1	Terminal Block 208-240VAC .....	67
6.1.2	Terminal Block 120VAC .....	68
6.1.3	Terminal Block Assignments — High Voltage (TB2) Terminal Block (208-240VAC) .....	69
6.1.4	Terminal Block Assignments — High Voltage (TB2) Terminal Block (120VAC) .....	70
6.1.5	Terminal Block Assignments — Low Voltage (TB1) Terminal Block (120VAC -or- 208-240VAC) .....	71
6.1.6	MFD NURO 208-240VAC Wiring Diagram .....	72
6.2	PARTS IDENTIFICATION .....	73
6.2.1	Main Assembly .....	73
6.2.2	NURO Control Panel .....	74
6.2.3	Heat Exchanger Assembly (Sizes 750 through 2000) .....	75
6.2.4	Heat Exchanger Assembly (Sizes 2500 & 3000) .....	76
6.2.5	Gas Train, Burner & Blower Assembly (Sizes 750 through 2000) .....	77
6.2.6	Gas Train, Burner & Blower Assembly (Sizes 2500 & 3000) .....	78
<b>7</b>	<b>MODU-FIRE FORCED DRAFT® SPECIFIC LIMITED WARRANTY .....</b>	<b>79</b>
<b>8</b>	<b>FIRE-TEST REPORT .....</b>	<b>81</b>
	<b>APPENDIX A – MAINTENANCE LOG .....</b>	<b>82</b>
	<b>APPENDIX B –ALTITUDE DERATE SCHEDULE .....</b>	<b>83</b>
	<b>APPENDIX C –WATER QUALITY STANDARD FOR HYDRONIC BOILERS IN MULTI-METAL SYSTEMS .....</b>	<b>84</b>
	<b>APPENDIX D – BEST PRACTICES FOR NEW &amp; RETROFIT SYSTEMS .....</b>	<b>85</b>
	<b>APPENDIX E – INSTALLATION AND QUICK REFERENCE .....</b>	<b>88</b>
	FUEL/GAS SUPPLY .....	88
	ELECTRICAL/POWER SUPPLY .....	88
	EXHAUST VENTING .....	88
	HYDRONICS/WATER FLOW (MFD 750 - 1000 SIZES) .....	89
	APPLIANCE CONNECTIONS (MFD 750 - 1000 SIZES) .....	90
	HYDRONICS/WATER FLOW (MFD 1500 - 2000 SIZES) .....	91
	APPLIANCE CONNECTIONS (MFD 1500 - 2000 SIZES) .....	92
	HYDRONICS/WATER FLOW (N2500-MFD & N3000-MFD) .....	93
	APPLIANCE CONNECTIONS (N2500-MFD & N3000-MFD) .....	94
	PROPYLENE GLYCOL FLOW .....	95





## **WARNING**

If the information in this manual is not followed, fire or explosion may result causing property damage, personal injury, or loss of life.

Do not store or use gasoline or other flammable vapors or liquids in the vicinity of this or any other appliance. Installation and service must be performed by a qualified installer, service agency, or the gas supplier.

### **WHAT TO DO IF YOU SMELL GAS:**

- Do not try to light any appliance.
- Do not touch any electrical switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.

If you cannot reach your gas supplier, call the fire department.

## **WARNING**

It is essential to read, understand, and follow the recommendations of this manual before installing, operating or servicing this equipment. Failure to do so could result in personal injury or death.

## **WARNING**

Installation and service must be performed by a qualified and knowledgeable individual who has been certified on the P-K appliance. The features which permit this appliance to achieve high-efficiency performance can be misused which could result in personal injury or death.

## 1 Introduction

This manual describes the installation and operation of P-K MODU-FIRE Forced Draft "MFD" series boilers and water heaters featuring NURO controls:

MFD Boilers	MFD Water Heaters
Category II or IV Venting See <a href="#">Section 1.1</a> for modulation ANSI Z21.13 / CSA 4.9 ASME "H" Stamp 160 PSI Maximum Pressure 250°F Maximum Temperature	Category II or IV Venting See <a href="#">Section 1.1</a> for modulation ANSI Z21.10.3 / CSA 4.3 ASME "HLW" Stamp 160 PSI Maximum Pressure 210°F Maximum Temperature

Individual differences between each model will be called out and defined in separate sections and the titles of these sections will include the applicable model number. If model numbers are not listed in the section title, that section is common to all models.

If you have any questions on the information contained within, or do not fully and completely understand the content, please contact Patterson-Kelley Technical Service at **570.476.7261** or toll free at **877.728.5351**.

The MODU-FIRE Forced Draft gas-fired appliance is fully modulating using a variable speed combustion blower, sophisticated microprocessor controls, modulating gas safety shut off / control valves and a time tested copper finned-tube heat exchanger. The high-quality materials and state of the art design should provide years of trouble-free service if the instructions in this manual are followed carefully.

This appliance is only a part of the complete hydronic or domestic water system. This appliance may be fully operational and yet because of poor circulation, improper control, or other site related characteristics, not deliver heat to the desired location. Additional equipment such as temperature sensors, pumps, flow switches, balancing valves, and check valves will be required for satisfactory operation of any system. Patterson-Kelley cannot be responsible for the design or operation of such systems and a qualified engineer or contractor must be consulted.

While details may differ slightly, basic operation is the same for all models. Most models may be built to operate with natural gas or liquefied petroleum gas (propane). Check the rating plate for correct fuel type and gas pressures.



## 1.1 Reference Table –MODU-FIRE Forced Draft “MFD” Models

Model Number	Vent Category	Max Input Rating (Btu/hr)	Min Input Rating (Btu/hr)	Effective Turndown Ratio	Max Output Rating (Btu/hr)	Efficiency	Recovery Rating (GPH) 40°F to 140°F
<b>MFD Boilers: ASME “H” Stamp &amp; ANSI Z21.13 / CSA 4.9</b>							
N750-MFD	II or IV	750,000	150,000	5:1	637,500	85%	N/A
N1000-MFD	II or IV	1,000,000	166,000	6:1	850,000	85%	N/A
N1500-MFD	II or IV	1,500,000	250,000	6:1	1,275,000	85%	N/A
N2000-MFD	II or IV	2,000,000	335,000	6:1	1,700,000	85%	N/A
<b>N2500-MFD*</b>	II or IV	2,500,000	500,000	5:1	2,200,000	85%	N/A
<b>N3000-MFD*</b>	II or IV	3,000,000	500,000	6:1	2,640,000	85%	N/A
<b>MFD Water Heaters: ASME “HLW” Stamp &amp; ANSI Z21.13 / CSA 4.9</b>							
W750-MFD	II or IV	750,000	150,000	5:1	637,500	85%	772.5
W1000-MFD	II or IV	1,000,000	166,000	6:1	850,000	85%	1030
W1500-MFD	II or IV	1,500,000	250,000	6:1	1,275,000	85%	1545
W2000-MFD	II or IV	2,000,000	335,000	6:1	1,700,000	85%	2060

**\*\*NOTE:** Models N2500-MFD & N3000-MFD are only approved for use with Natural Gas.  
All other models can be ordered for Natural Gas or Propane Gas.



## 1.2 Purpose of this Document

The purpose of this Installation and Owner's Manual is to provide comprehensive documentation support for the P-K MODU-FIRE Forced Draft series of gas fired boilers and water heaters featuring NURO controls. This manual discusses requirements for all installations as well as recommended best practices for installation, operation and maintenance.

The primary concern of all Patterson-Kelley equipment installation procedures is safety. Safety instructions and considerations are presented and repeated throughout the document as required. If you have any questions on the information contained within, or do not fully and completely understand the content, please contact Patterson-Kelley Technical Service at **570.476.7261** or toll free at **877.728.5351**.

## 1.3 Common Abbreviations

Abbreviation	Description
AMP	Ampere or Amperage
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
AWG	American Wire Gauge
BTU	British Thermal Unit
CH	Comfort Heat
CO <sub>2</sub>	Carbon Dioxide
CSA	Canadian Standards Association
CSD-1	Controls and Safety Devices
CPVC	Chlorinated Polyvinyl Chloride
DHW	Domestic Hot Water
HWR	Heating Water Return / Hot Water Return (From Building)
HWS	Heating Water Supply / Hot Water Supply (To Building)
ID	Inside Diameter
MBH	Thousands of BTU / Hour
MFD	MODU-FIRE Forced-Draft Series Boiler or Water Heater
MODBUS	A serial communication protocol (not an abbreviation)
NFPA	National Fire and Protection Agency
NTC	Negative Temperature Coefficient
O <sub>2</sub>	Oxygen
OD	Outside Diameter
OEM	Original Equipment Manufacturer
SCFM	Standard Cubic Feet per Minute
SMACNA	Sheet Metal and Thermoplastic Duct Construction Manual Air Conditioning Contractors National Association
TB<#>	Terminal Block (1, 2, 3 etc.)
VAC	Volts Alternating Current
VDC	Volts Direct Current



### **⚠ WARNING**

Installation and service must be performed by a qualified installer, service agency, or gas supplier. Failure to install the equipment in accordance with this manual could result in an unsafe operating condition.

### **⚠ WARNING**

The appliance is heavy and requires additional technicians to support and move the unit(s) during installation. Use extreme caution to avoid dropping the appliance or cause any bodily injury while lifting or handling. When positioning this appliance, maintain positive control of it at all times. Do not attempt to move the boiler on surfaces that are not level. Failure to heed this warning could result in personal injury or death.

### **NOTICE!**

The appliance may be installed on a combustible floor; however, the appliance must never be installed on carpeting.

### **⚠ WARNING**

Bumping hazard from overhead ducts! Install all components with adequate vertical clearances. Insufficient clearance can restrict the service access, increasing the possibility of injury.

## **2 Site Preparation**

### **2.1 Initial Inspection upon Receiving**

Upon receiving the appliance, inspect it for signs of shipping damage. Some damage may be hidden. Unpack the appliance, open the front and side doors and inspect the appliance. Verify that the total number of pieces shown on the packing slip agrees with those actually received.

**NOTICE!** Note any damage, suspected potential damage, or shortage of materials on the freight bill and immediately notify the carrier. File all claims for shortage or damage with the carrier. Claims for hidden damages must be filed with your carrier within 7 days. The carton is equipped with a “Tip (N) Tell”. If the “Tip (N) Tell” arrow point is blue, that indicates the package has been on its side or tipped over in transit.

### **2.2 Storage Prior to Installation**

If the appliance is not installed immediately, it must be stored in a location adequately protected from the weather, preferably indoors. If this is not possible, then it should remain in the shipping container and be covered by a tarpaulin or other waterproof covering.

**NOTICE!** Controls and other equipment that are damaged or fail due to weather exposure are not covered by warranty.



## 2.3 Compliance with Codes

	MFD Series Boilers	MFD Series Water Heaters
Code of Construction	ASME Section IV – “H” (Latest Edition)	ASME Section IV – “HLW” (Latest Edition)
CSA/ANSI Specification	ANSI Z21.13 / CSA 4.9 (Latest Edition)	ANSI Z21.10.3 / CSA 4.3 (Latest Edition)
Maximum Allowable Working Pressure	160 PSIG	160 PSIG
Maximum Allowable Design Temperature	250°F	210°F
Maximum Setpoint	220°F	190°F
Hi-limit Setpoint	240°F	197°F
Suitable for Potable Water?	NO	YES

### 2.3.1 MFD Series: Boiler Specific Certifications

The “**N Series**” MODU-FIRE Forced-Draft **boilers** with standard components comply with American National Standard/CSA Standard ANSI Z21.13/CSA 4.9, latest edition. The heat exchanger is not suitable for use with potable water and is constructed and “H” stamped in accordance with ASME Boiler and Pressure Vessel Code, Section IV for 160 psig maximum pressure and 250°F maximum temperature. Other codes or approvals which apply will be labeled on the boiler.

### 2.3.2 MFD Series: Water Heater Specific Certifications

The “**W Series**” MODU-FIRE Forced-Draft **water heaters** with standard components comply with American National Standard/CSA Standard ANSI Z21.10.3/CSA 4.3, latest edition. The heat exchanger is suitable for use with potable water and is constructed and “HLW” stamped in accordance with ASME Boiler and Pressure Vessel Code, Section IV for 160 psig maximum pressure and 210°F maximum temperature. Other codes or approvals which apply will be labeled on the water heater.

**NOTE:** The appliance should be located in an area where leakage of the tank or connections will not result in damage to the area adjacent to the appliance or to lower floors of the structure. When such locations cannot be avoided, it is recommended that a suitable drain pan, adequately drained, be installed under the appliance. The pan must not restrict combustion air flow.

**NOTE:** If a water heater is installed in a closed water supply system, such as one having a backflow preventer in the cold water supply line, means shall be provided to control thermal expansion. Contact the water supplier or local plumbing inspector on how to control this situation.



**Note:** For tube type circulating water heaters installed only with a pressure relief valve, the separate storage vessel must have a temperature and pressure relief valve installed. This relief valve shall comply with the Standard for Relief Valves for Hot Water Supply Systems, ANSI Z21.22 • CSA 4.4. (Also see Clauses 4.21.4 and 4.21.5.)

### 2.3.3 Installation Codes

Installation of the boiler or water heater must conform to all the requirements of all national, state, and local codes established by the authorities having jurisdiction or, in the absence of such requirements, to the National Fuel Gas Code, ANSI Z223.1/NFPA 54 latest edition in the U.S. In Canada, the equipment shall be installed in accordance with the current Installation Code for Gas Burning Appliances and Equipment, CAN/CSA-B.149, latest edition, and applicable Provincial Regulations for the class, which should be carefully followed in all cases. Authorities having jurisdiction should be consulted before making any installation.

Where required by local codes, the installation must conform to American Society of Mechanical Engineers Safety Code for Controls and Safety Devices for Automatically Fired Boilers (ASME CSD-1).

In the Commonwealth of Massachusetts (a) this unit must be installed by a licensed pipe fitter/plumber, (b) field installed gas cocks must be “T” handle type, (c) piping of condensate shall conform to the State Plumbing Code, and (d) refer to the Massachusetts Supplement for further details.

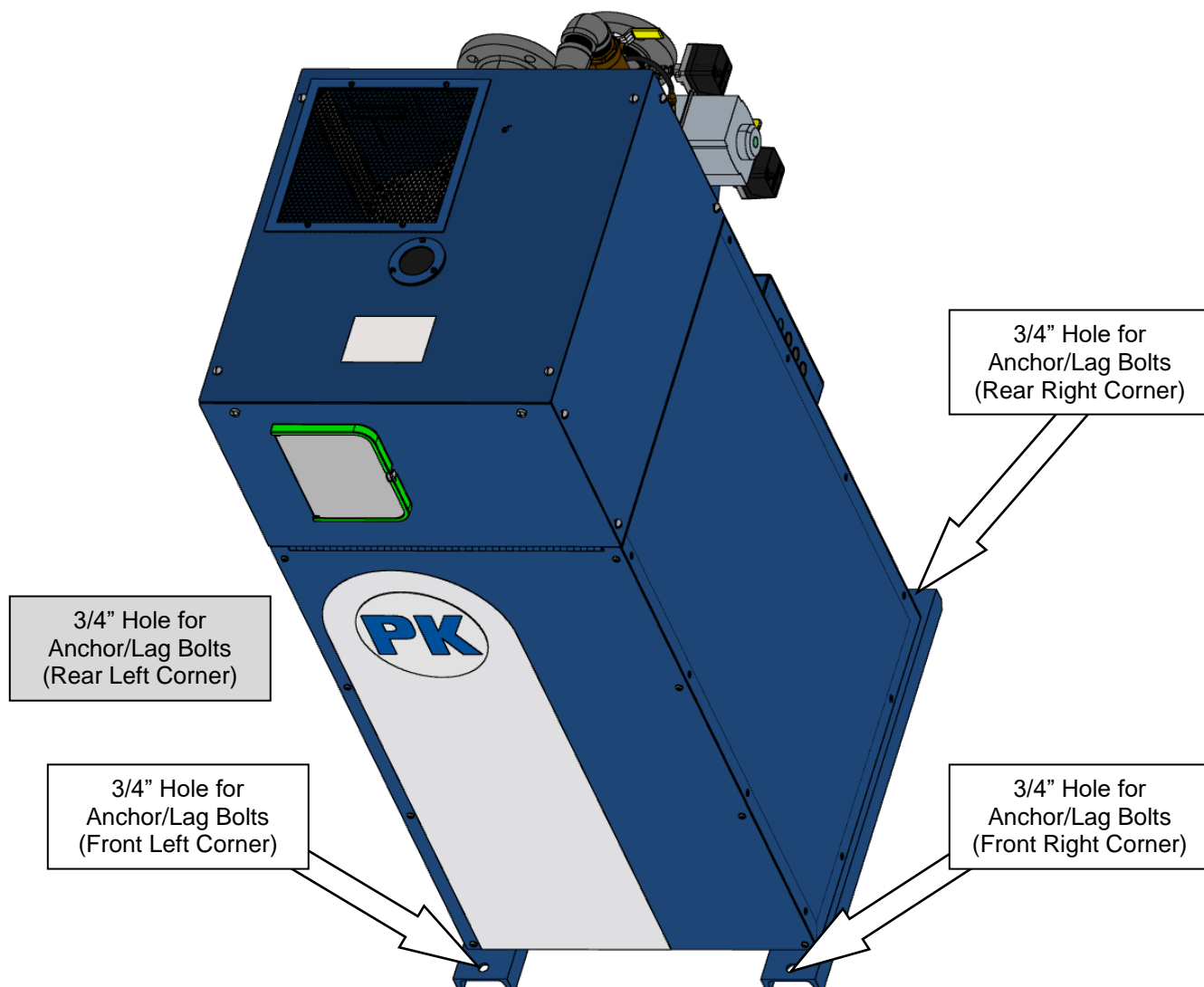




## 2.4 Location Setup

### 2.4.1 Foundation

Provide a firm, level foundation, preferably made of concrete. The MODU-FIRE Forced Draft boilers and water heaters **must** be level and upright to function properly. There are 3/4" holes at the four corners of the structural steel c-channel base for anchoring and leveling as shown below. Once the appliance is installed on the foundation and furnished with anchor/lag bolts, use a bubble level and adjust the four anchor nuts until the appliance is secure and level.



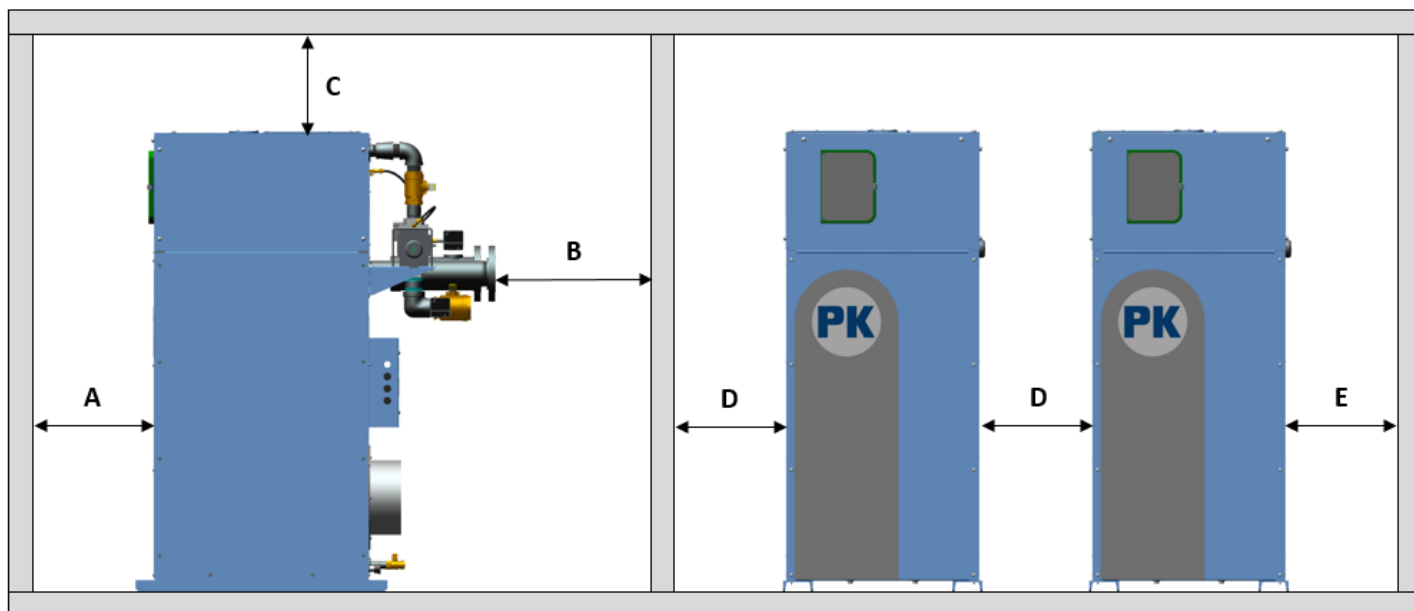
**NOTICE!** The appliance may be installed on a combustible floor; however, the appliance must **NEVER** be installed on carpeting.

**NOTICE!** This appliance is certified for **INDOOR** use only!



## 2.4.2 Clearances

If the boiler or water heater is to be installed near combustibles surfaces, there must be twenty-four (24") inches minimum clearance. Failure to provide adequate service clearances, even with non-combustible surfaces, may present problems during routine maintenance of the appliance. The appliance must be installed in a space large in comparison to the appliance as described in the National Fuel Gas Code, NFPA 54/ANSI Z223.1, Latest Edition.



Type of Surface	Dimensions (inches)				
	A	B	C†	D**	E**
CSA Minimum Clearances to Combustibles	24	24	24	24	24
Clearance to Non-Combustible Surfaces	0	0	0	0	0
Recommended Service Clearances	36	24*	24	24**	24**

† "C" dimension includes clearance to remove the burner. Do not put pipes, ducts, etc. in area above the appliance.

\*CSA minimum. Actual clearance depends upon venting requirements.

\*\* Left & Right-Side service access ("D" & "E" Dimension") are needed to view the appliance's runout & safety warning labels, and access the electrical junction box.

**Note:** Failure to provide recommended service clearances may make it difficult to perform service on the appliance(s).



### **⚠ WARNING**

Design and installation of venting systems should be done only by qualified and knowledgeable venting systems personnel and in accordance with the vent system manufacturer's installation instructions. Installing an appliance or vent system using improper installation methods or materials can result in serious injury or death due to fire or asphyxiation.

### **⚠ WARNING**

Before connecting an appliance to a venting system, it must be determined whether the appliance is to be installed in a conventional or direct vent configuration. In the US, provisions for combustion air must be in accordance with NFPA 54/ANSI Z223.1, National Fuel Gas Code, latest edition, or applicable provisions of local building codes. In Canada, combustion and ventilation air openings shall comply with CAN/CSA B-149.1 Natural Gas and Propane Installation Code.

### **⚠ WARNING**

For correct installation of a vent system, read all of these instructions and refer to the vent manufacturer's instructions.

Failure to use a proper vent system (types and materials), as described in this manual will void the warranty and may result in rapid deterioration of the venting system, creating a health or life safety hazard. Faulty vent installation can allow toxic fumes to be released into living areas. This may cause property damage, injury, or death.

## 2.5 Inlet Air and Exhaust Venting Considerations

### 2.5.1 Applicable Codes and Standards

#### United States Installation Codes:

NBIC – Part I	National Board Inspection Code - Installation
NFPA 54/ANSI Z223.1	National Fuel Gas Code
NFPA/ANSI 211	Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances

#### Canada Installation Codes:

CAN/CSA B149.1	Installation Codes for Gas Burning Equipment
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#### Flue Gas Exhaust Vent Standards:

UL 441 / ULC S605	Standard for Gas Vents
ULC S636	Standard for Type BH Gas Venting Systems
UL 1738	Venting Systems for Gas-Burning Appliances, Categories II, III and IV

These codes and standards contain information for the venting of gas fired appliances, including, but not limited to vent sizing, location, clearance to combustibles, and safe installation practices. The installation must comply with both the above Federal Codes and with state, provincial, and local codes.

### 2.5.2 Combustion Air Inlet Planning (United States and Canada Considerations)

- Air inlet considerations for the United States are established by NFPA 54/ANSI Z223.1 & NFPA/ANSI 211.
- Air inlet requirements for Canada are established by CAN/CSA B149.1.

Refer to [Section 3.4](#) for more details on combustion air inlet requirements in the United States and Canada.



### 2.5.3 Category II/IV Flue Gas Exhaust Vent Planning (MFD Boilers & Water Heaters)

Several codes and standards, e.g. NFPA 54/ANSI Z223.1 categorize appliances in accordance with the flue gas temperature and pressure produced by the appliance, which are defined as follows:

#### MODU-FIRE Forced Draft Boilers & Water Heaters

- **Category II:** An appliance that operates with a non-positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.
- **Category IV:** An appliance that operates with a positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.
- **Direct Vent:** An appliance that is constructed and installed so that all air for combustion is derived directly from outdoors and all flue gases are discharged to the outdoors.

MODU-FIRE Forced-Draft series boilers are dual-certified as **Category II or IV** appliances, as defined in ANSI Z21.13/CSA 4.9, latest edition. MODU-FIRE Forced-Draft series water heaters are also dual-certified as **Category II or IV** appliances, as defined in ANSI Z21.10.3/CSA 4.3, latest edition. The MFD series boilers and water heaters are capable of operating with slightly negative to slightly positive exhaust pressure. It is critical to ensure the flue vent material is certified for **Category II or IV** operation.

**NOTE:** For **Category II** installations, ensure the flue venting system is designed to maintain a slightly negative exhaust pressure **between -0.01" W.C. and -0.05" W.C.**

**NOTE:** For **Category IV** installations, ensure the flue venting system is designed to maintain a slightly positive exhaust pressure which **MUST BE** in the following ranges:

- **+0.01" W.C. and +1.5" W.C.** (MFD Sizes 750 through 2000)
- **+0.01" W.C. and +1.0" W.C.** (MFD Sizes 2500 & 3000).

The vent material to be used for US and Canada is listed in the Table of Acceptable Materials for Venting Systems located in [Section 2.5.4](#).

Vent installations shall be in accordance with NFPA 54/ANSI Z223.1, the National Fuel Gas Code, or CAN/CSA-B149.1, the Natural Gas and Propane Installation Code, or applicable provisions of the local building codes.

#### Vent Sizing for Category II / IV Operation (MFD Boilers & Water Heaters Only)



The vent must be sized in accordance with the ASHRAE Systems and Equipment handbook (Chapter 30) or according to the vent manufacturer's recommendations. When using manufactured venting systems, consult your vent supplier for correct sizing and structural support requirements.


MFD Appliance Size	Exhaust Pressure	Stack Temperature	CO <sub>2</sub> Natural Gas	CO <sub>2</sub> Propane Gas
750/1000/1500/2000	1.5" W.C.	325 °F (gross)	8.7%	10.0%
2500/3000	1.0" W.C.	325 °F (gross)	8.4%	N/A



## 2.5.4 Venting Materials for Flue/Exhaust Systems

MODU-FIRE Forced-Draft series boilers and water heaters are dual-certified as **Category II or IV** appliances, which vent with a gas temperature that is likely to cause condensation in the vent. Therefore, any venting system used with a MFD series boiler or water heater **MUST** comply with the requirements for Category II or IV venting systems as specified in the latest edition of NFPA 54/ANSI Z223.1 in the US or the latest edition of CAN/CSA B-149.1 in Canada.

	The use of plastic venting materials including CPVC, PVC, PolyPropylene, etc. is <b>PROHIBITED!</b> Failure to comply with this warning could result in injury or death due to failed flue material.
	The venting materials listed below are intended for the venting of gas burning appliances only. Do not use these venting materials for venting liquid or solid fuel (such as oil, kerosene, wood, or coal) appliances.  Maintain clearances to combustibles as listed in the vent manufacturer's installation instructions or as set forth in the codes and standards listed in this section. Do not use these vent pipes for incinerators of any sort.


The venting materials listed are intended for the venting of gas burning appliances only. Do not use these venting materials for venting liquid or solid fuel (such as oil, kerosene, wood, or coal) appliances.
Maintain clearances to combustibles as listed in the vent manufacturer's installation instructions or as set forth in the codes and standards listed in this section.
Do not use these vent pipes for incinerators of any sort!
This appliance is not certified for use with PVC venting. Use of PVC venting may result in vent failure and possible serious injury or death.
Do NOT insulate non-metallic vents.

As per ANSI Z21.13b-2012 \* CSA 4.9b-2012:

- The use of cellular core PVC, cellular core CPVC, or Radel® as venting materials is prohibited.
- The use of plastic vent pipe is **prohibited**.

Table of Acceptable Venting Materials for MFD Appliances

Product Series	Category	Country	Type B	AL29-4C	316L SS	PVC	CPVC	PP
MFD Boilers	II, IV	US	No	Yes	Yes	No	No	No
MFD Water Heaters	II, IV	US	No	Yes	Yes	No	No	No
MFD Boilers	II, IV	Canada	No	Yes	Yes	No	No	No
MFD Water Heaters	II, IV	Canada	No	Yes	Yes	No	No	No
<b>Note 1:</b> Ensure this flue material is suitable for Category I applications.								



## 2.5.5 Required Clearances

The vent for this appliance shall not terminate:

- 1) Over public walkways; or
- 2) Near soffit vents or crawl space vents or other areas where condensate or vapor could create a nuisance or hazard or cause property damage; or
- 3) Where condensate vapor could cause damage or could be detrimental to the operation of regulators, relief valves, or other equipment.

### Conventional Vent Systems Clearances

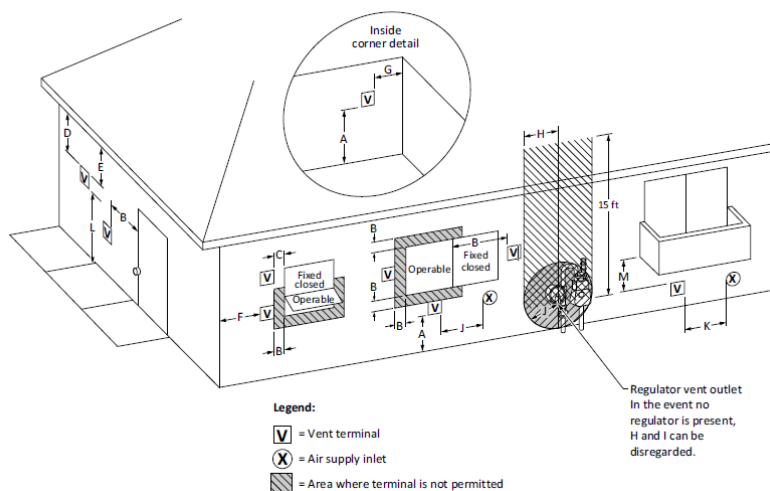
The following termination clearance requirements are for conventional non direct-vent installations:

- The vent system shall terminate at least 3 ft. above a forced air inlet located within 10 ft. horizontally.
- The vent system shall terminate at least 4 ft. below, 4 ft. horizontally from, or 1 ft. above any door, operable window, or gravity inlet into any building. The bottom of the vent terminal shall be at least 12 in. above grade or highest expected snow line (if applicable).
- Through-the-wall terminations shall not terminate over public walkways or over an area where condensate or vapor could create a nuisance or hazard or could be detrimental to the operation of regulators, relief valves, or other equipment.

### Direct Vent (Sealed Combustion) Systems Clearances

- The vent terminal shall be located at least 12 in. from any air opening into a building. The bottom of the vent terminal shall be at least 12 in. above grade. Both the vent and air intake terminals must be at least 12 in. above the highest expected snow line.
- Through-the-wall terminations shall not terminate over public walkways or over an area where condensate or vapor could create a nuisance or hazard or could be detrimental to the operation of regulators, relief valves, or other equipment.
- When multiple direct vent appliances are adjacent, the exhaust must terminate at least 10 ft. horizontally or 3 ft. vertically from the air intake of another appliance.

**NOTE:** Kit required for sealed combustion for models N2500 & N3000.



### **WARNING**

The appliance vent should not be connected into any portion of another mechanical draft system without consulting the vent manufacturer. Improper interconnection of venting systems may result in leakage of flue gases into occupied spaces.





**P-K MFD Gas Fired Appliance  
Technical Service 1.877.728.5351**

Mark	Description	US Installations	Canadian Installations
A	Clearance above grade, veranda, porch, deck, or balcony	12 in (30 cm)	12 in (30 cm)
B	Clearance to window or door that may be opened	4 ft (1.2 m) below or to side of opening; 1 ft (300 mm) above opening	<ul style="list-style-type: none"> <li>• 6 in (15 cm) for appliances <math>\leq</math> 10,000 Btuh (3 kW),</li> <li>• 12 in (30 cm) for appliances <math>&gt;</math> 10,000 Btuh (3 kW) and <math>\leq</math> 100,000 Btuh (30 kW)</li> <li>• 36 in (91 cm) for appliances <math>&gt;</math> 100,000 Btuh (30 kW)</li> </ul>
C	Clearance to permanently closed window	Clearance in accordance with local installation codes and the requirements of the gas supplier.	See Note 4
D	Vertical clearance to ventilated soffit located above the terminal within a horizontal distance of 2 ft (61 cm) from the center line of the terminal	See Note 4	See Note 4
E	Clearance to unventilated soffit	See Note 4	See Note 4
F	Clearance to outside corner	See Note 4	See Note 4
G	Clearance to inside corner	See Note 4	See Note 4
H	Clearance to each side of center line extended above meter/regulator assembly	See Note 4	3 ft (91 cm) within a height 15 ft (4.6 m)
I	Clearance to service regulator vent outlet	See Note 4	3 ft (91 cm)
J	Clearance to nonmechanical air supply inlet to building or the combustion air inlet to any other appliance	4 ft (1.2 m) below or to side of opening; 1 ft (300 mm) above opening	<ul style="list-style-type: none"> <li>• 6 in (15 cm) for appliances <math>\leq</math> 10,000 Btuh (3 kW),</li> <li>• 12 in (30 cm) for appliances <math>&gt;</math> 10,000 Btuh (3 kW) and <math>\leq</math> 100,000 Btuh (30 kW)</li> <li>• 36 in (91 cm) for appliances <math>&gt;</math> 100,000 Btuh (30 kW)</li> </ul>
K	Clearance to a mechanical air supply inlet	3 ft (91 cm) above if within 10 ft (3 m) horizontally	6 ft (1.83 m)
L	Clearance above paved sidewalk or paved driveway located on public property	7 ft (2.13 m) for mechanical draft systems (Category I appliances). Vents for Category II and IV appliances cannot be located above public walkways or other areas where condensate or vapor can cause a nuisance or hazard	7 ft (2.13 m) <sup>†</sup>
M	Clearance under veranda, porch, deck, or balcony	See Note 4	12 in (30 cm) <sup>‡</sup>
For clearances not specified maintain clearance in accordance with local installation codes and the requirements of the gas supplier			

<sup>†</sup> A vent shall not terminate directly above a sidewalk or paved driveway that is located between two single family dwellings and serves both dwellings.

<sup>‡</sup> Permitted only if veranda, porch, deck, or balcony is fully open on a minimum of two sides beneath the floor.

**Notes:** 1) In accordance with the current CSA B149.1, Natural Gas and Propane Installation Code.

2) In accordance with the current ANSI Z223.1/NFPA 54, National Fuel Gas Code.

3) If locally adopted installation codes specify clearances different than those illustrated, then the most stringent clearance shall prevail.

4) Clearance in accordance with local installation codes and the requirements of the gas supplier.



## Interior Component Clearances

All vent system components shall be installed so as to maintain the following required minimum clearances:

Material	Combustible	Non-Combustibles
Unlisted single wall metal pipe	Do NOT Use	Do NOT Use
Single wall CPVC, PVC or PP pipe	Do NOT Use	Do NOT Use
UL 441 listed Category I vent	Per manufacturer's listing	Per manufacturer's listing
UL 1738 listed Category II or IV vent	Per manufacturer's listing	Per manufacturer's listing

## Flue Connection

The connection from the appliance to the vent should be as direct as possible and the upward slope of any horizontal breaching should be at least 1/4 inch per linear foot. Examples of the complete exhaust system with drain is [Section 3.5](#). The appliance connector should incorporate provisions to drain condensate formed in the vent system. The connector should include an appropriate drain section (not provided).

## 2.6 Gas Piping Considerations

Before making the gas hook-up, make sure the appliance is being supplied with the type of fuel shown on the nameplate.

### **WARNING**

Supplying a fuel other than that shown on the appliance's nameplate can lead to overfiring of the appliance. This can cause damage to the equipment which could result in serious injury and/or death.

The appliance shall be installed such that the gas ignition system components are protected from water (dripping, spraying, rain, etc.) during appliance operation and service (circulator replacement, control adjustment, etc.).

## 2.7 Water Quality Standard

The appliance's heat exchanger contains copper finned-tubing. The heat exchanger requires proper water conditions to remain efficient and function properly. For information, please refer to Patterson-Kelley Multi-Metal Systems Water Quality Standards as it appears in [Appendix C –Water Quality Standard for Hydronic Boilers in Multi-Metal Systems](#) as this applies to the warranty of your heat exchanger.

**NOTE:** Failure to maintain the water quality according to the requirements of the multi-metal systems water quality standards can void the heat exchanger warranty.



## 3 Installation

### 3.1 Overview

For the preliminary site preparation, follow the guidelines discussed in [Section 2](#). Section 3 details the installation requirements for electrical connections, combustion air, flue vent piping, hydronic or domestic water piping, etc.

### 3.2 Appliance Connections

The table below summarizes the appliance connections to the MFD series boilers:

Boiler Size	750, & 1000	1500	2000	2500 & 3000	2500* & 3000*
Power Requirement	208-240/1/60 VAC				
Air Intake Connection	8"			12" x 12"	10"
Nominal Exhaust Vent Connection	6"	8"	8"	10"	10"
Recommended Flue Size	Category II/IV: See <a href="#">Section 3.5.1</a>				
Fireside Drain Pipe	3/4" NPT-M (Steel)				
Heat Exchanger Drain	3/4"			3/4" NPT-F	
Gas Shutoff Valve	1-1/4" NPT-F		1-1/2" NPT-F	2" NPT-F	
HWR Connection	2-1/2" NPT-M (Steel)			3" 150# Flange (Steel)	
HWS Connection	2-1/2" NPT-F (Cast Iron)			3" 150# Flange (Cast Iron)	
*With optional air intake adapter (part # 23-0000-0480) installed for a 10" circular connection.					

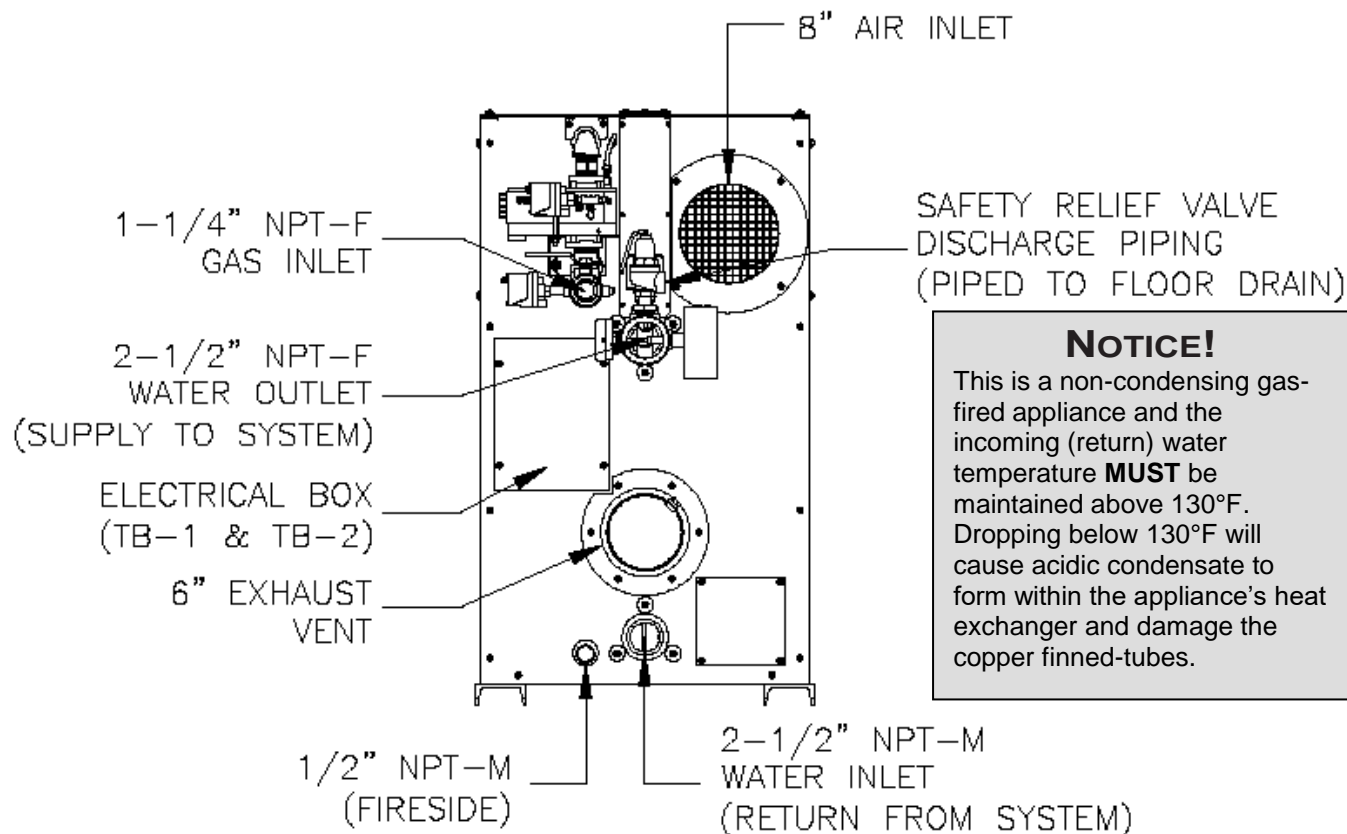
The table below summarizes the appliance connections to the MFD series water heaters:

Water Heater Size	750 & 1000	1500	2000
Power Requirement	208-240/1/60 VAC		
Air Intake Connection	8"		
Nominal Exhaust Vent Connection	6"	8"	
Recommended Flue Size	Category II/IV: see table in <a href="#">Section 3.5.1</a>		
Fireside Drain Pipe	3/4" NPT-M (Steel)		
Heat Exchanger Drain Valve	3/4" NPT-F		
Gas Shutoff Valve	1-1/4" NPT-F		1-1/2" NPT-F
HWR Connection	2-1/2" NPT-M (Brass)		
HWS Connection	2-1/2" NPT-F (Nickel Plated)		



### 3.2.1 Appliance Connections (750 & 1000 Sizes)

All connections must be in compliance with national, state, and local code requirements.



#### NOTICE!

This is a non-condensing gas-fired appliance and the incoming (return) water temperature **MUST** be maintained above 130°F. Dropping below 130°F will cause acidic condensate to form within the appliance's heat exchanger and damage the copper finned-tubes.

#### NOTICE!

This appliance is furnished with a 3/4" drain pipe which is used to drain built-up condensation inside the combustion chamber. Connect this 3/4" drain pipe to the common drain piping.

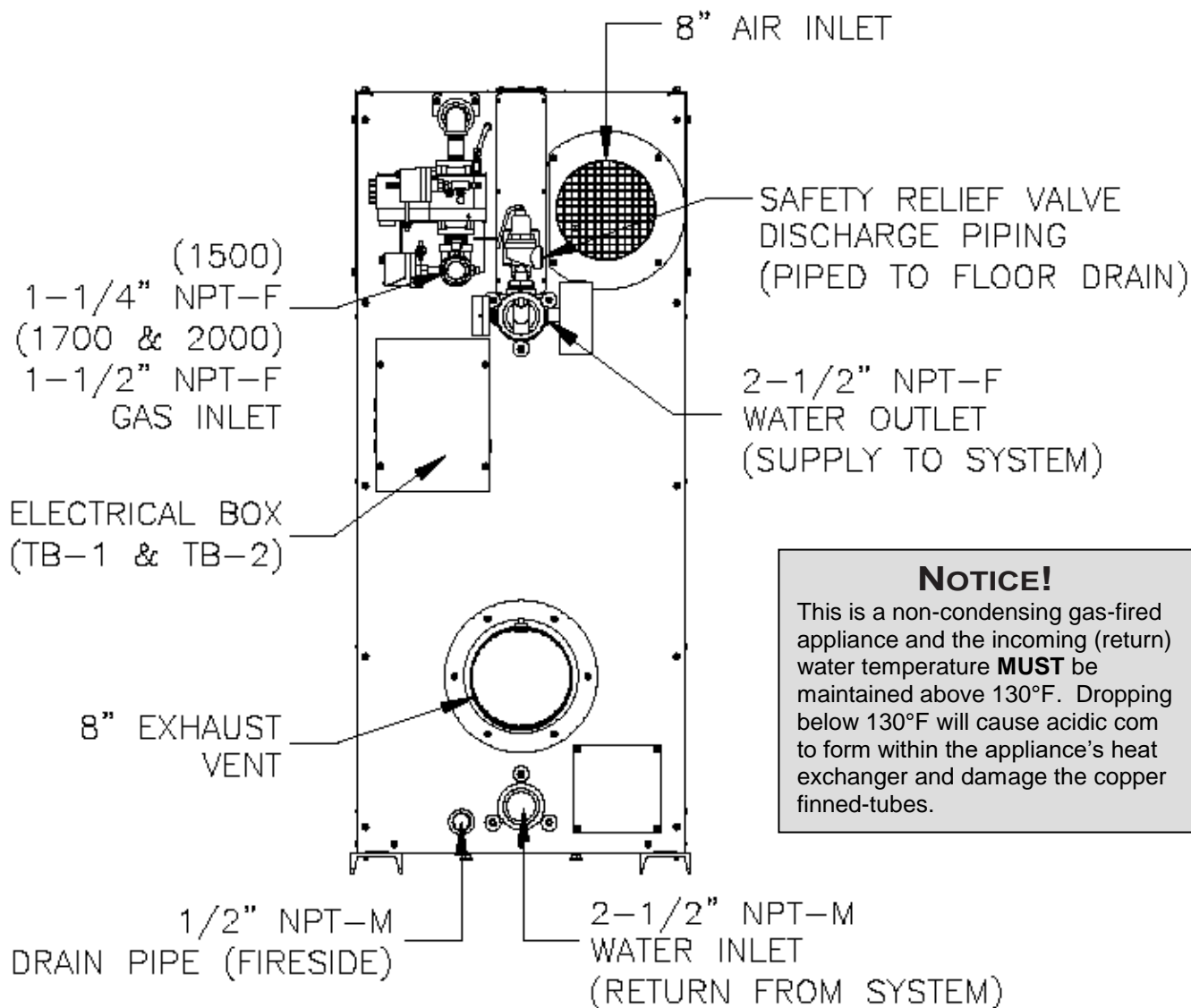
#### NOTICE!

Most installation codes require a 3/4" manual drain (ball) valve to be installed at the lowest point on the heat exchanger. Make sure the appliance is isolated from the heating system before using the manual drain valve.



### 3.2.2 Appliance Connections (1500 & 2000 Sizes)

All connections must be in compliance with national, state, and local code requirements.



#### NOTICE!

This is a non-condensing gas-fired appliance and the incoming (return) water temperature **MUST** be maintained above 130°F. Dropping below 130°F will cause acidic com to form within the appliance's heat exchanger and damage the copper finned-tubes.

#### NOTICE!

This appliance is furnished with a 3/4" drain pipe which is used to drain built-up condensation inside the combustion chamber. Connect this 3/4" drain pipe to the common drain piping.

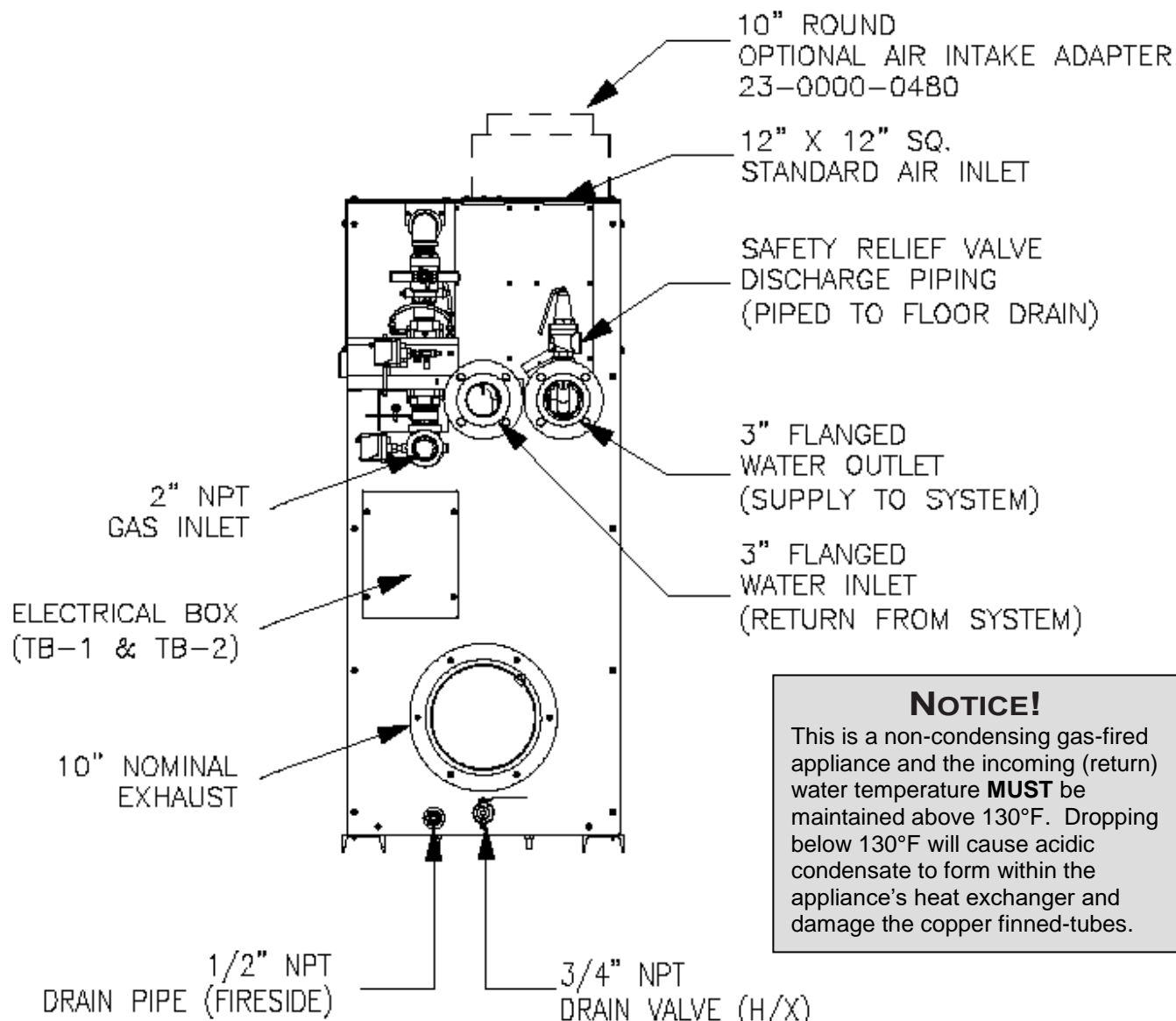
#### NOTICE!

Most installation codes require a 3/4" manual drain (ball) valve to be installed at the lowest point on the heat exchanger. Make sure the appliance is isolated from the heating system before using the manual drain valve.



### 3.2.3 Appliance Connections (N2500-MFD & N3000-MFD)

All connections must be in compliance with national, state, and local code requirements.



#### NOTICE!

This appliance is furnished with a 3/4" drain pipe which is used to drain built-up condensation inside the combustion chamber. Connect this 3/4" drain pipe to the common drain piping.

#### NOTICE!

The appliance is furnished with a 3/4" manual drain (ball) valve which allows the user to completely drain the heat exchanger. Make sure the appliance is isolated from the heating system before using the manual drain valve.





## 3.3 Electrical Connections

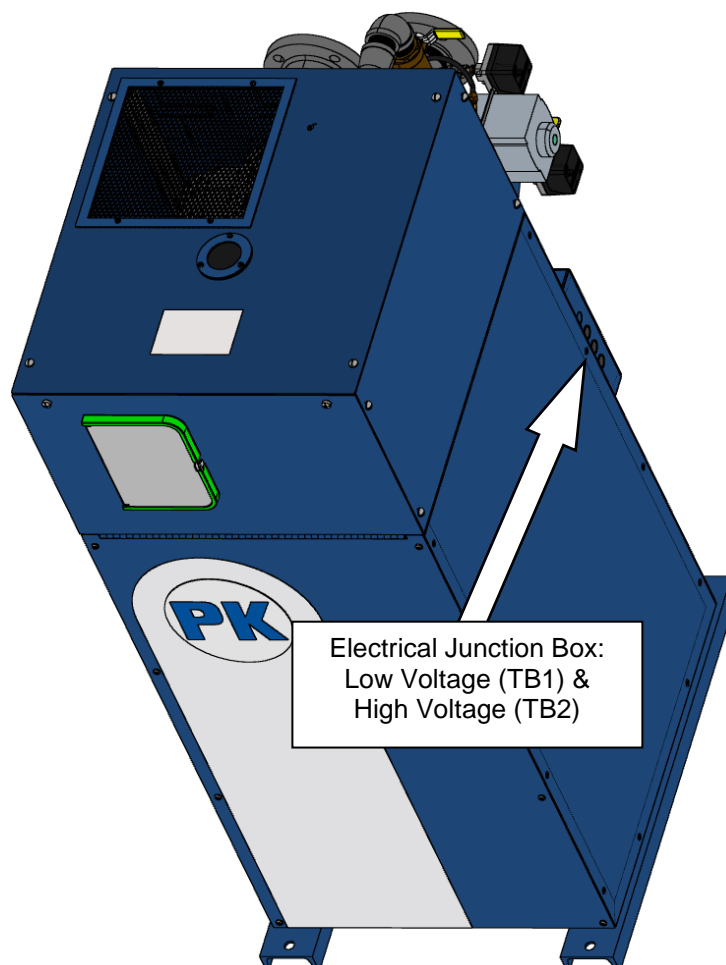
### 3.3.1 Power Requirements

The MFD series boilers and water heaters require either 120VAC -or- 208-240 VAC, **single phase**, 60 hertz electrical service. The MCA and MOCP are indicated on the appliance's rating nameplate. Before starting the appliance, check to ensure that the proper electrical service is connected to the appliance.

	750 – 1000		1500 – 2000		2500 – 3000
	120VAC	208-240VAC	120VAC	208-240VAC	
<b>Maximum Over-Current Protection</b>	6 Amps	5 Amps	15 Amps	10 Amps	15 Amps
<b>Recommended Circuit Capacity</b>	10 Amps		20 Amps	15 Amps	20 Amps

An external electrical disconnect and overload protection (not supplied with the appliance) **are required**. Refer to [Section 6.1](#) for proper wiring and configuration of the electrical connections. The electrical service must be installed and grounded in accordance with local codes or in the absence of such requirements, in the U.S. with National Electrical Codes, ANSI/NFPA No. 70 latest edition or, in Canada, to the current Canadian Electrical Code, Part I, CSA C22.1 latest edition. Installed conduit must not block any of the appliance's openings and must allow the front door to be opened.

The low voltage (TB1) and high voltage (TB2) terminal blocks are located inside the junction box, located on the right rear surface of the appliance as shown to the right:





## ⚠ CAUTION

Be sure to check the nameplate on the appliance before connecting the electrical supply.

## NOTICE!

A dedicated earth ground (green wire) is required to avoid nuisance shutdowns. Do not ground through the conduit!

## ⚠ WARNING

The high voltage (TB2) terminal block on the MFD boilers & water heaters with NURO controls requires two hot leads (L1 & L2), one neutral (N), and a ground lead (G) for 208-240 VAC, single phase 60Hz electrical supply. This terminal block (TB2) also contains dry-contact relays with a maximum voltage rating of 240VAC and 1/2 Amp maximum current capacity. Incorrect wiring can result in equipment damage, injury, or death.

### 3.3.2 High Voltage (TB2) Terminal Block (208-240VAC)

Refer to [Section 6.1](#) for a detailed drawing of the electrical junction box on the rear surface of the appliance. An image of the high voltage (TB2) terminal block and descriptions of each of the terminals are provided below:

**L1 208-240V** – Connect the 1<sup>st</sup> hot lead of the 208-240VAC, single phase, 60Hz electrical service to the TB2-1 terminal.

**L2 208-240V** – Connect the 2<sup>nd</sup> hot lead of the 208-240VAC, single phase, 60Hz electrical service to the TB2-2 terminal.

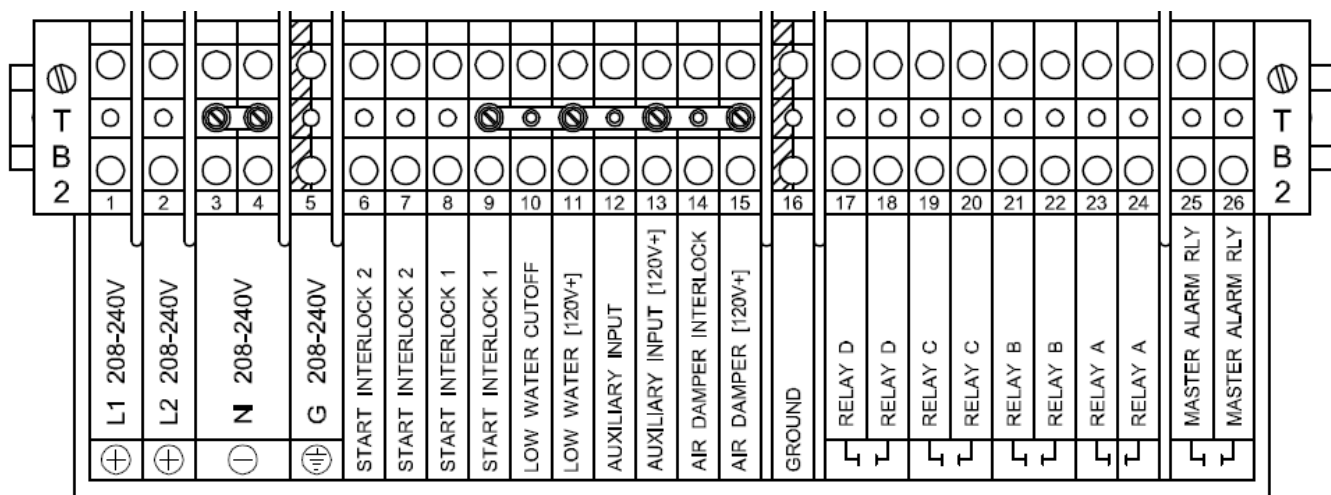
**NEUTRAL 208-240V** – Connect the neutral lead of the 208-240VAC, single phase, 60Hz electrical service to the TB2-3 or TB2-4 terminals.

**GROUND G1** – Connect the ground lead from the electrical service to the TB2-5 terminal.

**Start Interlock #2** – The Start Interlock #2 TB2-6 & TB2-7 terminals are in series with Start Interlock #1 and provide additional connection points for auxiliary safety devices. This circuit is energized with 120VAC, so the contacts on any auxiliary safety devices must be rated for minimum 120VAC.

**Start Interlock #1** – The Start Interlock #1 TB2-8 & TB2-9 terminals can be used for auxiliary safety devices such as damper limit switches, control valve limit switches, emergency stop buttons, and low water cutoff devices. This circuit is energized with 120VAC, so the contacts on any auxiliary safety devices must be rated for a minimum of 120VAC. The appliance ships with a factory-installed jumper across Start Interlock #1 and Start Interlock #2 terminals. Remove the jumper(s) if using any auxiliary safety devices.

**NOTE:** The Start Interlock circuit must close within 5 minutes of a call for heat. Failure to close the Start Interlock circuit will cause the appliance to lockout on alarm.



**Low Water Cutoff** – Connect the common (COM) and normally-open (NO) terminals from an auxiliary low water cutoff device to the TB2-10 & TB2-11 terminals. This circuit is energized with 120VAC, so the contacts on the auxiliary low water cutoff device must be rated for a minimum of 120VAC.



**Auxiliary Input** – The TB2-12 & TB2-13 terminals are reserved for future use. This circuit is energized with 120VAC.

**Air Damper Interlock** – The Air Damper Interlock TB2-14 & TB2-15 terminals allow for proof of open end limit switch on a motorized air damper. This circuit is energized with 120VAC, so the contacts on the end limit switch must be rated for minimum 120VAC. The appliance ships with a factory-installed jumper across the Air Damper Interlock terminals. Remove the jumper if connecting a motorized air damper with end limit switch.

**Ground** – Grounding connection for auxiliary safety/limit devices on terminal TB2-16.

**NOTE:** This ground terminal is connected to the TB2 sheet metal and is not common with the appliance's electrical service ground.

**Relay A** – User-configurable relay output #1 located on terminals TB2-23 & TB2-24. The normally-open contacts on this relay have a maximum voltage rating of 240VAC and maximum capacity of 1/2 Amp.

**Relay B** – User-configurable relay output #2 located on terminals TB2-21 & TB2-22. The normally-open contacts on this relay have a maximum voltage rating of 240VAC and maximum capacity of 1/2 Amp.

**Relay C** – User-configurable relay output #3 located on terminals TB2-19 & TB2-20. The normally-open contacts on this relay have a maximum voltage rating of 240VAC and maximum capacity of 1/2 Amp.

**Relay D** – User-configurable relay output #4 located on terminals TB2-17 & TB2-18. The normally-open contacts on this relay have a maximum voltage rating of 240VAC and maximum capacity of 1/2 Amp.

**NOTE:** Refer to [Section 6.1](#) for proper wiring and configuration of the electrical connections. Relays A through C can be user-configured through the NURO touch screen interface to control devices such the Comfort Heat (CH) Pump, Domestic Hot Water (DHW) Pump, Air Damper, System Pump, etc. Relay D cannot be used for Air Damper.

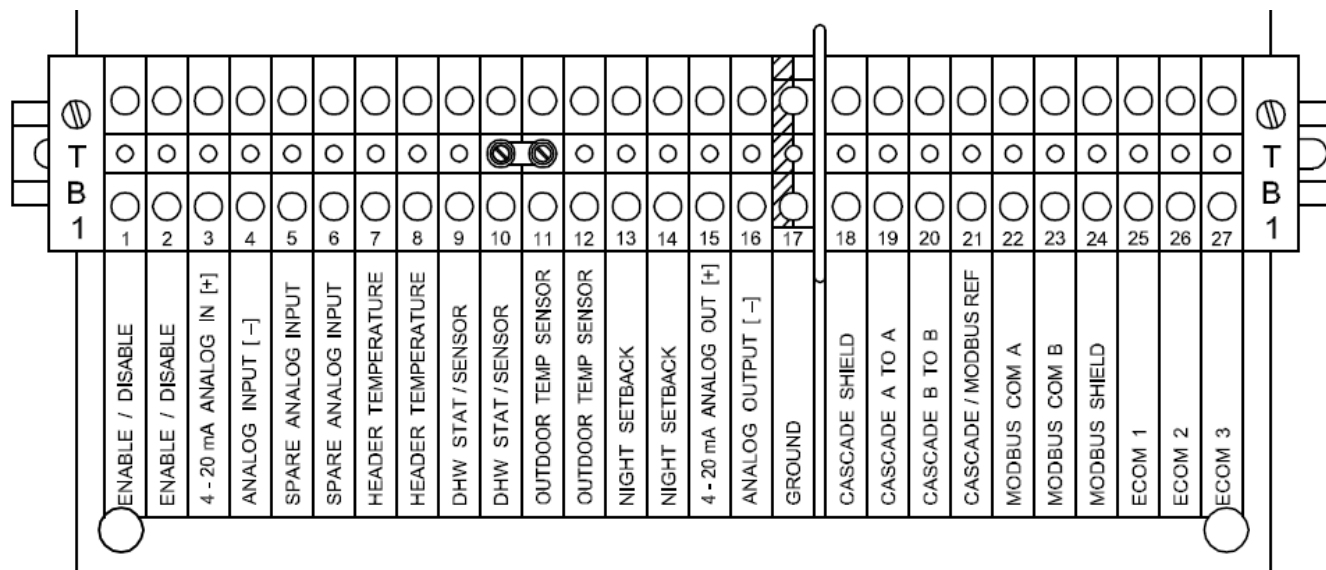
**Master Alarm Relay** – The Master Alarm Relay TB2-25 & TB2-26 terminals are normally-open dry contacts that close in the event of an alarm output from the NURO control. The normally-open contacts on this relay have a maximum voltage rating of 240VAC and maximum current capacity of 1/2 Amp.

**NOTE:** The two 24VAC transformers in the control panel cannot be used to power any other devices. They are dedicated to the NURO and SOLA only.



### 3.3.3 Low Voltage (TB1) Terminal Block (120VAC -or- 208-240VAC)

Refer to [Section 6.1](#) for a detailed drawing of the electrical junction box on the rear surface of the appliance. An image of the low voltage (TB1) terminal block and descriptions of each of the terminals are provided below:



**Enable/Disable** – TB1-1 and TB1-2 can be used to remotely enable or disable the appliance. The functionality of these terminals is user-configurable through the NURO controls, but generally closure of the Enable/Disable circuit provides a call for heat to the appliance. Opening this circuit prevents the appliance from running.

The appliance ships with a factory-installed jumper across the Enable/Disable terminals. This circuit is energized with a 24VAC potential, so the contacts on any remote enable devices must be rated for minimum 24VAC.

**4-20mA Analog Input** – TB1-3 and TB1-4 can be used to provide a remote analog 4-20mA control signal to the appliance. This analog signal can be used to change the appliance's operating setpoint or firing rate.

**Spare Analog Input** – TB1-5 and TB1-6 are reserved for future use.

**HDR Temp Sensor** – TB1-7 and TB1-8 can be used to connect a remote header temperature sensor, installed in the primary hydronic system piping, downstream of all the appliances. This temperature sensor must be a 2-wire 12k $\Omega$  NTC thermistor. This circuit is energized by the appliance with a 5VDC potential.

**DHW Stat/Sensor** – TB1-9 and TB1-10 can be used to connect either an aquastat or remote DHW temperature sensor installed in a domestic hot water storage tank. If using an aquastat, use a SPST normally-closed, break on rise type with either a fixed or adjustable deadband above and below the setpoint.

Alternatively, if using a temperature sensor, it must be a 2-wire 12k $\Omega$  NTC thermistor and be of sufficient length to measure an accurate storage tank temperature. This circuit is energized by the appliance with a 5VDC potential.



**Outdoor Temp Sensor** – TB1-11 and TB1-12 can be used to connect an outdoor air temperature sensor which allows the NURO control to be programmed to run an outdoor air schedule. The outdoor air temperature sensor must be a 2-wire 12kΩ NTC thermistor and should be installed on the North face of the building and shielded from direct sunlight exposure. This circuit is energized by the appliance with a 5VDC potential.

**Night Setback** – TB1-13 and TB1-14 can be used to connect a day/night or occupancy timer. Closure of the Night Setback circuit enables the Night Setback mode which reduces the appliance's operating setpoint. Opening this circuit resumes normal operation. This circuit is energized by the appliance with a 5VDC potential, so the contacts on the day/night timer must be rated for minimum 5VDC.

**4-20mA Analog Output** – TB1-15 and TB1-16 provide a 4-20mA analog output signal which tracks the appliance's firing rate. When operating at full power (maximum firing rate), the appliance will provide a 20mA output (adjustable). When operating at minimum power (minimum firing rate), the appliance will provide a 4mA output (adjustable). See *NURO Boiler Controller: Advanced User's Guide* for additional instructions on adjusting the analog output signals.

**Ground** – TB1-17 provides an equipment (frame) ground connection for input, output, or communication connections. For independently powered control devices, it may be necessary to create a common ground.

**Cascade Shield & Cascade** – TB1-18, TB1-19, and TB1-20 can be used to setup a cascade system with multiple MFD appliances with NURO controls. Terminals TB1-19 and TB1-20 are reserved for the cascade communication between the master and member positions. Terminal TB1-18 should be used to connect the cascade communication wiring shield between all appliances. The cascade and shielding must be wired from the master appliance to each individual member appliance in a daisy-chain fashion.

**NOTE:** Only ground the shield at the master boiler or water heater.

**MODBUS COM & MODBUS Shield** – TB1-22, TB1-23, and TB1-24 can be used to integrate the appliance with a Building Management System (BMS), Protocol Converter, or other device capable of RS-485 2-wire MODBUS communication. Terminals TB1-22 and TB1-23 are reserved for MODBUS and terminal TB1-18 provides a connection for the MODBUS communication wire shield.

**NOTE:** Only ground the shield at the master boiler or water heater.

**ECOM 1, 2, & 3** – TB1-25, TB1-26, and TB1-27 can be used to connect a wireless outdoor air temperature sensor. The wireless receiver should be installed at or near the appliance, and the wireless temperature sensor should be installed on the North face of the building and shielded from direct sunlight exposure.





## 3.4 Combustion Air

### 3.4.1 Air Inlet Requirements – United States

Air inlet requirements for the United States are established by NFPA 54/ANSI Z223.1 & NFPA/ANSI 211. When air is supplied from inside the building, the total required volume shall be the sum of the required volume for all the appliances located in the mechanical room. Adjacent rooms furnished with fixed openings communicating directly with the mechanical room are considered part of the required volume. The minimum volume is 50 ft<sup>3</sup> per 1,000 Btu/hr (4.8 m<sup>3</sup>/kW) of installed appliance input capacity.

Openings used to connect indoor spaces to obtain the required minimum volume shall be sized as follows:

- When rooms are on the same floor, each opening shall have an area equal to 1 square inch for each 1,000 Btu/hr (2,200 mm<sup>2</sup>/kW) of installed appliance input capacity, but not less than 100 square inches. One opening should commence less than 12 inches above the floor and the other less than 12 inches below the ceiling. The minimum dimension of air openings shall be 3 inches.
- When rooms are on different floors, each opening shall have an area equal to 2 square inches for each 1,000 Btu/hr (4,400 mm<sup>2</sup>/kW) of installed appliance input capacity.

When combustion air is supplied from outside the building, the mechanical room shall be provided with one or two openings to ensure adequate combustion air and proper ventilation.

When using one permanent opening, the opening shall commence within 12 inches of the ceiling and shall communicate directly with the outdoors or through a vertical or horizontal duct that communicates to the outdoors.

#### **WARNING**

**Under no circumstances shall the mechanical room ever be under a negative pressure.**

**Particular care should be taken when exhaust fans, compressors, air-handling units, or other equipment may rob air from the boiler. Note that this equipment might be in rooms other than the boiler room. This applies to both sealed combustion and atmospheric room combustion air applications.**

When using two permanent openings, one opening shall commence within 12 inches above the floor and the other within 12 inches below the ceiling, preferably on opposite walls. The openings shall communicate directly, or by way of ducts, with free outdoor air. The minimum net free area of the openings shall be calculated in accordance with the following:

- When air is taken directly from outside the building, each opening (minimum of two, as outlined above), 1 square inch for each 4,000 Btu/hr (550 mm<sup>2</sup>/kW) of total appliance input is required.
- When air is taken from the outdoors through a vertical duct into the mechanical room, 1 square inch per 4,000 Btu/hr (550 mm<sup>2</sup>/kW) of total appliance input is required.
- When air is taken from the outdoors through a horizontal duct into the mechanical room, 1 square inch per 2,000 Btu/hr (1,100 mm<sup>2</sup>/kW) of total appliance input is required.

#### **NOTES:**

1. The required size of openings for combustion and ventilation air shall be based on the net free area of the opening.
2. Screens shall be not smaller than 1/4 inch.
3. Motorized louvers shall be interlocked with the appliance so that they are proven open prior to main burner ignition and operation.





United States Minimum Area of Ventilation Openings per Appliance (Sq. In)

Appliance Size (BTU/Hr)	AIR SOURCE					
	INDOOR AIR SUPPLY		OUTDOOR AIR SUPPLY			
	SAME FLOOR	DIFF FLOORS	ONE OPENING	TWO OPENINGS		
				DIRECT	VERT DUCT	HORIZ DUCT
750,000	750	1500	250	188	188	375
1,000,000	1000	2000	334	250	250	500
1,500,000	1500	3000	500	375	375	750
1,700,000	1700	3400	567	425	425	850
2,000,000	2000	4000	667	500	500	1000
2,500,000	2500	5000	834	625	625	1250
3,000,000	3000	6000	1000	750	750	1500

### 3.4.2 Air Inlet Requirements - Canada

Air inlet requirements for the Canadian Provinces are established by CAN/CSA B149.1. Ventilation of the space occupied by fuel burning appliance(s) or equipment shall be supplied by a ventilation opening at the highest practicable point communicating with the outdoors. The total cross sectional area of the ventilation opening must be either 10% of the net free area required for combustion air or 10 sq. in. (6,500 mm<sup>2</sup>), whichever is greater.

**NOTES:**

1. The free area of a combustion air supply opening is calculated by deducting the blockage area of any fixed louvers, grilles or screens from the total area of the opening.
2. Screens shall be not smaller than 1/4 inch.
3. Motorized louvers shall be interlocked with the appliance so that they are proven open prior to main burner ignition and operation.

- A.** Ventilation of the space occupied by fuel burning appliance(s) or equipment shall be supplied by a ventilation opening at the highest practicable point communicating with the outdoors. The total cross sectional area of the ventilation opening must be either 10% of the net free area required for combustion air or 10 sq. in. (6,500 mm<sup>2</sup>), whichever is greater.
- B.** Use the following opening calculation for MFD boilers and water heaters:
- When combustion air is supplied for a forced draft burner by natural airflow from the outdoors and there is no draft regulator or draft hood in the same space, there shall be a permanent opening with a cross sectional area not less than 1 sq. in./30,000 Btu/Hr (70 mm<sup>2</sup>/kW) of the total rated input to the burner(s). This opening must not interfere with the ventilation air opening defined in **Paragraph A**.
- C.** Use the following opening calculation for MFD boilers and water heaters or other natural draft or fan-assist appliances:
- When combustion air is supplied for natural or fan-assisted burners by natural airflow from the outdoors, there shall be a permanent opening with a cross sectional area not less than 1 sq. in./7,000 Btu/Hr (321 mm<sup>2</sup>/kW) up to and including 1,000,000 Btu/Hr plus 1 sq. in./14,000 Btu/Hr (155 mm<sup>2</sup>/kW) in excess of 1,000,000 Btu/Hr. This opening must be either located at or ducted to a point not more than 18 in. (450 mm) or less than 6 inches (150 mm) above floor level. This opening is in addition to the ventilation air opening defined in **Paragraph A**.
- D.** When combustion air is supplied by natural airflow into a space containing both types of appliances described in **Paragraphs B and C**, the cross sectional area of the opening shall not be less than



the sum of the cross sectional areas for all appliances in the space as calculated by the applicable method. This opening is in addition to the ventilation air opening defined in **Paragraph A**.

- E. When a duct is used to meet the requirement for combustion air supply, as described in **Paragraphs A through D** above, the opening of the duct shall be located so there is no possibility of cold air affecting steam or water piping, electrical equipment, or mechanical equipment.
- F. When combustion air is supplied by mechanical means, an airflow-sensing device must be installed. It must be wired into the pre-ignition limit interlock circuit to prevent the burner from starting or to stop an operating burner in case of air supply failure.
- G. When all combustion air is supplied through a make-up air heater, and the appliance is interlocked to the heater, the requirements of **Paragraphs A through F** do not apply.

#### Canadian Minimum Area of Combustion and Ventilation Air Openings

Appliance Size (BTU/Hr)	Required Combustion Air Opening		Ventilation Air Opening	
	in <sup>2</sup>	mm <sup>2</sup>	in <sup>2</sup>	mm <sup>2</sup>
750,000	25	16,129	10	6,452
1,000,000	33.3	24,484	10	6,452
1,500,000	50	32,258	10	6,452
1,700,000	57	36,774	10	6,452
2,000,000	67	43,225	10	6,452
2,500,000	83.3	53,742	10	6,452
3,000,000	100	64,516	10	6,452

### 3.4.3 MFD Combustion Air Requirements

The table below summarizes the combustion air requirements for MFD appliances:

MFD Boiler	MFD Water Heater	Air Intake Connection	Required SCFM Combustion Air
N750-MFD	W750-MFD	8"	188
N1000-MFD	W1000-MFD	8"	251
N1500-MFD	W1500-MFD	8"	364
N2000-MFD	W2000-MFD	8"	501
N2500-MFD	-	12" x 12"	583
N3000-MFD	-	12" x 12"	700
N2500-MFD*	-	10"	583
N3000-MFD*	-	10"	700
*With air intake adapter (part # 23-0000-0480) installed for a 10" circular connection.			



### 3.4.4 Direct Vent / Sealed Combustion Installations

The MFD series boilers and water heaters are certified for operation in direct vent / sealed combustion systems, which feature combustion air intake ductwork which sources the combustion air supply from outdoors. The flow of combustion air through this ductwork is maintained by the appliance's internal combustion blower.

The combustion air intake ductwork can be constructed with PVC, CPVC, single wall galvanized steel, or other suitable materials. The ductwork must be rigid enough to maintain the full required cross sectional area under all operating conditions.

**NOTE:** The combustion air intake ductwork must be sufficiently rigid in order to prevent collapse due to the potential for negative pressures inside the ductwork. If the ductwork collapses, this will restrict the combustion air supply to the appliance which may prohibit operation.

Proper sealing of the combustion air intake ductwork is necessary to prevent infiltration of air from conditioned space. For example, joints in PVC or CPVC piping must be cemented. For galvanized duct, wrap each joint and seam with adhesive aluminum tape or other sealant. Patterson-Kelley recommends installing a 1" x 1" or larger bird screen on the exterior termination. Ensure that the screen does not become blocked with snow, ice, insects etc.

The combustion air supply must be free from dust, lint, etc. The presence of such materials in the air supplied to the burner could cause nuisance "Low Air" shutdowns or premature burner failure. The appliance should not be operated during construction while the possibility of drywall dust, demolition dust, etc. exists.

The combustion air supply must be completely free of chemical fumes which may be corrosive when burned in the appliance. Common chemicals which must be avoided are fluorocarbons and other halogenated compounds, most commonly present as refrigerants or solvents, such as Freon®, trichloroethylene, perchloroethylene, chlorine, etc. These chemicals, when burned, cause improper combustion and premature appliance failure due to the formation of acids which quickly attack the heat exchanger and the flue piping materials.



## Sizing the Combustion Air Intake Ductwork

The combustion air flow rate requirements per appliance model are summarized in [Section 3.4.3](#). When sizing the combustion air intake ductwork, the pressure drop through this ductwork **MUST NOT** exceed 0.5" W.C. as described in the table below:

Appliance Size	Total Allowable Pressure Drop /Friction Loss	Maximum Allowable Pressure Drop through Combustion Air Duct	Allowable Vent Pressure
750/1000/1500/2000 MFD Category II	N/A	0.5" W.C.	-.01" W.C. to -0.05" W.C.
2500/3000 MFD Category II	N/A	0.5" W.C.	-.01" W.C. to -0.05" W.C.
750/1000/1500/2000 MFD Category IV	1.5" W.C.	0.5" W.C.	+0.01" W.C. to +1.0" W.C.
2500/3000 MFD Category IV	1.0" W.C.	0.5" W.C.	+0.01" W.C. to +0.5" W.C.

**NOTE:** If the combustion air intake ductwork and the exhaust vent terminate on the same wall of the building, they must utilize the same type of termination fitting.

**NOTE:** Patterson-Kelley recommends including a motorized combustion air damper in each appliance's air intake ductwork. Proceed to [Section 3.4.5](#) for more information.



### 3.4.5 Motorized Combustion Air Dampers

Patterson-Kelley recommends, and most installation codes require, the use of motorized combustion air dampers with end limit switches installed in the combustion air intake ductwork upstream of each appliance. This damper isolates the combustion air supply when the appliance is in standby. Once the appliance receives a call for heat, the motorized combustion air damper opens and the end limit switch must close before the appliance can proceed to ignition. Patterson-Kelley offers motorized combustion air dampers with built-in end limits switches for sale, which are summarized in the table below:

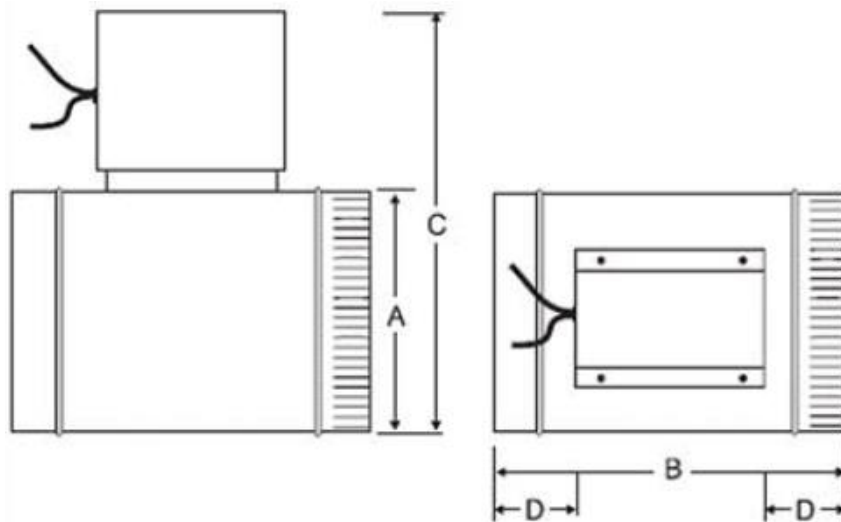


Table of Recommended Motorized Combustion Air Dampers

Combustion Air Ductwork Size	Normally-Closed Motorized Damper	A	B	C	D
8"	10-0490-6944	8"	8"	11"	2.38"
10"	10-0490-6945	10"	10"	13"	3.38"
12"	10-0490-6946	12"	12"	15"	4.38"
14"	10-0490-6989	14"	14"	17"	5.5"

These normally-closed motorized combustion air dampers operate on 120 VAC and feature a built in end limit switch which must be wired to the appliances' Air Damper Interlock circuit (terminals TB2-13 & TB2-14). Upon a call for heat, the appliances' Air Damper Relay energizes, which drives the damper motor open. Once the damper reaches the fully-open position, the end limit switch makes contact and closes the Air Damper Interlock circuit, allowing the appliance to proceed to ignition. The diagram below shows the wiring necessary to install the normally-closed motorized damper.

**NOTE:** The power source to drive the damper actuator motor must be provided externally. The appliance **DOES NOT** provide a power source for this purpose.

**NOTE:** Combustion air dampers other than those listed in the table above may require voltages other than 120VAC. This is acceptable, provided the required voltage does not exceed 240VAC.

**NOTE:** The Air Damper Interlock circuit for the end limit switch is always 120VAC which is sourced from the appliance itself. All end limit switches must be rated for 120VAC.



## ⚠ WARNING

For correct installation of a vent system, read all of these instructions and refer to the vent manufacturer's instructions.

Failure to use a proper vent system (types and materials) as described in this manual will void the appliance warranty and may result in rapid deterioration of the venting system, creating a health or life safety hazard.

Faulty vent installation can allow toxic fumes to be released into living areas. This may cause property damage, injury, or death

Motorized combustion air dampers must be powered from an external power supply other than the appliance. The figure below shows a sample installation in which Relay C is user-selected to operate a 120VAC motorized air damper. Relay C is normally-open, so when the appliance is in standby, the combustion air damper remains closed. Once a call for heat is received, Relay C closes the 120VAC circuit (external power supply) which provides power to the damper motor, opening the damper.

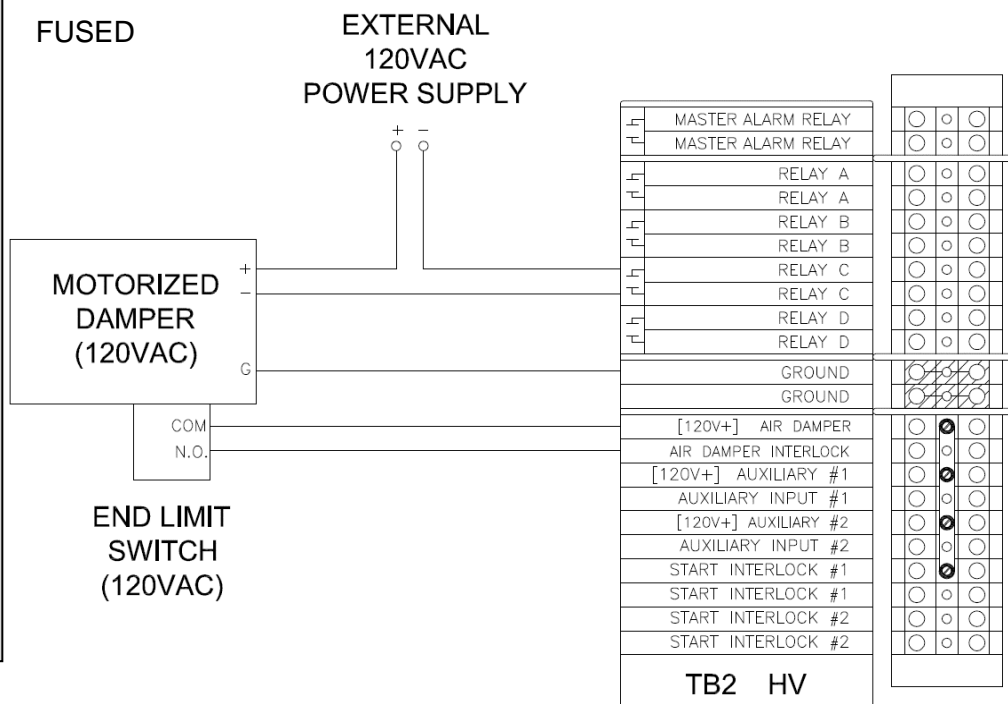
Once the motorized damper is fully-open, its end limit switch completes the Air Damper Interlock circuit (120VAC) which allows the appliance to proceed to ignition.

## ⚠ WARNING

External power supplies are required for Relay A, Relay B, Relay C and Relay D. Because power is provided from an external source, the power is still present when the appliance is turned off. Check all voltage sources have been disconnected prior to servicing. Failure to do so could result in electrocution, injury, or death.

## NOTICE!

Relay A, Relay B, Relay C, and Relay D are rated for a maximum voltage of 120VAC -or- 240VAC and a maximum current capacity of 1/2 Amp. Customer must supply fusing for all current connected to the relays. Connecting a motorized damper which exceeds the voltage or current capacity of the relay could cause



**NOTE:** The NURO control allows the user to allocate Relay A, B, or C for use with a motorized combustion air damper. The figure above shows Relay C in use for the motorized combustion air damper. Depending on the user-configuration, Relay A, Relay B, or Relay C can be selected to operate the combustion air damper.





### 3.5 Flue Gas / Exhaust Venting

All vent installations shall be in accordance with NFPA 54/ANSI Z223.1, the National Fuel Gas Code, or CAN/CSA-B149.1, the Natural Gas and Propane Installation Code, or applicable provisions of the local building codes.

The vent material to be used for US and Canada is listed in the Table of Acceptable Materials for Venting Systems located in [Section 2.5.4](#).

For interior clearance requirements, refer to [Section 2.5.5](#). The vent shall extend at least three (3) feet above the roof, or at least two (2) feet above the highest part of any structure within ten (10) feet of the vent. Refer to [Section Error! Reference source not found.](#) and [Section 3.5.2](#) for an illustration of the flue termination. Additionally, the boiler vent shall terminate at least three (3) feet above a forced air inlet located within ten (10) feet.

To prevent the possible re-circulation of flue gases, the vent designer must take into consideration such things as prevailing winds, eddy zones, building configurations, etc. **Patterson-Kelley cannot be responsible for the effects such adverse conditions may have on the operation of the appliances.**

#### **WARNING**

The boiler condensate drain line can get as hot as the stack. This may be up to 400°F. This line should be insulated to prevent thermal injury or burns.

#### **WARNING**

Do NOT use copper or plastic for the boiler condensate line, as these may fail and allow exhaust gas to leak into the room.

Vertical vents are allowed to be terminated with a variety of ends, including plain straight pipe, elbow, or vent tee. Horizontal vents must be terminated with an elbow or vent tee. Similarly, a bird screen with 1" x 1" openings is recommended for termination. Patterson-Kelley does not recommend using a vent rain cap of any type.

### MODU-FIRE Forced Draft Boilers & Water Heaters (Category II or IV Venting)

MODU-FIRE Forced-Draft series boilers are dual-certified as **Category II or IV** appliances, as defined in ANSI Z21.13/CSA 4.9, latest edition. MODU-FIRE Forced-Draft series water heaters are also dual-certified as **Category II or IV** appliances, as defined in ANSI Z21.10.3/CSA 4.3, latest edition. The MFD series boilers and water heaters are capable of operating with slightly negative to slightly positive exhaust pressure. It is critical to ensure the flue vent material is certified for **Category II or IV** operation and is suitable for use with the MFD appliance. Refer to [Section 3.5.1](#) for more information on Category II/IV vent installations.

**NOTE:** For **Category II** installations, ensure the flue venting system is designed to maintain a slightly negative exhaust pressure which **MUST NOT** exceed **-0.05" W.C.**

**NOTE:** For **Category IV** installations, ensure the flue venting system is designed to maintain a slightly positive pressure which **MUST BE** in the following ranges:

- **+0.01" W.C. and +1.5" W.C.** (MFD Sizes 750 through 2000)
- **+0.01" W.C. and +1.0" W.C.** (MFD Sizes 2500 & 3000).



### 3.5.1 Category II or IV Vent Installation (MFD Boilers and Water Heaters Only)

MODU-FIRE Forced-Draft series boilers are dual certified as **Category II or IV** appliances, as defined in ANSI Z21.13/CSA 4.9, latest edition and are not suitable for use with Type “B” Vents. MODU-FIRE Forced-Draft series water heaters are also dual-certified as **Category II or IV** appliances, as defined in ANSI Z21.10.3/CSA 4.3, latest edition and are **not suitable** for use with Type “B” vents.

MFD Boiler	MFD Water Heater	Air Intake Connection	Exhaust Vent Connection	Minimum Recommended Category II/IV Vent Pipe Size
N750-MFD	W750-MFD	8"	6"	5"
N1000-MFD	W1000-MFD	8"	6"	5"
N1500-MFD	W1500-MFD	8"	8"	6"
N2000-MFD	W2000-MFD	8"	8"	6"
N2500-MFD		12" x 12"	10"	8"
N3000-MFD		12" x 12"	10"	8"
N2500-MFD*		10"	10"	8"
N3000-MFD*		10"	10"	8"

\*With air intake adapter (part # 23-0000-0480) installed for a 10" circular connection.

#### **WARNING**

The appliance vent should not be connected into any portion of another mechanical draft system without consulting the vent manufacturer. The appliance shall not be connected to any part of a vent system serving a Category I or III appliance, nor shall a Category I or III appliance be connected to any part of the vent system serving this appliance. Improper interconnection of venting systems may cause leakage of flue gases into occupied spaces. **This can cause serious injury or death.**

#### **WARNING**

**Do not use a barometric damper** if operating with a positive stack pressure (Category IV). Harmful flue gases may leak into the room which can cause serious injury or death.

**NOTE:** For **Category II** installations, ensure the flue venting system is designed to maintain a slightly negative exhaust pressure **between -0.01" W.C. and -0.05" W.C.**

**NOTE:** For **Category IV** installations, ensure the flue venting system is designed to maintain a slightly positive exhaust pressure which **MUST BE** in the following ranges:

- **+0.01" W.C. and +1.5" W.C.** (MFD Sizes 750 through 2000)
- **+0.01" W.C. and +1.0" W.C.** (MFD Sizes 2500 & 3000).

The connection from the appliance to the vent should be as direct as possible and the upward slope of any horizontal breaching should be at least 1/4 inch per linear foot. Support the venting system in accordance with the manufacturer's instructions which specify to have support brackets no more than 39" (1m) apart.



## Category IV Installations

If the vent installation is designed for Category IV conditions only (condensing – positive pressure) as it is defined in ANSI Z21.13/CSA 4.9, latest edition, the installations shall be in accordance with NFPA 54/ANSI Z223.1, the *National Fuel Gas Code*, or CAN/CSA-B149.1, the *Natural Gas and Propane Installation Code*, or applicable provisions of the local building codes.

The following materials are used by venting manufacturers to produce listed venting systems.

- AL29-4C Stainless Steel Vent Systems listed and labeled to UL1738 *Venting Systems for Gas-Burning Appliances, Categories II, III, and IV*
- 316L Stainless Steel where certified and warranted by the vent manufacturer for venting of Category II, III or IV appliances

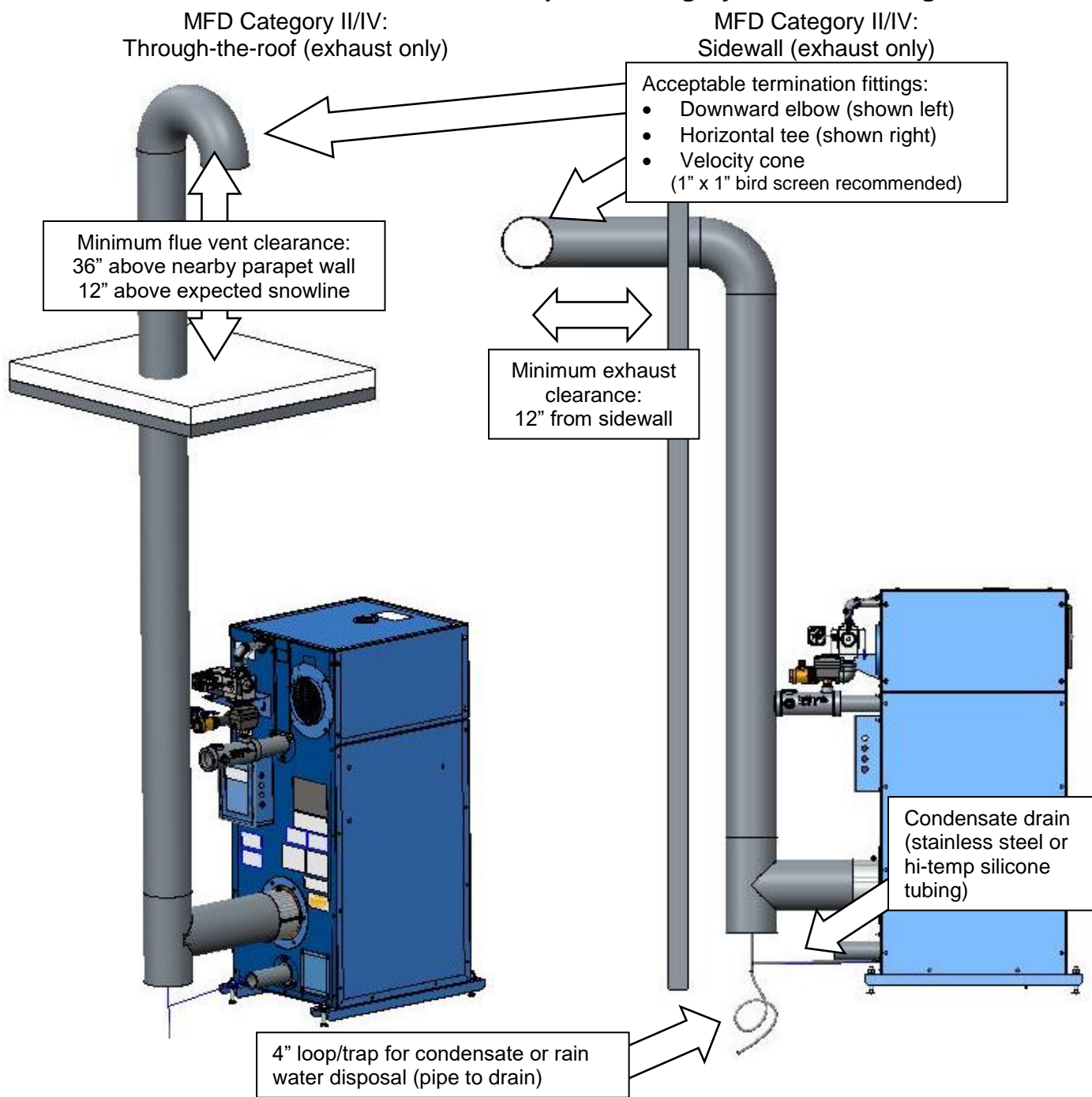
These prefabricated venting systems must be installed according to the manufacturer's installation instructions. Special care should be taken to ensure that any and all integral gasketing is properly assembled and creates a gas and water tight seal. Systems that require silicone caulking for gasketing should only be installed with silicone caulk that is recommended by the vent manufacturer, or if none is recommended, only high temperature, waterproof, silicone caulk should be used. Support of the venting system must be according to the manufacturer's instructions. The vent connection on the appliance itself shall not be used to support the weight of the vent.

## Direct Vent / Sealed Combustion

If the Category II or IV installation is direct vent / sealed combustion, then a normally-closed motorized damper is required on the combustion air intake ductwork. Refer to [Section 3.4.4](#) for more information.



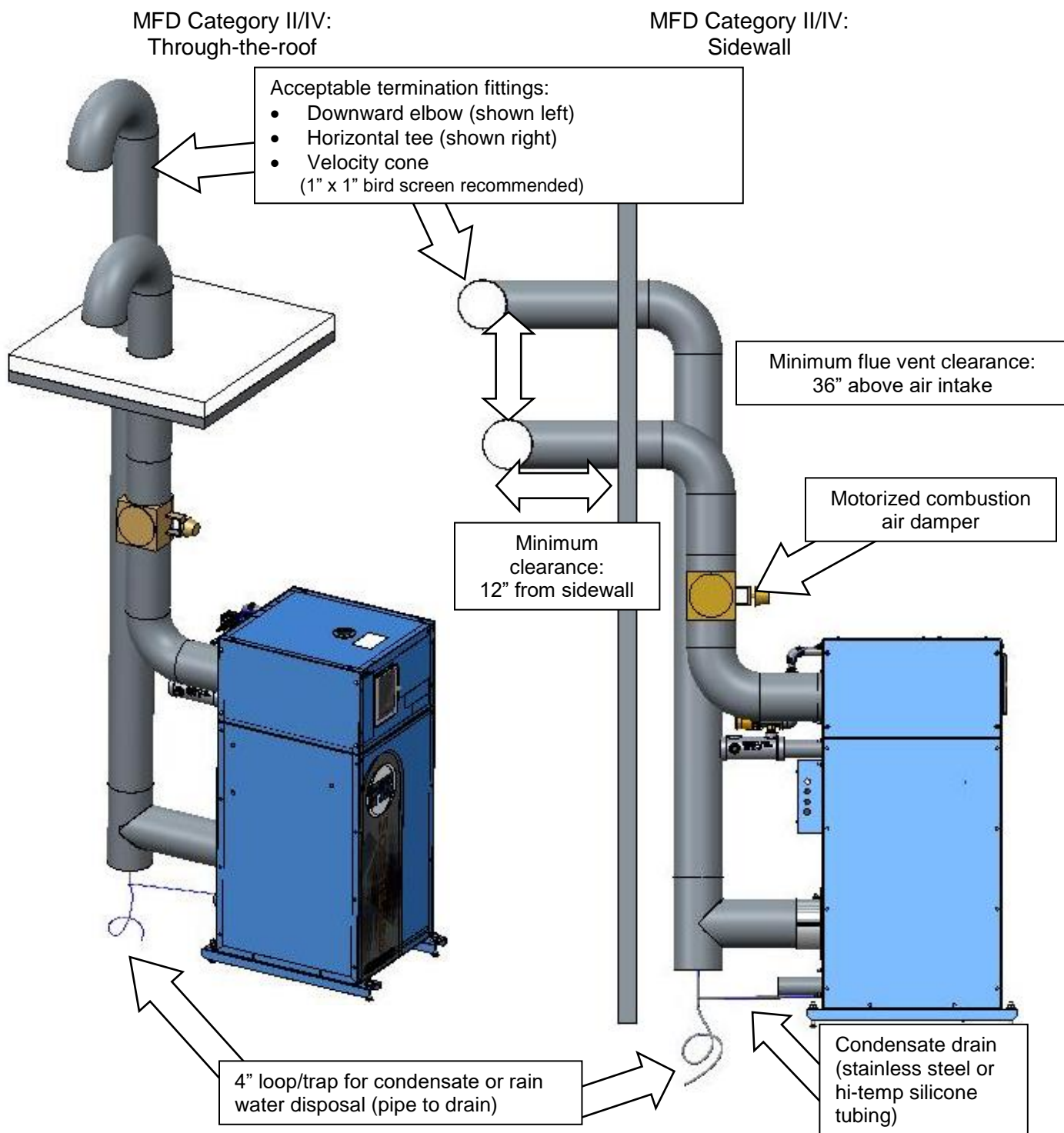
### 3.5.2 MFD Boilers & Water Heaters: Acceptable Category II/IV Vent Configurations



**NOTE:** For **Category II** installations, ensure the flue venting system is designed to maintain a slightly negative exhaust pressure **between -0.01" W.C. and -0.05" W.C.**

**NOTE:** For **Category IV** installations, ensure the flue venting system is designed to maintain a slightly positive exhaust pressure which **MUST BE** in the following ranges:

- **+0.01" W.C. and +1.5" W.C.** (MFD Sizes 750 through 2000)
- **+0.01" W.C. and +1.0" W.C.** (MFD Sizes 2500 & 3000).



**NOTE:** For **Category II** installations, ensure the flue venting system is designed to maintain a slightly negative exhaust pressure which does not exceed **-0.05" W.C.**

**NOTE:** For **Category IV** installations, ensure the flue venting system is designed to maintain a slightly positive exhaust pressure which does not exceed **+1.5" W.C.** (sizes 750 through 2000) or **+1.0" W.C.** (sizes 2500 & 3000).



### 3.5.3 Venting for Multiple Appliances

While the vent design parameters outlined in [Section 3.4](#) and [Section 3.5](#) still apply, achieving those same parameters in a combined vent system adds a significant degree of complexity. Therefore, venting systems for multiple appliances shall be designed by experienced and knowledgeable venting professionals. The venting system shall be designed to prevent backflow of exhaust gas through idle appliances. For combined breeching installations, please follow recommendations of a qualified venting engineer/manufacturer.

Patterson-Kelley recommends that common venting systems be designed for a maximum continuous exhaust pressure of -0.05" W.C. when measured in the common vent. Locking inline dampers are recommended on the exhaust connection of each individual appliance in order to control the exhaust back pressure within the appliance and upstream of this damper. The -0.05" W.C. in the common flue will also help make sure the exhaust gases from an online appliance does not backflow through offline appliance(s).

In addition, Patterson-Kelley also recommends the use of motorized combustion air dampers in the combustion air intake ductwork of each individual appliance. When an appliance is offline, its combustion air damper will remain closed which will also help prevent the backflow of flue gases from online appliances. Please refer to [Section 3.4.5](#) for more information.

#### **WARNING**

If the common venting system uses a draft inducer fan or damper device, this **MUST** be interlocked with the appliances. In the event this draft inducer device fails, the interlock circuits to the appliances must be opened in order to prevent operation. Failure to do so could result in appliance operation under excessive back pressure conditions which could result in damage to the appliance and lead to serious injury or death.

#### **WARNING**

The design of any common venting system **MUST** prevent backflow of combustion gases through offline boilers or water heaters. Failure to do so could result in damage to the appliance and lead to serious injury or death.





### 3.6 Removing an Existing Boiler or Water Heater

When an existing boiler or water heater is removed from a common venting system, the common venting system is likely to be too large for proper venting of the appliances remaining connected to it.

At the time of removal of an existing boiler or water heater, while the other appliances remaining connected to the common venting system are not in operation, the following steps should be followed with each appliance remaining connected to the common venting system placed in operation:

1. Seal any unused openings in the common venting system.
2. Visually inspect the venting system for proper size and horizontal pitch and determine that there is no blockage or restriction, leakage, corrosion or other deficiency which could cause an unsafe condition.
3. Insofar as is practical, close all building doors and windows and all doors between the space in which the appliance remaining connected to the common venting system are located and other spaces of the building. Turn on clothes dryers and any appliances not connected to the common venting system. Turn on any exhaust fans, such as range hoods and bathroom exhausts, so they will operate at maximum speed. Do not operate a summer exhaust fan. Close fireplace dampers.
4. Place the appliance being inspected in operation. Follow the lighting instructions. Adjust the thermostat so that the appliance will operate continuously.
5. Test for spillage at the draft hood relief opening after 5 minutes of main burner operation. Use the flame of a match or candle or smoke from a cigarette, cigar or pipe or smoke pen.
6. After it has been determined that each appliance remaining connected to the common venting system properly vents when tested as outlined above, return doors, windows, exhaust fans, fireplace dampers, and any other gas-burning appliance to their previous conditions of use.

Any improper operation of the common venting system should be corrected so the installation conforms to the National Fuel Gas Code, ANSI Z223.1 and CSA B149 Installation Code. When resizing any portion of the common venting system, the common vent system should be resized to approach the minimum size as determined using the appropriate tables in part 11 of the National Fuel Gas Code, ANSI Z223.1/NFPA 54 and/or CAN/CSA B149.1 Natural Gas and Propane Installation Code.

#### **WARNING**

**All threaded connections must be made using a pipe compound that is resistant to the action of liquefied petroleum gases. Do not use Teflon tape on gas line threads!**

#### **NOTICE!**

See Pipe Capacity Charts for Natural Gas or Propane Gas on the following pages for required pipe size, based on overall length of pipe from the meter plus equivalent length of all fittings. Approximate sizing may be based on 1 cubic foot of natural gas per 1,000 Btu per hour input, i.e., 3,000,000 Btu/hr requires about 3,000 cubic feet per hour.



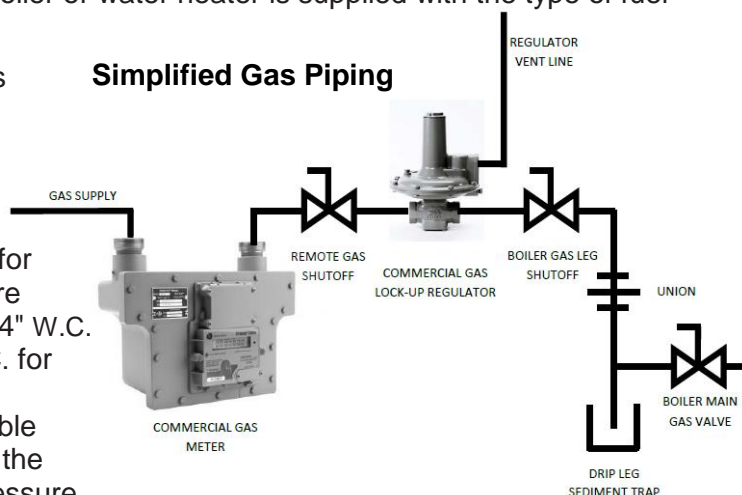
## 3.7 Piping

### 3.7.1 Gas Piping Overview

Before making the gas hook-up, make sure the boiler or water heater is supplied with the type of fuel shown on the nameplate.

The appliance shall be installed such that the gas ignition system components are protected from water (dripping, spraying, rain, etc.) during appliance operation and service (circulator replacement, control adjustment, etc.)

The appliance is factory fire-tested and adjusted for proper combustion. The gas train components are certified to handle a maximum inlet pressure of 14" W.C. (1/2 psig). Typical gas pressure supply is 7" W.C. for natural gas and 11" W.C. for propane gas. If the available gas pressure exceeds 14" W.C., a suitable additional intermediate gas pressure regulator of the "lock up" type must be provided to reduce the pressure to less than 14" W.C. Refer to the table below or the appliance's label for the minimum inlet gas pressure.



	750 & 1000	1500	2000	2500 & 3000
Natural gas	3.5" W.C	4" W.C.	3.5" W.C.	4" W.C.
Propane gas	7" W.C.			N/A

**NOTE:** When using a vented lock-up gas pressure regulator, the vent piping should be increased by one pipe size for every 10 equivalent feet of length. Never connect vent piping that is small in size than the gas regulator's vent port connection.

Install a sediment trap (drip leg) and a union connection ahead of the primary manual shutoff valve on the appliance. A gas piping schematic is shown above. Gas piping should be installed in accordance with National Fuel Gas Code, ANSI Z223.1, latest edition, and any other local codes which may apply; in Canada see CAN/CSA-B.149.1, latest edition. In the Commonwealth of Massachusetts, the gas cock must be a "T-handle type."

Appliance Size (BTU/Hr)	Natural Gas Requirement (CFH)	Propane Gas Requirement (CFH)
750,000	750	295
1,000,000	1000	394
1,500,000	1500	590
2,000,000	2000	788
2,500,000	2500	N/A
3,000,000	3000	N/A



### 3.7.2 Natural Gas Piping

The table below should be used to size the natural gas piping to the appliance. The approximate energy content of natural gas is 1,000 BTU / cu. Ft:

Pipe Capacity for Natural Gas

Nominal Iron Pipe Size (Inches)	Internal Diameter (Inches)	Equivalent Pipe Length		Maximum Capacity in Cubic Feet of Natural Gas Per Hour Pressure Drop of 0.5" W.C. Equivalent Length of Pipe (in feet)						
		90° Ell (Feet)	Tee (Feet)	20	40	60	80	100	150	200
1- 1/2	1.610	4.02	8.04	1460	990	810				
2	2.067	5.17	10.3	2750	1900	1520	1300	1150	950	800
2- 1/2	2.469	6.16	12.3	4350	3000	2400	2050	1850	1500	1280
3	3.068	7.67	15.3	7700	5300	4300	3700	3250	2650	2280
4	4.026	10.1	20.2	15800	10900	8800	7500	6700	5500	4600

### 3.7.3 Propane Gas Piping

The table below should be used to size the propane gas piping to the appliance. The approximate energy content of propane gas is 2,500 BTU / cu. Ft:

Pipe Capacity for Propane Gas

Nominal Iron Pipe Size (Inches)	Internal Diameter (Inches)	Equivalent Pipe Length		Maximum Capacity in MBH Propane Gas Pressure Drop of 0.5" W.C. Equivalent Length of Pipe (in feet)						
		90° Ell (Feet)	Tee (Feet)	10	20	40	80	150	300	
1- 1/4	1.380	3.45	6.90	1900	1305	900				
1- 1/2	1.610	4.02	8.04	2850	1960	1345	925			
2	2.067	5.17	10.3	5490	3770	2590	1780	1270	870	
2- 1/2	2.469	6.16	12.3	8740	6010	4130	2840	2020	1390	

### 3.7.4 Pressure Testing the Gas Piping

The appliance and all gas piping connections should be pressure-tested and must be checked for leaks before being placed into service. The appliance **must be disconnected** at the manual shut-off valve (located within 6' from the boiler connections) from the gas supply piping during any pressure testing of the system at pressures in excess of 0.0723 psig (2" W.C.). Perform the pressure test with compressed air or inert gas if possible.

Some leak test methods, including the use of soap and water, may cause corrosion of the carbon steel gas pipe fittings. If using soap and water or a similar leak test method, make sure to clean off all moisture from the gas pipe fittings prior to placing the appliance into service.

**NOTE**

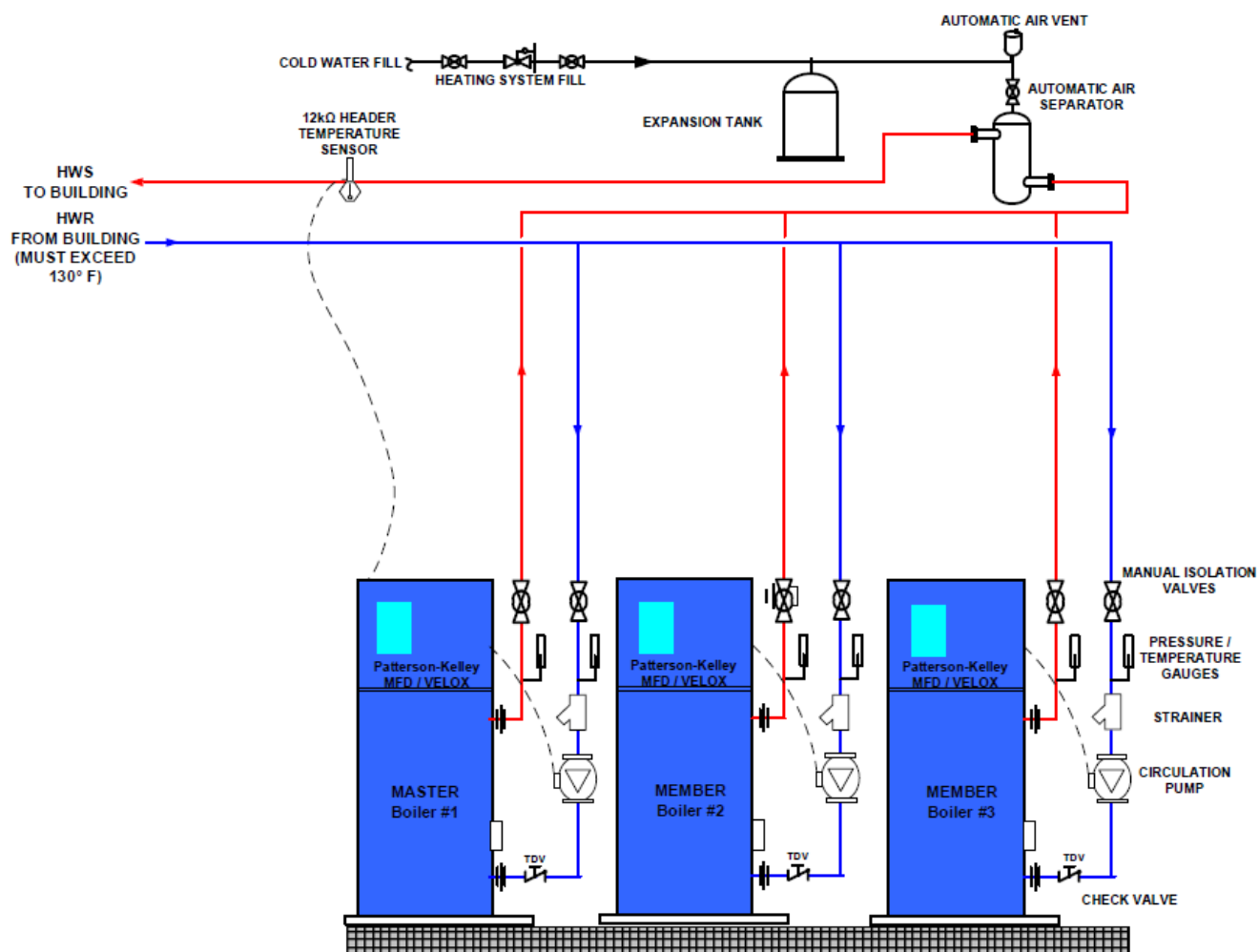
Install a union for servicing when required

**NOTE**

In Canada, the manual gas valve must be identified by the installer



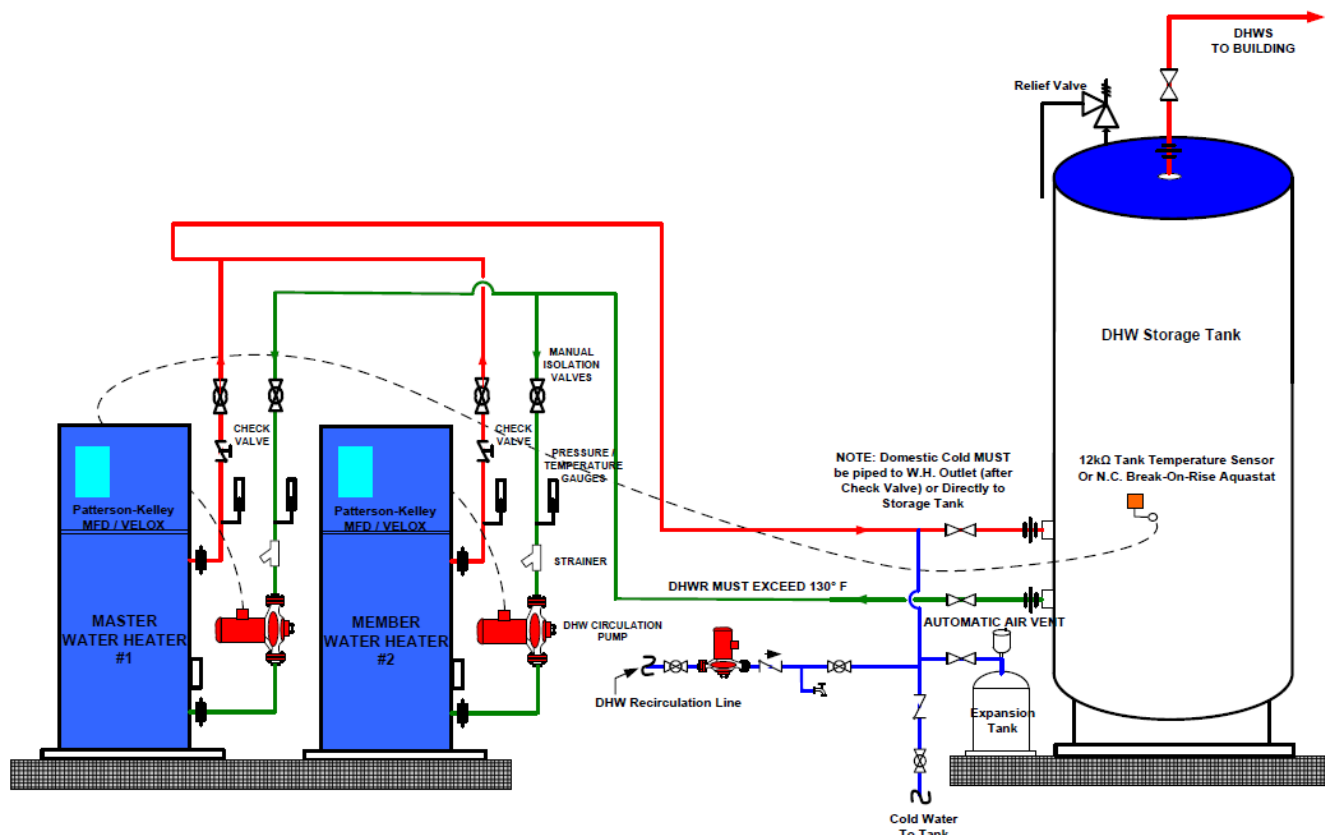
### 3.7.5 Sample Piping Diagram – MFD Series Boilers



**NOTE:** Refer to [Appendix D – Best Practices For New & Retrofit Systems](#) for best piping practices for both new and retrofit boiler installations.



### 3.7.6 Sample Piping Diagram – MFD Series Water Heaters



**NOTE:** Refer to [Appendix D – Best Practices For New & Retrofit Systems](#) for best piping practices for both new and retrofit water heater installations.



### 3.7.7 Water Piping Accessories & Connections (for Installer)

#### Strainer

To avoid possible contamination of the boiler or water heater with dirt, rust or sediment from the system, a strainer near the boiler inlet is strongly recommended. Even new systems may contain sufficient foreign material to eventually reduce the performance of the heat exchanger. Adequate circulation of good clean water is essential for maximum efficiency and long life of the appliance. Refer to [Appendix D – Best Practices For New & Retrofit Systems](#) for more information on best piping practices in new and retrofit installations.

#### Relief Valve Piping

Each appliance is supplied with a pressure-relief valve sized in accordance with ASME requirements. The relief valve discharge must be piped to an acceptable drain at a safe point of discharge. Reducing couplings or other restrictions are not permitted in the discharge line.

#### Low Water Cut-off

The MFD boilers and water heaters can accommodate an external low water cutoff device, which may be required by the local jurisdiction. If the water level in the boiler drops below the probe, the appliance will shut down and a LOCKOUT LOW WATER LEVEL will be displayed on the NURO control. The low water cut-off will automatically reset when the low water condition clears; however the NURO control will retain the lockout condition until the reset button on the display is pressed.

**NOTICE!** Some local jurisdictions may require an auxiliary low water cut-off device installed in the external piping. The auxiliary low water cutoff device only prevents operation when the water level in the appliance is insufficient. It does not detect low water conditions in other parts of the system. Installation of automatic air vents in the “high points” of the piping or additional low water safety devices should be considered to protect the system.

#### Drain Valve and Piping

The MFD boilers and water heaters feature a 3/4" drain connection. Prior to draining the appliance, electrical power and gas supply must be turned off to the appliance, and the appliance must be isolated from the system at the supply and return connections.

**NOTICE!** The 3/4" manual drain is for draining the water inside the heat exchanger only, not the entire hydronic or domestic system. Draining the entire system through the boiler or water heater's drain valve will deposit sediment and debris from the system inside the heat exchanger. This will result in poor heat transfer and premature failure. Refer to Appendix D for more information on best piping practices.

#### Combustion Chamber Drain Piping

The MFD boilers and water heaters feature a 1/2" condensate drain pipe which allows any condensate that forms in the combustion chamber to drain. Connect this drain pipe to a common condensate drain system.

#### Piping with Refrigeration Systems

When installed in a two-pipe system that provides both chilled and hot water, the control system should be configured so as to limit the time rate of change of temperature at the boiler. Consult your authorized Patterson-Kelley boiler representative for application guidance.

#### Piping with air handling units

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





### 3.8 Water Quality

The MFD heat exchanger consists of copper finned-tubes. The heat exchanger requires proper water conditions to remain efficient and function properly. Information of proper water treatment can be found on our website [www.pattersonkelley.com](http://www.pattersonkelley.com) type in search: "water quality". For information, please refer to Patterson-Kelley Multi-Metal Systems Water Quality Standards as it appears in [Appendix C –Water Quality Standard for Hydronic Boilers in Multi-Metal Systems](#) as this applies to the warranty of your heat exchanger.

**NOTICE!** The chemical manufacturer for use must certify glycol or other treatment chemicals added to the system in multi-metal systems that include a copper heat exchanger.

Under no circumstances should petroleum based cleaning or sealing compounds be used in the boiler system.

Under no circumstances should the hydronic system be flushed while the appliance is attached to the system since the debris or corrosion products may accumulate in the appliance and obstruct the appliance's heat exchanger.

If the piping system attached to this unit will be chemically cleaned, the appliance must be disconnected from the system and a bypass installed so that the chemical cleaning solution does not circulate through the appliance. Following chemical cleaning, the system should be thoroughly rinsed to remove cleaning agents prior to reconnecting the appliance to the system.

### 3.9 Pre-Start Checklist

#### **WARNING**

**Never attempt to operate an appliance that has failed to pass all the safety checks described below. Operating an appliance that has failed a safety check could result in injury. Bypassing safety mechanisms will result in unsafe appliance operation which could result in injury or death.**

#### **WARNING**

**After checking controls by manual adjustment, make sure they are always reset to their proper settings.**

#### **NOTICE!**

If the expected error code(s) do not appear, call for qualified service.

Before attempting to start the appliance, make sure the following items have been completed.

- ☐ Inspect the gas train, blower, ignition electrode, and appliance in general to be sure there was no damage during shipment or installation.
- ☐ Flue gas from the appliance is properly vented.
- ☐ Gas connection has been made, pressure tested for leakage, and the line purged of air. Make sure all required vents have been installed.
- ☐ Water connections are complete and the appliance and system have been filled and purged of air.
- ☐ The appliance is connected to the correct electrical power source listed on the nameplate, a disconnect having adequate overload protection is required.
- ☐ Combustion air openings are not obstructed in any way and have adequate capacity.
- ☐ The appliance is placed the proper distance from any combustible walls.
- ☐ Relief valves have been piped to an acceptable drain at a safe point of discharge.
- ☐ Combustion chamber drain piping is properly connected.
- ☐ Verify system water quality is within specifications.



### 3.10 Safety Checks

The following checks of safety systems must be made before putting the appliance into normal operation. Before firing the appliance refer to [Section 4](#) for information on the use of the controls, lighting, and shut-down procedures.

#### 3.10.1 Ignition Safety System Test

Test the ignition system safety shutdown as follows:

1. Cycle the appliance on by generating a heat request. (The method for this will depend on the control setup.)
2. During the pre-purge cycle (before ignition), smoothly close the downstream manual isolation valve (inside the appliance's cabinet) to restrict the gas flow.
3. Closing the manual isolation valve will prevent a successful ignition, and the NURO control will display either:

109: "Ignition Failed"

110: "Ignition Failure Occurred"

These alarms indicate an ignition failure and the lockout will remain until the NURO control is manually reset via the on-screen prompts. After completing this test, turn the appliance off, open the downstream manual isolation valve, then turn the appliance back on.

#### 3.10.2 Manual Reset High Temperature Limit Test

The appliance is furnished with a manual reset high temperature limit which features a probe installed near the appliance's outlet (supply) in order to measure the outgoing supply water temperature. This probe is connected to the manual reset high temperature limit by a thin, metal capillary tube. The manual reset high temperature limit is located inside the appliance's front door, toward the top of the control panel and is identified with a yellow label.

Test the manual reset high temperature limit control as follows:

1. Cycle the appliance on by generating a heat request. (The method for this will depend on the control setup.)
2. Allow the appliance to proceed through ignition until main flame is established.
3. Using a flathead screwdriver, turn down the setting on the manual reset high temperature limit to its lowest value. Turning the screwdriver counter-clockwise decreases the temperature setting.
4. When the outgoing supply water temperature exceeds the setting on the manual reset high temperature limit, the main burner will shut off.

The NURO touchscreen will display 10009: "High Temperature Limit". Return the system to normal operation by readjusting the setting on the manual reset high temperature limit to its desired setting, press the reset button on the manual reset high temperature limit, and finally touch any prompts from the NURO control.

#### 3.10.3 Low Gas Pressure Switch Test

The appliance is furnished with a low gas pressure switch, installed near the appliance's main gas shutoff/control valve and is factory-set to 2" W.C. The operation of this switch must be checked as follows:

#### CAUTION

The user should become thoroughly familiar with the operation of the appliance and controls before attempting to make any adjustments.

#### CAUTION

Changing parameters requires an understanding of the parameters and the functionality of the appliance. The appliance may not function properly if parameters are changed from the factory values.



1. Cycle the appliance on by generating a heat request. (The method for this will depend on the control setup.)
2. Allow the appliance to proceed through ignition until main flame is established.
3. Manually increase the setting on the low gas pressure switch until the gas pressure is below this newly adjusted value.
4. If gas pressure is too high to open the switch, reduce gas pressure below 5" W.C.
5. When the gas pressure drops below the newly adjusted value, the main burner will shut off.

When the low gas pressure switch opens, the NURO control will display 10012: **"Low Gas Limit"**. This error will remain until the gas pressure is above pressure setting and the appliance is manually reset.

**NOTICE!** After a successful test of the low gas pressure switch, make sure to readjust the setting on the switch to **2" W.C.**

### 3.10.4 High Gas Pressure Switch Test

The appliance is furnished with a high gas pressure switch, installed near the appliance's main gas shutoff/control valve and is factory-set between 2" W.C. and 3" W.C. The operation of this switch must be checked as follows:

1. Before starting the appliance, close the downstream gas cock.
2. Cycle the appliance on by generating a heat request. (The method for this will depend on the control setup.)
3. Allow the appliance to proceed to ignition.
4. When the gas pressure exceeds the setting of the high gas pressure switch, the main burner will shut off.

When the high gas pressure switch opens, the NURO control will display 10011: **"High Gas Limit"**. Even after re-opening the downstream gas cock, 10011: **"High Gas Limit"** will remain on the NURO display until the appliance is manually reset.

### 3.10.5 Low Water Cut-out Test (If Applicable)

Some local jurisdictions may require an auxiliary low water cutoff device to be installed in the piping external to the appliance. The probe is typically installed in the outlet (supply) piping, downstream of the appliance.

**NOTICE!** If the auxiliary low water cutoff probe is to be installed in a horizontal pipe, make sure the probe is installed in either the 3 o'clock or 9 o'clock positions (parallel to the floor) in order to avoid nuisance errors.

In order to test the auxiliary low water cutoff device, press and hold the **"TEST"** switch for at least 5 seconds. A manual lockout reset error displaying 10010: **"Low Water Limit"** on the NURO touch screen should occur. The auxiliary low water cutoff device may also have an LED indicator which will change states during the test condition.

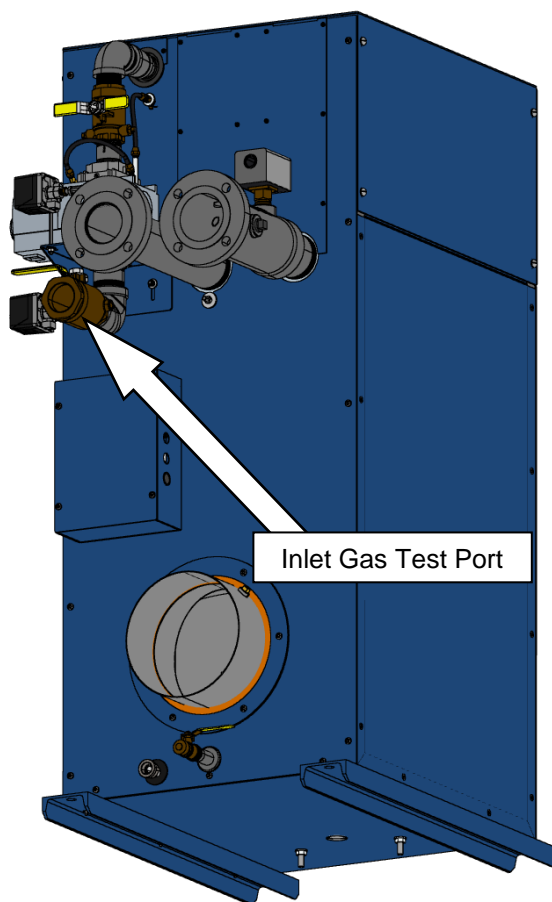


## 3.11 Burner Adjustment

### 3.11.1 Inlet Gas Test Port

**NOTICE!** Adjustments shall only be performed by a service representative specifically trained and certified to perform maintenance on the Patterson-Kelley equipment. Verify proper operation after servicing.

Refer to the appliance's rating plate for the minimum and maximum inlet gas pressures. The gas pressure during main burner operation must be greater than the minimum indicated on the rating plate. Nominal gas supply pressure 7" W.C. for natural gas and 11" W.C. for propane gas. The gas pressure **must not exceed 14" W.C.** which is the maximum allowable pressure on the gas train components. Each appliance is furnished with a manual shut-off valve with an integrated test port. This port is located on the upstream side of the valve body for measuring supply pressure and is sealed with a threaded plug.



The air flow is pre-set at the factory prior to shipment. Gas flow is primarily dependent on the combustion blower, not the upstream gas pressure. The air/gas ratio may need to be adjusted in order to obtain proper combustion readings for specific local conditions. A combustion analyzer must be used. The probe must be placed in the appliance exhaust vent immediately after the appliance. Combustion should be adjusted in accordance with Table of Combustion Exhaust Settings.

**NOTICE!** For high altitude adjustments (greater than 2,000 feet above sea level), see [Appendix B –Altitude Derate Schedule](#) at the end of this manual.



### 3.11.2 Manual Control Mode for High and Low Fire Adjustment

To adjust/tune combustion, use the NURO's "Manual Control Firing Rate" mode. To access this mode, press the "Info" button in the lower left corner of the screen, and then press "Service" in the lower left. Next, touch "Press to Activate Manual Control" which will open the "Manual Control Firing Rate" mode.

This test mode should be used when adjusting or tuning the gas safety shut off/control valve on the MFD series boilers and water heaters.

**NOTE:** Proper water flow should be established before performing any combustion adjustments to ensure the appliance doesn't short-cycle or overheat.

Once in "Manual Control Firing Rate" mode, a heat request is required. Once the appliance cycles on and is running in "Manual Control Firing Rate", use the UP and DOWN arrows or the slider to force the appliance to operate at low fire, high fire, or anywhere in-between. To prevent the appliance from cycling off prematurely during adjustment, ensure that any load devices (air handlers, control valves, radiators, etc.) are in operation and are able to shed/dump the heat created by the appliance.

#### Combustion Settings for All P-K MFD Boilers and Water Heaters (Category II / IV)

Fuel	Nominal Inlet Gas Pressure	High Fire Setting		Low Fire Setting	
		% O <sub>2</sub>	% CO <sub>2</sub>	% O <sub>2</sub>	% CO <sub>2</sub>
Natural Gas	7" W.C	5.5 – 6.2	8.4 – 8.8	6.2 – 8.0	7.3 – 8.1
Propane	11" W.C	5.5 – 5.9	9.9 – 10.1	6.5 – 7.9	8.5 – 9.0

The MFD boilers and water heaters are equipped with a combination gas/air control and gas safety shut off control valve. The "zero governor" gas valve responds to the variable speed combustion blower in order to supply the correct air/gas ratio for optimum performance and efficiency.

**NOTICE!** For high altitude adjustments (greater than 2,000 feet above sea level), see [Appendix B –Altitude Derate Schedule](#) at the end of this manual.



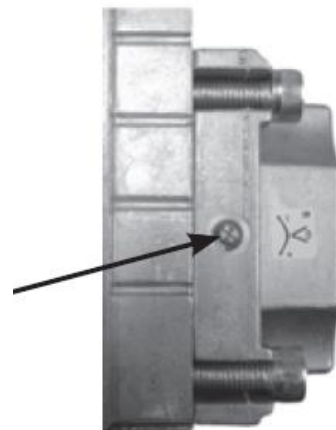
### 3.11.3 Adjusting High Fire Combustion

**NOTE: ALWAYS** adjust high fire combustion first!

Start the appliance and observe proper operating parameters for the system. Access the “Manual Control Firing Rate”, as described above, and increase the firing rate to 100%. Check combustion readings using the combustion analyzer. If the combustion readings are not in accordance with [Section 3.11.2](#), adjust as follows:

**Required Tools:** Slotted screw driver/no 2.5 allen wrench, Combustion analyzer and water tube manometer.

1. Using a slotted screw driver, set the maximum restrictor (high fire screw) on the outlet/shutter flange of the combination gas safety shut off / control valve by turning clockwise or counterclockwise to achieve the desired CO<sub>2</sub> or O<sub>2</sub> level. To increase the O<sub>2</sub> level, adjust towards the “-” symbol to decrease gas flow. To decrease the O<sub>2</sub> level, adjust towards the “+” symbol to increase gas flow.
2. There will be a slight time delay between the adjustment and the response of the CO<sub>2</sub>/O<sub>2</sub> measuring instrument.



### 3.11.4 Adjusting Low Fire

Start the appliance and observe proper operating parameters for the system. Access the “Manual Control Firing Rate”, as described above, and decrease the firing rate to 1%. Once the appliance has reached low fire operation, check combustion readings using the combustion analyzer. If the combustion readings are not in accordance with [Section 3.11.2](#), adjust as follows:

1. Using a 2 mm hex wrench, adjust the pressure regulator offset adjustment (pictured above) to achieve the desired CO<sub>2</sub> /O<sub>2</sub> level. To increase the O<sub>2</sub> level, adjust towards the “-” symbol to decrease gas flow. To decrease the O<sub>2</sub> level, adjust towards the “+” symbol to increase gas flow.
2. Adjustments to the offset pressure regulator should not exceed ¼ turn at a time before allowing the readings to respond and stabilize.



Following all gas valve adjustments, check for proper light-off and verify correct fuel/air mix and combustion quality throughout the entire firing range (from low fire to high fire).

### 3.11.5 Checking Flame Signal

Press the “Info” button on the NURO touch screen to load the “Information Screen” and scroll down to view the flame signal measured in Volts. Typical flame signals should read between 20-50V. If the flame signal is below 10V, the UV scanner may need to be replaced.



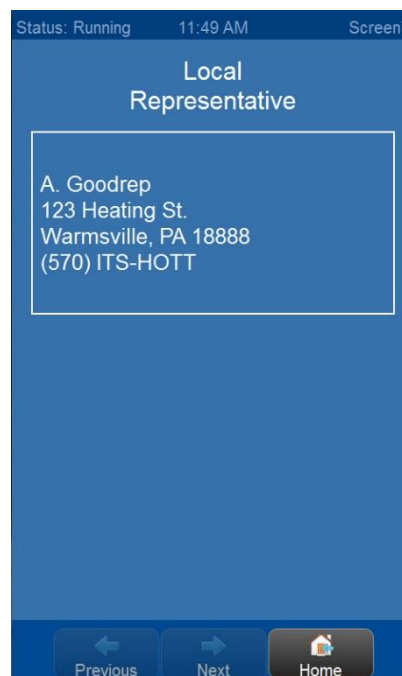


## 3.12 Initial NURO Control Setup & Adjustment

This manual covers basic NURO control setup and adjustment. For a walkthrough of the complete control setup, please refer to the *NURO Boiler Controller: Advanced User's Guide*, Part Number is 1004905979 which is helpful for more complex installations. For more complex boiler or water heater applications and more information on the parameters, please refer to the NURO Advanced User's Guide.

### 3.12.1 Startup

When the boiler or water heater is powered on, the NURO touchscreen will display an initial Startup Screen then the **Local Representative** screen. This shows the name, address and phone number of the local Patterson-Kelley representative.





### 3.12.2 Home Screen

After a brief time, the **Local Representative** Information screen will timeout displaying the **Home Screen**. The **Home Screen** shows a snapshot of the boiler or water heater's current operating conditions:

- Outlet (Supply) Temperature
- Inlet (Return) Temperature
- Exhaust Temperature
- Firing Rate, etc.

Pressing the “**Info**” button in the lower left corner will load the **Information** screen.

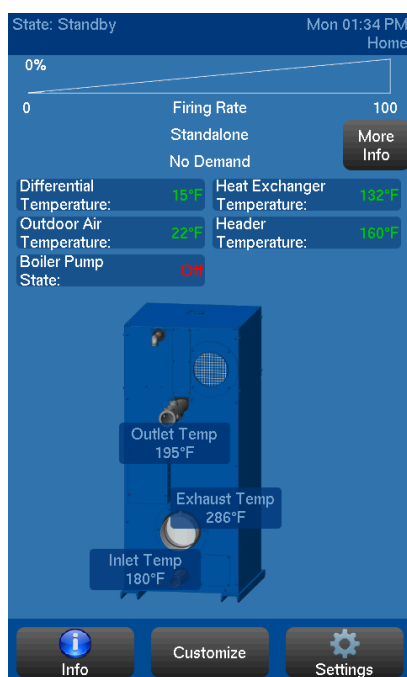
For the setup wizard, press the “**Settings**” button in the lower right corner to load the “**Settings**” or “**Main Menu**” screen.

### 3.12.3 Information Screen

The Information Screen contains real-time read-only values such as temperatures, relay states, etc. Scroll through the Information Screen by sliding your finger up or down.

This screen is helpful to determine the operating characteristics of the boiler or water heater.

**NOTE:** For more information on any parameter, please refer to the *NURO Boiler Controller: Advanced User's Guide*; Part Number is 1004905979.



State: Standby Thu 01:16 PM Info

Temperatures	
Outlet Temperature:	32°F
Inlet Temperature:	32°F
Differential Temperature:	0°F
Exhaust Temperature:	32°F
Heat Exchanger Temperature:	32°F
Outdoor Air Current Temperature:	32°F
Outdoor Air Filtered Temperature:	32°F
Header Temperature:	32°F
DHW Temperature:	32°F

Service Customize Home

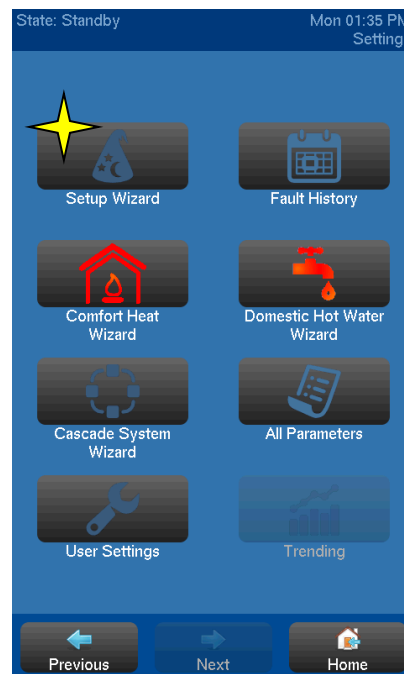


### 3.12.4 Setup Wizard

The Setup Wizard is recommended for all boilers and water heaters because it guides the user through setup for multiple applications (Standalone Comfort Heat, Standalone Domestic Hot Water, and/or Cascade operation). The Setup Wizard will guide the user through the parameter setup for all the relevant applications based on responses to a series of questions. To access the Setup Wizard, press <SETUP WIZARD> from the “SETTINGS” menu [Figure 3.8.1].

While navigating the Setup Wizard, press the desired buttons in the center content area. The selected choice will be indicated with a yellow light as seen below. To proceed to the next Setup Wizard screen, press <NEXT> at the bottom of the screen. The NURO® control also allows the user to back-track at any time by pressing <PREVIOUS> in the bottom-left corner of the screen.

The Setup Wizard allows the user to assign functionality to the user-configurable Relays A through D. This allows the user to assign functions like “Boiler Pump”, “System Pump”, “Flame Detected”, and “Air Damper” to the relays.



**NOTE:** The relay assignments must agree with the wiring to/from the appliance. For example, if Relay A is user-configured to enable/disable the Boiler Pump, the control wires to operate the boiler pump must be properly wired to the Relay A terminals in the High Voltage (TB2) terminal block.

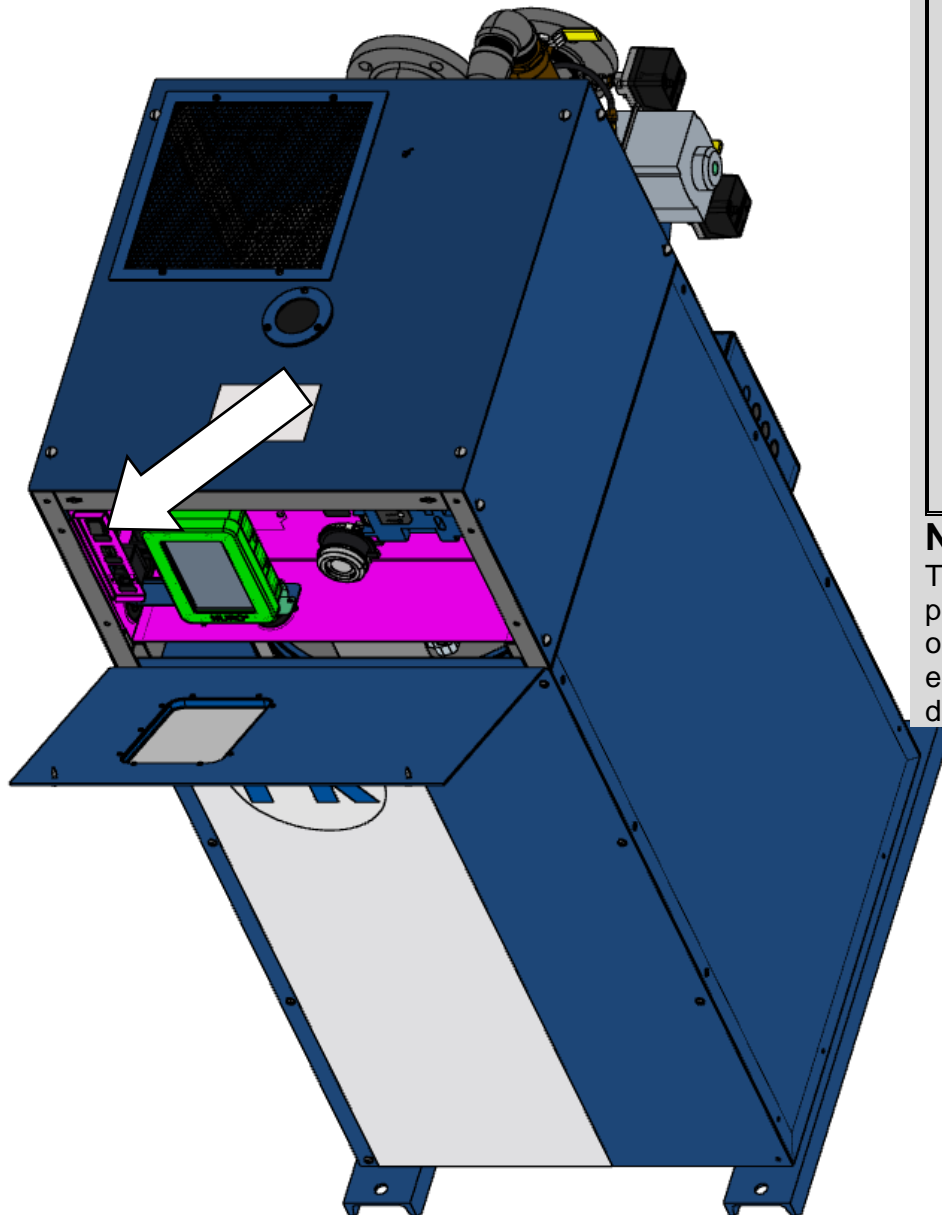


## 4 Operations

### 4.1 NURO Touchscreen Control System

#### 4.1.1 Power On/Off Switch

After the appliance has been installed in compliance with this manual, it is necessary to access the power (on/off) switch located in the upper-left corner under the hinged sheet metal cover as shown below:



#### **⚠ WARNING**

Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the appliance and to replace any part of the control system and any gas control which has been under water. Failure to do so could result in electrocution, injury, or death.

#### **⚠ WARNING**

If overheating occurs or the gas supply fails to shut off, do not turn off or disconnect the electrical supply to the pump. Instead, shut off the gas supply at a location external to the appliance.

#### **NOTICE!**

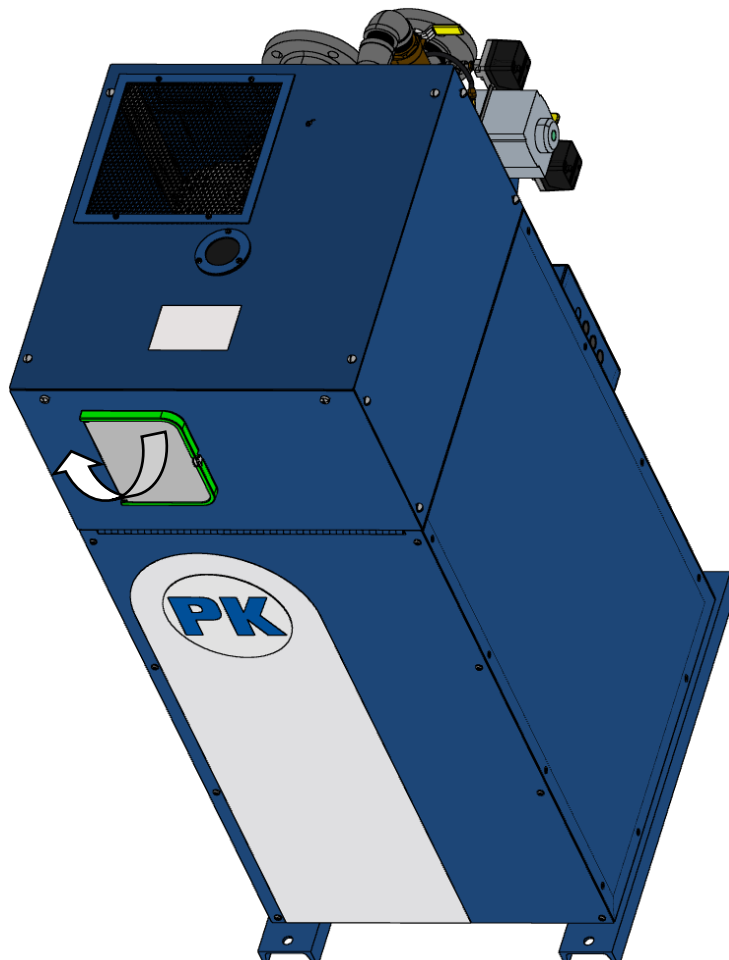
The On/Off switch only interrupts power to the NURO control. In order to fully remove power to the entire appliance, use the external disconnect.

**NOTE:** The operating instructions can be found on either the left side of the unit or on the backside of the hinged sheet metal cover



#### 4.1.2 NURO Touch Screen Interface and Control Panel

Once the power switch is in the “ON” position, the P-K appliance can be programmed and operated with the NURO touch screen interface located on the front door as shown below. A clear plastic cover protects the touch screen which can be opened by pinching the clasp and swinging open to the left.



The NURO touch screen interface features a patented design which allows the user to rotate the control 90° for service clearance. After opening the appliance front door, pinch the upper and lower spring plungers to free the control assembly from the frame. This feature allows for up to 90° of travel so the user can access the electrical components behind the display.

**NOTE:** Always return the NURO control to the default position (facing out through the front door) before closing the appliance's front door. Failure to do so could result in damage to the NURO control or wiring.

#### 4.1.3 Factory Tests

Safe lighting and other performance criteria were met with the gas manifold and control assembly provided on this boiler when the boiler underwent factory tests specified in ANSI Z21.13/CSA 4.9, latest edition. The same applies to water heaters which underwent factory tests specified in ANSI Z21.10.3/CSA 4.3, latest edition. (See "Factory Firetest" label on the rear surface of the appliance).



## 4.2 Normal Lighting and Shut-down Procedures

### 4.2.1 Normal Lighting Procedures

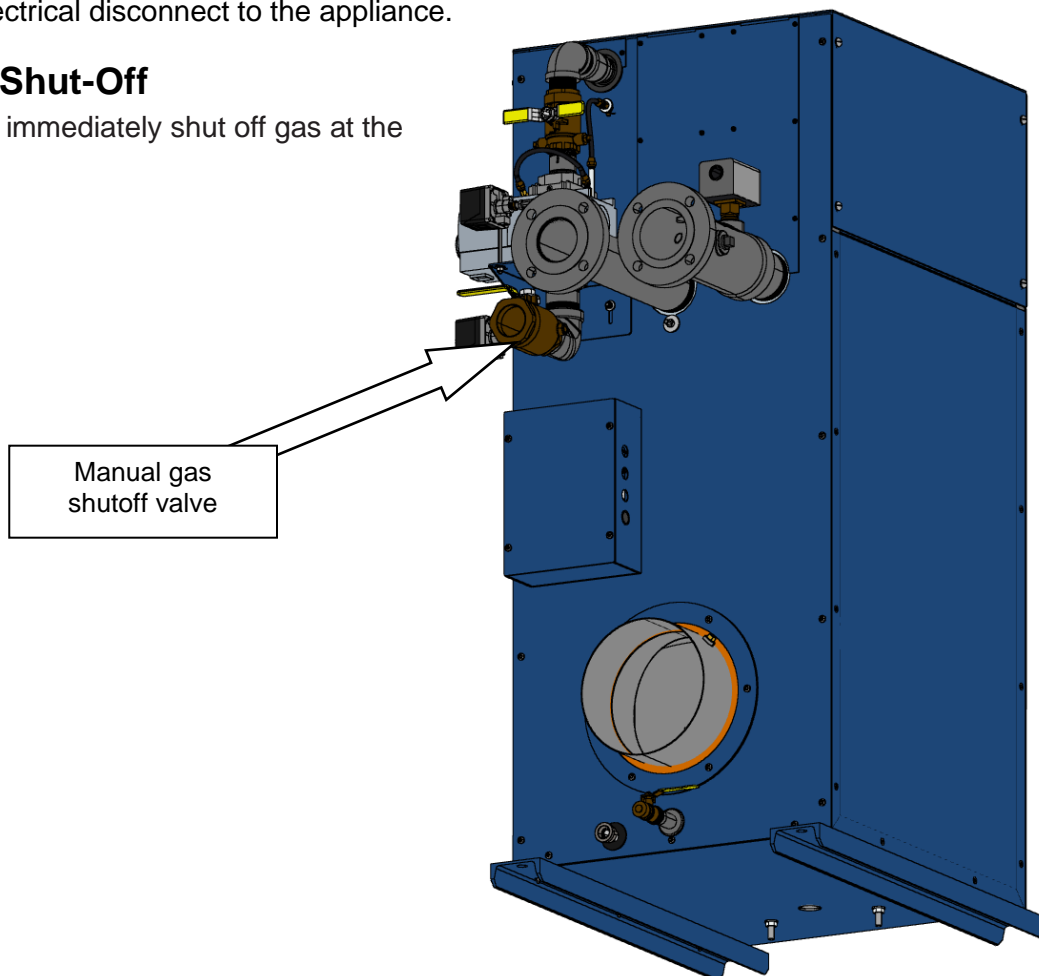
1. Make sure the system is filled with water and water is circulating in the system. Turn on electrical supply and open the gas supply valves to the appliance.
2. Turn the on/off switch to the "On" position. If an error is indicated, refer to the NURO Advanced User's Guide to troubleshoot the problem and take necessary corrective action before proceeding.
3. Set the desired high temperature limit and operating temperature. The NURO controller will now begin the automatic firing sequence.

### 4.2.2 Normal Shut Down Procedures

1. Allow the appliance to turn off on its own once the temperature satisfies, or remove the call for heat to the appliance.
2. Once the appliance completes a successful "Post-Purge" and "Post-Pump", it will return to "Standby".
3. Once in standby, turn the on/off switch to the "Off" position.
4. Close all manual gas valves on the gas train.
5. Turn off the electrical disconnect to the appliance.

## 4.3 Emergency Shut-Off

In case of emergency, immediately shut off gas at the rear of the appliance.







### **WARNING**

Lockout/tagout procedure must be employed when servicing this unit. Failure to do so could result in electrocution, injury, or death.

### **WARNING**

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

### **WARNING**

Use care when reassembling the main gas line and ensure all connections are tight. Use a leak detector to check for leaks before and after servicing any component of the gas piping. Failure to do so could result in injury or death.

### **WARNING**

Use care when servicing the appliance to prevent the accumulation of gas in or around the combustion chamber. Pockets of accumulated gas are subject to combustion and/or explosion which could result in injury or death.

### **WARNING**

Determine the cause of any lockout or errors before resetting the appliance. If able to determine cause of lockout, take appropriate corrective action. If unable to determine cause of the problem, call a qualified service technician. Verify proper operation after servicing.

### **WARNING**

Check daily to be sure that the appliance area is free and clear of any combustible materials, including flammable vapors and liquids.

## 5 Maintenance

### 5.1 Preventative Maintenance

**NOTICE!** Proper maintenance schedule and record keeping is critical for optimum performance and to maintain the Patterson-Kelley warranty.

**NOTE:** The combustion blower motor is permanently lubricated and does not require periodic lubrication.

#### 5.1.1 Daily Preventative Maintenance

Observe operating temperature and general conditions. Make sure that the flow of combustion and intake air to the appliance is not obstructed. Determine the cause of any service codes or lockouts on the display panel. Observe any unusual noises or operating conditions and make the necessary corrections. Notify responsible individuals for required corrective action or repair.

Inspect relief valve for any discharging. If a relief valve discharges periodically, this may be due to thermal expansion in a closed water supply system. Contact the water supplier or local plumbing inspector on how to correct this situation. Do not plug the relief valve.

### **WARNING**

Check daily to be sure that the immediate area around the boiler or water heater is free and clear of any combustible materials, including flammable vapors and liquids.

#### 5.1.2 Weekly Preventative Maintenance

Observe the conditions of the main flame. A normal high fire flame is mostly orange with a blue halo. A normal low fire flame will glow reddish-orange. However, do not attempt to adjust the flame “by eye”.

Correct air adjustment is essential to the efficient operation of this appliance. Ensure that the flow of combustion and ventilation air is not obstructed. If an adjustment in the combustion appears necessary, the flue gas composition should be checked with a carbon dioxide (CO<sub>2</sub>) or oxygen (O<sub>2</sub>) analyzer and compared to the values stated in the Combustion Setup and Adjustment combustion settings table ([Section 3.11.2](#)) If an adjustment to the combustion is necessary, call a qualified and knowledgeable installer or service agency that has been trained on the Patterson-Kelley appliance.



### 5.1.3 Monthly Preventative Maintenance

1. Press the “Info” button on the NURO touch screen to load the Information Screen and scroll down to view the flame signal measured in Volts. Typical flame signals should read between 20-50V. If the flame signal is below 10V, the UV scanner may need to be replaced.
2. Test the low water level cut-off. Refer to [Section 3.10.5 Low Water Cut-out Test \(If Applicable\)](#).
3. Test the manual reset high-temp limit. Refer to [Section 3.10.2 Manual Reset High Temperature Limit Test](#).
4. Test the low gas pressure switch. Refer to [Section 3.10.3 Low Gas Pressure Switch Test](#).
5. Test operating temperature controls by reducing or increasing temperature settings as necessary to check burner operation.
6. Check the combustion chamber drain piping for leaks or obstructions.
7. Check screens for inlet air and vents for blockage.

**NOTICE!** Installation and service must be performed by a qualified installer or service agency that has been trained on the appliance.

8. Visually examine the vent system to ensure the integrity of components and connections.



## 5.2 Maintenance and Inspection Schedule

This schedule applies when the appliance is in constant use. The section is divided into critical semi-annual and annual maintenance followed by scheduled routine maintenance.

**NOTICE!** Proper maintenance schedule and record keeping is critical for optimum performance and to maintain the Patterson-Kelley warranty.

### 5.2.1 Semi-Annually

In addition to the recommended monthly service:

1. Clean burner of any accumulated dust or lint. Refer to [Section 5.3](#).
2. Inspect burner for any signs of deterioration or corrosion. Replace immediately if deterioration or corrosion is evident.
3. Check the water quality of the system fluid in accordance with [Appendix C –Water Quality Standard for Hydronic Boilers in Multi-Metal Systems](#).
4. Inspect and clean the combustion chamber drain piping and check for leaks or obstruction.
5. Check the gap between the electrode and ground rod. For Natural Gas, the gap should be 1/8" (+1/16", -0"). For Propane Gas, the gap should be exactly 1/8".

### 5.2.2 Annually

In addition to the recommended monthly and semi-annual service:

1. Inspect and clean the inlet screen of any accumulated dust.
2. Check burner and clean off any soot or foreign material that may have accumulated. Check for corrosion of the burner and its parts. If there is evidence of deterioration or corrosion, replace immediately. Inspect the combustion chamber when the burner is removed for inspection. Note any signs of deterioration. Refer to [Section 5.3](#) for cleaning instructions if needed.
3. Inspect and clean the copper finned tube heat exchanger. Clean the combustion side by flushing with clean water and blowing dry with compressed air. Do not use any cleaning agents or solvents. Do not use soap. A soft nylon brush may be used in accessible areas. Be sure to inspect the condensate collection pan that is the lowest part of the heat exchanger.
4. Replace the ignition electrode and gasket.
5. Check the gap between the electrode and ground rod. For Natural Gas, the gap should be 1/8" (+1/16", -0"). For Propane Gas, the gap should be exactly 1/8".
6. Drain and flush the water side of the heat exchanger as required (separate from system flush) using clean water only.
7. Take a sample of system fluid and verify the water quality is in compliance as defined in [Appendix C –Water Quality Standard for Hydronic Boilers in Multi-Metal Systems](#).
8. Inspect the combustion chamber drain piping and check for leaks or obstruction.
9. Examine the venting system. Refer to the vent manufacturer's instructions for requirements in addition to those listed below.
  - a. Check all joints and pipe connections for tightness.
  - b. Check pipe for corrosion or deterioration. If any piping needs replacing, do so immediately.
  - c. Inspect and clean any screens in the vent terminal.



10. Qualified service personnel should thoroughly inspect the heating system and correct any problems prior to re-starting the appliance.
11. Perform combustion analysis and readjust as necessary according to the Combustion Setup and Adjustment combustion settings table. Refer to [Section 3.11](#).
12. Perform a leak test of the gas valves in accordance with the manufacturer's instructions.

### 5.3 Cleaning the Burner & Combustion Chamber

Patterson-Kelley recommends cleaning the burner and combustion chamber at least once annually. A list of the required replacement (consumable) parts and tools are provided below:

#### Required Replacement Parts

Appliance Size	Part	Part Number
750 - 1000	Burner Gaskets	23-0000-0327 23-0000-0354
	Ignition Assembly Gasket	23-0000-0077
	Ignition Electrode	23-0000-0484
	Ground Rod	23-0000-0485
1500 – 2000	Burner Gaskets	23-1300-0033 23-1300-0035
	Ignition Assembly Gasket	23-0000-0077
	Ignition Electrode	23-0000-0282
	Ground Rod	23-0000-0127
2500 – 3000	Burner Gaskets	23-0000-0382 23-0000-0462
	Ignition Assembly Gasket	23-0000-0437
	Ignition Electrode	23-0000-0466
	Ground Rod	23-0000-0467

#### Tools Required

Screwdrivers	Wrenches / Sockets	Cleaning Supplies
<ul style="list-style-type: none"><li>Flat Head</li><li>Phillips Head</li></ul>	<ul style="list-style-type: none"><li>Pipe Wrench</li><li>7/16" Socket</li><li>1/2" Socket</li></ul>	<ul style="list-style-type: none"><li>Pressurized Fresh Water Supply</li><li>Hose w/ Nozzle</li><li>SimpleGreen or similar mild detergent</li></ul>
<b>NOTE:</b> Spare parts and replacement parts can be ordered from Patterson-Kelley by calling toll free <b>(877) 728-5351</b> . Reach us by fax at <b>(570) 476-7247</b> .		

***(Step-by-step instructions on next page)***



1. Lockout/tagout gas supply to the boiler or water heater.
2. Lockout/tagout electrical power to the boiler or water heater.
3. Use a flat-head screwdriver to remove the top and side panels and open the front door of the appliance.
4. Protect the electrical and control components from exposure to water with towels, a nylon tarp, or plastic wrap.
5. Locate the blower and burner assembly bolted to the top of the copper finned-tube heat exchanger. Refer to [Section 6.2.1](#), [Section 6.2.5](#), and [Section 6.2.6](#) for an illustration of these components.
6. Disconnect the two wire plug connectors from the blower motor.
7. Disconnect the clear and blue tubing from the air/gas mixer head. **NOTE:** These tubes are color-coded and must be correctly reinstalled.
8. Follow the model-specific instructions below to remove the blower and air/gas mixer head assembly:

**(750 through 2000):**

- Use a pipe wrench to disconnect the gas pipe union inside the appliance's cabinet.
- Next, use a 1/2" socket to remove the four (4) nuts from the lower flange on the blower.
- Carefully lift the blower motor and air/gas mixer head assembly out the top of the appliance and set aside in a safe place.
- Carefully remove the blower gasket and set aside in a safe place.

**(2500 through 3000):**

- Use a pipe wrench to disconnect the gas pipe union outside the appliance's cabinet.
- Remove the two screws from the cover plate directly above where the gas piping enters the appliance's cabinet and then remove the cover plate itself.
- Next, use a 7/16" socket to remove the four (4) nuts, the lock washer and flat washer from the lower flange on the blower.
- Set these parts aside in a safe place for reuse.
- Next, carefully lift the blower motor and air/gas mixer head assembly out the top of the appliance and set aside in a safe place.
- Carefully remove the blower gasket and set aside in a safe place.

9. Disconnect the UV scanner, ignition wire, ground wire and the high exhaust back pressure switch wire plug.
10. Remove the Phillips head screws from the ignition assembly and carefully lift the ignition assembly out of the combustion chamber and set aside in a safe place. Remove and discard the ignition electrode and ground rod.
11. Remove the ignition assembly gasket and discard.



12. Use a 1/2" socket to remove the four (4) nuts and flat washers from the burner mounting plate and set these parts aside in a safe place. Follow the model-specific instructions below in order to remove the burner cylinder:

**(750 through 1000):**

- First, remove the burner hood and set aside in a safe place.
- Next, remove and discard the upper burner gasket (23-0000-0354 w/ 5.5" I.D.).
- Next, carefully lift the burner cylinder out of the appliance's combustion chamber. Take extra precaution to prevent damage to the burner's mesh while removing from the combustion chamber.
- Finally, remove and discard the lower burner gasket (23-0000-0327 w/ 5.8" I.D.).

**(1500 through 2000):**

- First, use a 7/16" socket to remove the four (4) nuts and set aside in a safe place.
- Next, remove the top cover plate and set aside in a safe place.
- Next, remove and discard the upper burner gasket (23-1300-0033 w/ 7.5" I.D.).
- Carefully lift the burner cylinder out of the appliance's combustion chamber. Take extra precaution to prevent damage to the burner's mesh while removing from the combustion chamber.
- Remove the circular burner spacer plate and set aside in a safe place.
- Finally, remove and discard the lower burner gasket (23-1300-0035 w/ 8.27" I.D.).

**(2500 through 3000):**

- First, remove the burner hood casting and set aside in a safe place.
- Next, remove and discard the upper burner gasket (23-0000-0462 w/ 6.6" I.D.).
- Next, carefully lift the burner cylinder out of the appliance's combustion chamber. Take extra precaution to prevent damage to the burner's mesh while removing from the combustion chamber.
- Finally, remove and discard the lower burner gasket (23-0000-0382 w/ 5.72" I.D.).

After removing from the appliance, use pressurized water (approximately 40 psig) to thoroughly rinse and clean the cylindrical burner.

**NOTE:** Do not attempt to wash the burner while installed in the appliance. When cleaning the burner, use a mild detergent such as Simple Green® to help loosen built-up debris trapped in the burner mesh.

13. Locate the 1/2" combustion chamber drain pipe on the rear contact surface of the appliance (close to the floor). The drain pipe should be connected to a drain system; ensure this is free from obstruction and can drain freely. If the 1/2" pipe cap is installed on the drain pipe notify the installer to connect this appliance to an adequate drain.





14. With the burner removed, the open burner hole provides access to the appliance's combustion chamber / heat exchanger. Use pressurized water (approximately 40 psig) to thoroughly rinse and clean the inside of the appliance's combustion chamber. When cleaning the combustion chamber, use a mild detergent such as Simple Green to help loosen built-up debris trapped in the copper finned-tubes.

**⚠ CAUTION**

Be very careful when cleaning to avoid spraying any of the electrical or control components. Water may cause a short circuit and damage circuitry.

15. After several minutes of washing, turn off the hose and allow all the wash water to drain out of the combustion chamber.
16. Follow the model-specific instructions below to install new burner gaskets and reinstall the burner cylinder:

**(750 through 1000):**

- First, install a new lower burner gasket (23-0000-0327 w/ 5.8" I.D.) and make sure the circular openings for the ignition assembly face the front surface of the appliance.
- Next, carefully reinsert the burner cylinder into the combustion chamber and align the ignition assembly holes with the lower gasket.
- Finally, install a new upper burner gasket (23-0000-0354 w/ 5.5" I.D.) and make sure to align the ignition assembly holes.

**(1500 through 2000):**

- First, install a new lower burner gasket (23-1300-0035 w/ 8.27" I.D.) and make sure the circular openings for the ignition assembly face the front surface of the appliance.
- Next, reinstall the circular burner spacer plate before reinserting the burner cylinder into the combustion chamber and aligning the ignition assembly holes with the lower gasket.
- Install a new upper burner gasket (23-1300-0033 w/ 7.5" I.D.) and make sure to align the ignition assembly holes.
- Finally, reinstall the top cover plate and use a 7/16" socket to tighten the four (4) nuts and compress the gaskets to seal this assembly.

**(2500 through 3000):**

- First, install a new lower burner gasket (23-0000-0382 w/ 5.72" I.D.) and make sure the circular openings for the ignition assembly face the front surface of the appliance.
- Next, carefully reinsert the burner cylinder into the combustion chamber and align the ignition assembly holes with the lower gasket.
- Finally, install a new upper burner gasket (23-0000-0462 w/ 6.6" I.D.) and make sure to align the ignition assembly holes.

17. Reinstall the four flat washers and use a 1/2" socket to tighten the four (4) nuts on the edges of the burner mounting plate.



18. Install a new ignition assembly gasket:
  - **(750 through 2000):** 23-0000-0077
  - **(2500 through 3000):** 23-0000-0437
19. Install a new ground rod and ignition electrode and refer to [Section 5.1.1](#) for proper spacing of the spark gap:
  - **(750 through 1000):** 23-0000-0484 Ignition Electrode & 23-0000-0485 Ground Rod
  - **(1500 through 2000):** 23-0000-0282 Ignition Electrode & 23-0000-0127 Ground Rod
  - **(2500 through 3000):** 23-0000-0466 Ignition Electrode & 23-0000-0467 Ground Rod
20. With a new ignition assembly gasket, ground rod and ignition electrode installed, reinsert the ignition assembly into the hole. Tighten the two Phillips head screws to compress the gasket and seal this assembly.
21. Carefully reinstall the blower gasket before reinstalling the blower and air/gas mixer head assembly on top of the burner assembly per the model-specific instructions below:
  - **(750 through 2000):** Reinstall the four (4) 5/16-18 nuts on the blower's flange. Use a pipe wrench to retighten the gas pipe union inside the appliance's cabinet.
  - **(2500 through 3000):** Align the black rubber grommet to the entrance area for the gas piping and reinstall the cover plate and two (2) screws to secure the gas piping. Reinstall the four (4) flat washers, lock washers and 1/4-20 nuts on the blower's flange. Reconnect the gas flange to the gas valve by reinstalling and tightening the four (4) screws.
22. Reconnect the two wire plug connectors to the blower motor.
23. Reconnect the UV scanner, ignition wire, ground wire and high exhaust back pressure switch wire plug to the ignition assembly.
24. Reconnect the air/gas mixer sensing tubes.

**NOTE:** These tubes are color-coded and must be correctly reinstalled. The clear tubing must be reconnected to port on the air "cage" and the blue tubing must be reconnected to the port on the air/gas mixer cylinder.

25. Remove the temporary protection (towel, tarp or plastic wrap) from the electrical and control components.
26. Reattach the top and side panels to the appliance.



## 5.4 After Repairs or Maintenance

Following any major repairs or preventative maintenance, follow the steps below before returning the appliance to service.

1. Follow “[Section 3.9 Pre-Start Checklist](#)” and all safety checks in “[Section 3.10 Safety Checks](#)”.
2. Check the gas pressure, refer to [Section 3.11.1 Inlet Gas Test Port](#) to ensure proper operation of the appliance.
3. Perform combustion check (Refer to [Section 3.11.3](#) and [Section 3.11.4](#)) and adjust air/gas mixture at high fire & low fire if the O<sub>2</sub>% or CO<sub>2</sub>% are out of range.

**NOTE:** Installation and service must be performed by a qualified installer or service agency that has been trained on the Patterson-Kelley appliance!

### **WARNING**

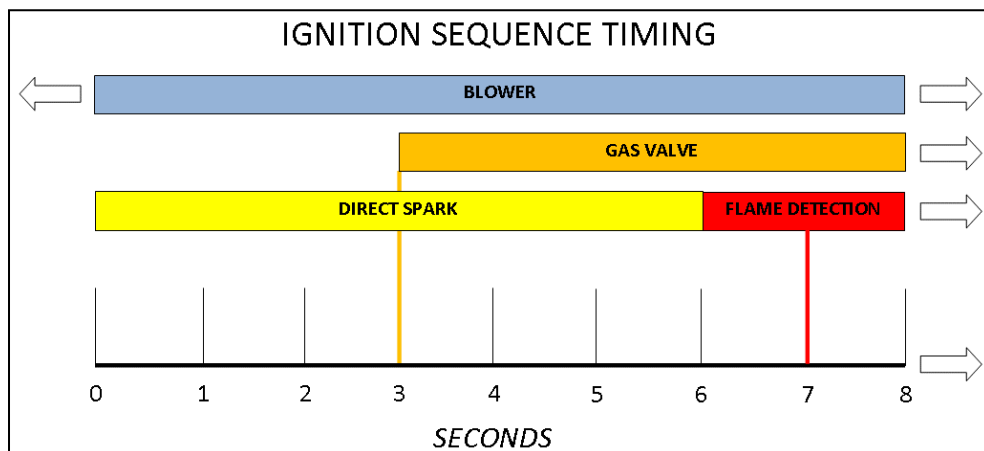
If any “Manual Reset” limit device trips, **DO NOT** reset without determining and correcting the cause. Manual Reset Limits include: Flame safeguard, high or low gas pressure, high temperature limit, stack temperature, low water level. Attempting to operate an appliance without diagnosing the cause of failure can result in unsafe operation, increasing the risk of injury. **Never attempt to bypass a safety limit device.**

### **NOTICE!**

Once the appliance begins the ignition sequence, the firing sequence may continue until main flame is reached regardless of heat request. The sequence can be interrupted by turning the power switch off.

## 5.5 Sequence of Operations

1. When the On/Off switch is turned on, power is provided through over-current protection (fuse and/or circuit breaker) to the NURO control and the combustion blower.
2. For boilers operating in Comfort Heat (CH) mode, when the outlet (supply) water temperature drops below “**CH SETPOINT**” minus “**CH DIFFERENTIAL ON**”, a heat request is generated.
3. For water heaters operating in Domestic Hot Water (DHW) mode, when the outlet (supply) water temperature drops below “**DHW BOILER SETPOINT**” minus “**DHW BOILER DIFFERENTIAL ON**”, a heat request is generated.
4. Provided all interlocks are made and the remote enable signal (if installed) is active, the appliance will attempt to start.
5. The NURO control checks to make sure the air pressure switch is open indicating there is no airflow through the appliance. The combustion blower is then driven towards the pre-start fan speed. When the air pressure switch closes, the “**PRE PURGE TIME**” timer is started. Once the “**PRE PURGE TIME**” timer expires, the blower is driven to the ignition speed.
6. A trial for ignition begins and the sequence of events is illustrated graphically on the next page. A valid flame signal must be detected within 4 seconds after the gas valves open (total elapsed time 7 seconds).



7. After a successful ignition, the fan is driven to low fire and the “**CH LOW FIRE HOLD TIME**” timer or “**DHW LOW FIRE HOLD TIME**” is started. Once the applicable “**LOW FIRE HOLD TIME**” timer expires, the appliance is released to modulation.
8. The NURO control modulates the firing rate between low and high fire to maintain the desired outlet water temperature.
9. For boilers operating in Comfort Heat (CH) mode, the burner will continue firing until the outlet (supply) water temperature exceeds “**CH SETPOINT**” plus “**CH DIFFERENTIAL OFF**”. At this temperature, the gas valves are closed and the combustion blower continues to run until the “**POST PURGE TIME**” timer has expired.
10. For water heaters operating in Domestic Hot Water (DHW) mode, the burner will continue firing until the outlet (supply) water temperature exceeds “**DHW BOILER SETPOINT**” plus “**DHW BOILER DIFFERENTIAL OFF**”. At this temperature, the gas valves are closed and the combustion blower continues to run until the “**POST PURGE TIME**” timer has expired.
11. When the outlet water temperature is reduced by the load on the system, a heat request is generated. The operating sequence will resume at *Step 4*.



## 5.6 Troubleshooting

The NURO control will display graphical and/or text based error descriptions to announce any problems with the appliance. There are two types of lockouts: manual reset lockouts which require the operator to physically press the on-screen or device's reset button, and automatic reset lockouts which will self-reset when the error condition clears. For a comprehensive list of errors and potential resolutions, please refer to the NURO Advanced User's Guide.

Should the unit fail to operate, call a qualified service technician to troubleshoot the problem and implement corrective actions.

### 5.6.1 Loss of Power

In the event of a power failure, the NURO touch screen will go dark and the entire appliance will de-energize. The signal relays used to command auxiliary devices connected to the appliance (air dampers, pumps, etc.) will also lose power, so these devices will deactivate. When power is restored, the sequence of operation will resume at [Step 4 \(Section 5.5\)](#). If any error/lockout errors were present at the time of the power failure, the NURO control will retain that error/lockout when power is restored.

### 5.6.2 Loss of Water Flow

The paddle type flow switch opens when there is an insufficient water flow through the appliance. The NURO control will display 272: **"Flow Switch Not Closed"**, close the gas valve, and lock the appliance out. When the water flow is corrected and the on-screen reset button is pressed, the appliance will reset and resume operation at [Step 4 \(Section 5.5\)](#).

### 5.6.3 Low Gas Pressure

The low gas pressure switch opens when there is (or has been) insufficient gas pressure available for proper operation of the appliance. If an external gas-supply shut-off valve is closed for any reason, a low gas condition will result. The NURO control will display 10012: **"Low Gas Limit"**, close the gas valve, and lock the appliance out. When proper gas pressure is restored, and the on-screen reset button is pressed, the appliance will reset and resume operation at [Step 4 \(Section 5.5\)](#).

### 5.6.4 High Gas Pressure

The high gas pressure switch opens when there is (or has been) excessive gas pressure for the proper operation of the appliance. The NURO control will display 10011: **"High Gas Limit"**, close the gas valve, and lock the appliance out. When proper gas pressure is restored and the on-screen reset button is pressed, the appliance will reset and resume operation at [Step 4 \(Section 5.5\)](#).

### 5.6.5 High Water Temperature

When the outlet (supply) water temperature has exceeded both the operating temperature limit and the manual reset high-temperature limit, the NURO control will display 10009: **"High Temperature Limit"**, close the gas valve, and lock the appliance out. When the outlet (supply) water temperature falls below the high-limit temperature setting, the appliance will remain locked out until the high-temperature limit switch is manually reset and the on-screen reset button is pressed. Once reset, the control will resume operation at [Step 4 \(Section 5.5\)](#).



### 5.6.6 Low Air

If the NURO control displays either 65: **“Interrupted Airflow Switch OFF”** or 66: **“Interrupted Airflow Switch ON”**, this indicates improper airflow through the appliance. First, verify proper standby blower operation – when the appliance is in **“Standby”**, the blower should also be in standby.

Next, check for obstructions of the combustion air intake and/or exhaust (flue) piping. Next, check the hoses leading to the air switches are not kinked or obstructed. An error related to the air switch does not necessarily mean that the air switch is defective.

When 66: **“Interrupted Airflow Switch ON”** is displayed, check that the air switch is open when the blower is offline. Ensure there is no air flow through the appliance when the blower is offline. An excessive negative draft in the flue piping can cause air flow through the offline appliance which may be strong enough to maintain closure of the air switch.

When 65: **“Interrupted Airflow Switch OFF”** is displayed, check that the air switch is closed when the blower is running. If the air switch does not close within 5 minutes during purge, the appliance locks out. Check that the burner is clean (Cleaning the Burner, [Section 5.3](#)) and that there are no obstructions to airflow in the intake or exhaust ducts.

### 5.6.7 Flame Failure

In the event of a flame failure, the NURO control may display one of the following error messages:

- 106: **“Flame Lost in Main Flame Establish Period”**
- 107: **“Flame Lost Early in Run”**
- 108: **“Flame Lost in Run”**
- 109: **“Ignition Failed”**
- 110: **“Ignition Failure Occurred”**

When 109: **“Ignition Failed”** or 110: **“Ignition Failure Occurred”** is displayed, the appliance did not light during the trial for ignition. Check that the ignition electrode, ignition wire, and gas valve are functioning properly. Check that the direct spark ignition is visible through the flame observation port during the trial for ignition.

When 106: **“Flame Lost in Main Flame Establish Period”**, 107: **“Flame Lost Early in Run”**, or 108: **“Flame Lost in Run”** is displayed, the appliance lost the flame signal during operation. Check that combustion is adjusted properly, the gas pressure is correct, and the ignition electrode, ignition wire, and gas valve are functioning properly.

### 5.6.8 Flame Error

In the event of a flame error (premature or late flame signal), the NURO control will display 105: **“Flame Detected Out of Sequence”**. This may be caused by a failed/leaking gas valve or a flame rod malfunction. If gas valve leakage is suspected, the unit must be isolated by turning off the main gas supply line. Lockout/tagout the appliance until qualified and knowledgeable service personnel are available to evaluate and repair or replace the failed parts. Check that the incoming gas pressures have not exceeded 14” W.C. (1/2 psig).

### 5.6.9 Flue Problem

When the normally-closed high exhaust back pressure switch opens, the NURO control will display 10013: **“High Back Pressure Limit”**. This may be caused by an obstruction in the flue piping, an obstruction in the combustion air intake, or a blocked condensate system. When the blockage is removed, the boiler will automatically restart. If no blockage is found, it may be necessary to replace the high exhaust back pressure switch.





## 6 Parts/Technical Support

Spare parts and replacement parts can be ordered from Patterson-Kelley by calling toll free **(877) 728-5351**. Reach us by fax at **(570) 476-7247**.

Refer to the parts list shown on the assembly drawings provided in this manual.

Technical information is also available by calling or visit the Patterson-Kelley website: [www.pattersonkelley.com](http://www.pattersonkelley.com).

When ordering replacement parts please have the model number and serial number of your boiler or water heater available.

Typical schematic drawings and information about the low and high voltage terminals are shown on the following pages. Drawings specific to your particular boiler or water heater can also be supplied by your local Patterson-Kelley representative.

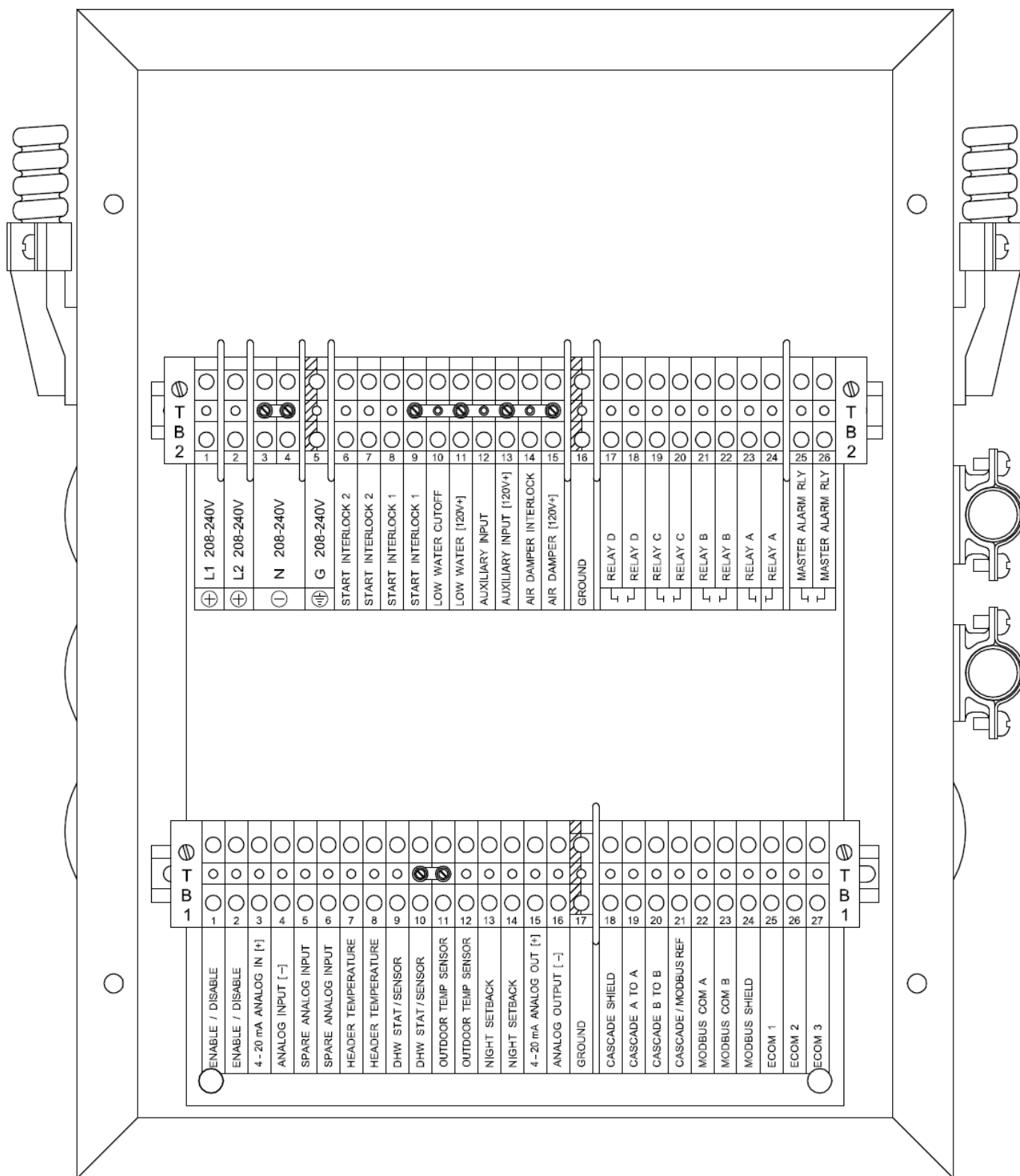
### **WARNING**

Use of Non-Factory Authorized replacement parts are not recommended for this equipment. All control components are engineered for safety and are designed to work in unison with each of the other components. Use of non-factory authorized replacement parts jeopardizes the functionality of the safety features as well as the performance of the appliance.



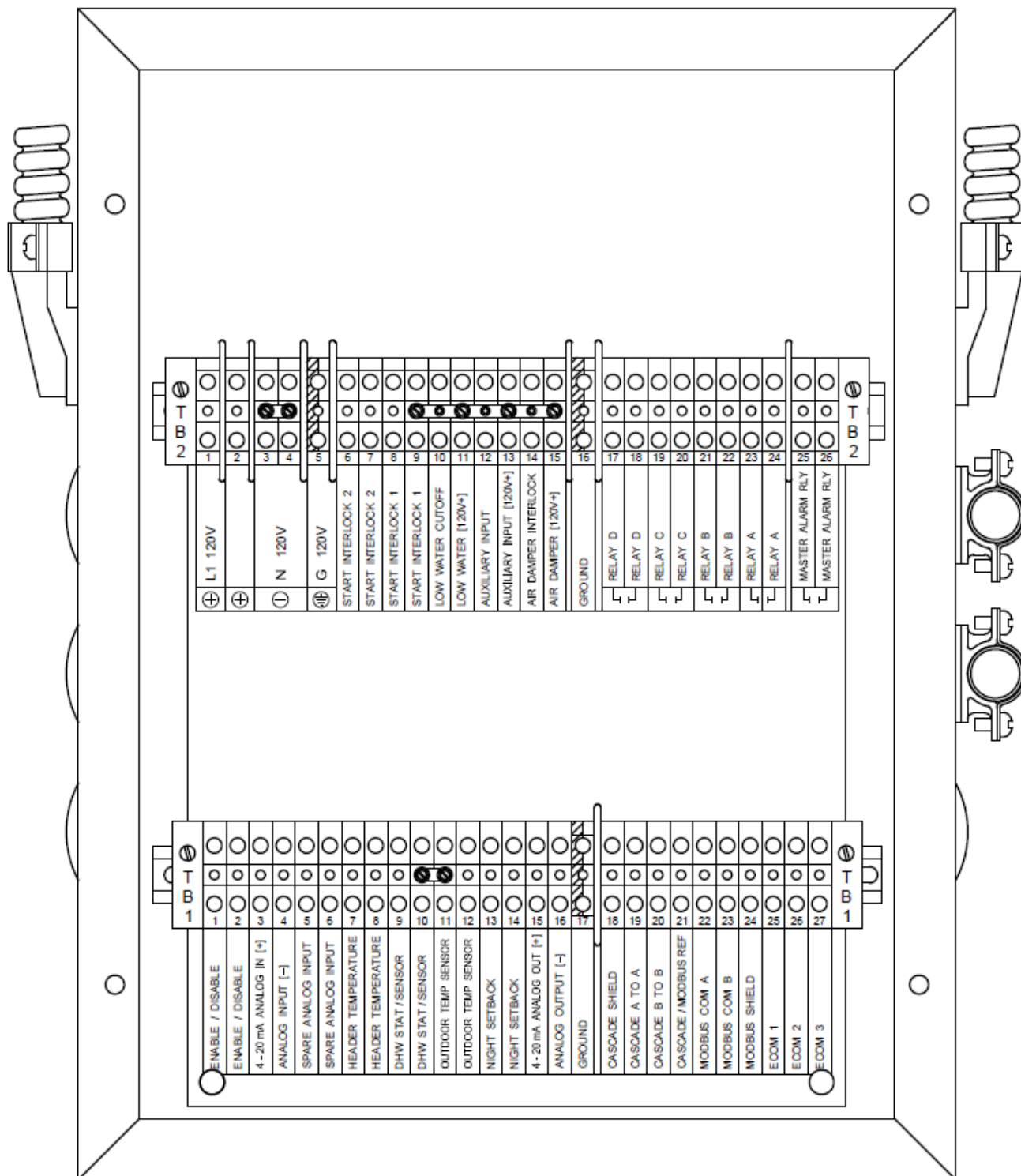
## 6.1 Terminal Block Assignments and Wiring Diagrams

### 6.1.1 Terminal Block 208-240VAC





## 6.1.2 Terminal Block 120VAC





### 6.1.3 Terminal Block Assignments — High Voltage (TB2) Terminal Block (208-240VAC)

Terminal Number	Label	Description
26	MASTER ALARM RELAY	Normally-Open Dry Contact, Close on Alarm (240VAC Max Voltage & 1/2Amp Max Current)
25	MASTER ALARM RELAY	
24	RELAY A	User-Configurable Normally-Open Dry Contact A (240VAC Max Voltage & 1/2Amp Max Current)
23	RELAY A	
22	RELAY B	User-Configurable Normally-Open Dry Contact B (240VAC Max Voltage & 1/2Amp Max Current)
21	RELAY B	
20	RELAY C	User-Configurable Normally-Open Dry Contact C (240VAC Max Voltage & 1/2Amp Max Current)
19	RELAY C	
18	RELAY D	User-Configurable Normally-Open Dry Contact D (240VAC Max Voltage & 1/2Amp Max Current)
17	RELAY D	
16	GROUND	Ground Terminals for I/O Devices
15	[120V+] AIR DAMPER	120VAC Pilot-Duty for Air Damper End Limit Switch Contact Closure When Air Damper Proven Open
14	AIR DAMPER INTERLOCK	
13	[120V+] AUXILIARY INPUT	Reserved for Future Use
12	AUXILIARY INPUT	
11	[120V+] LOW WATER	120VAC Pilot-Duty for Auxiliary/External Low Water Cutoff Device
10	LOW WATER CUTOFF	
9	START INTERLOCK #1	External Interlock Circuit #1 (110-120VAC, Single phase, 60Hz)
8	START INTERLOCK #1	
7	START INTERLOCK #2	External Interlock Circuit #2 (In Series w/ #1) (110-120VAC, Single phase, 60Hz)
6	START INTERLOCK #2	
5	GROUND	G for 208-240VAC, Single phase, 60Hz
4	NEUTRAL	N for 208-240VAC, Single phase, 60Hz
3		
2	HOT L2	L2 for 208-240VAC, Single phase, 60Hz
1	HOT L1	L1 for 208-240VAC, Single phase, 60Hz



#### 6.1.4 Terminal Block Assignments — High Voltage (TB2) Terminal Block (120VAC)

Terminal Number	Label	Description
26	MASTER ALARM RELAY	Normally-Open Dry Contact, Close on Alarm (120VAC Max Voltage & 1/2Amp Max Current)
25	MASTER ALARM RELAY	
24	RELAY A	User-Configurable Normally-Open Dry Contact A (120VAC Max Voltage & 1/2Amp Max Current)
23	RELAY A	
22	RELAY B	User-Configurable Normally-Open Dry Contact B (120VAC Max Voltage & 1/2Amp Max Current)
21	RELAY B	
20	RELAY C	User-Configurable Normally-Open Dry Contact C (120VAC Max Voltage & 1/2Amp Max Current)
19	RELAY C	
18	RELAY D	User-Configurable Normally-Open Dry Contact D (120VAC Max Voltage & 1/2Amp Max Current)
17	RELAY D	
16	GROUND	Ground Terminals for I/O Devices
15	[120V+] AIR DAMPER	120VAC Pilot-Duty for Air Damper End Limit Switch Contact Closure When Air Damper Proven Open
14	AIR DAMPER INTERLOCK	
13	[120V+] AUXILIARY INPUT	Reserved for Future Use
12	AUXILIARY INPUT	
11	[120V+] LOW WATER	120VAC Pilot-Duty for Auxiliary/External Low Water Cutoff Device
10	LOW WATER CUTOFF	
9	START INTERLOCK #1	External Interlock Circuit #1 (110-120VAC, Single phase, 60Hz)
8	START INTERLOCK #1	
7	START INTERLOCK #2	External Interlock Circuit #2 (In Series w/ #1) (110-120VAC, Single phase, 60Hz)
6	START INTERLOCK #2	
5	GROUND	G for 120VAC, Single phase, 60Hz
4	NEUTRAL	N for 120VAC, Single phase, 60Hz
3		
2	HOT L2	L2 for 120VAC, Single phase, 60Hz
1	HOT L1	L1 for 120VAC, Single phase, 60Hz



### 6.1.5 Terminal Block Assignments — Low Voltage (TB1) Terminal Block (120VAC -or- 208-240VAC)

Terminal Number	Label	Description
27	ECOM 3	Wireless Outdoor Air Receiver
26	ECOM 2	
25	ECOM 1	
24	MODBUS SHIELD	2-Wire MODBUS RS485 & Shield Terminal
23	MODBUS COM B	
22	MODBUS COM A	
21	MODBUS/CASCADE REF	Reference Terminal (Application Dependent)
20	CASCADE B TO B	2-Wire Cascade & Shield Terminal
19	CASCADE A TO A	
18	CASCADE SHIELD	
17	GROUND	Ground Terminal for I/O Devices
16	ANALOG OUTPUT [-]	4-20mA Analog Output Tracks Boiler Firing Rate 100% Firing Rate = 20mA, 1% Firing Rate = 4mA
15	4-20mA ANALOG OUTPUT [ + ]	
14	NIGHT SETBACK	Contact Closure Enables Night Setback Operation Open Circuit Disables Night Setback Operation
13	NIGHT SETBACK	
12	OUTDOOR TEMP SENSOR	Outdoor Air Temperature Sensor for ODA Reset (12k $\Omega$ Sensor)
11	OUTDOOR TEMP SENSOR	
10	DHW STAT / SENSOR	DHW Enable Circuit Configurable for SPST Break-on-rise Aquastat or 12k $\Omega$ Tank Sensor
9	DHW STAT / SENSOR	
8	HDR TEMP SENSOR	Hydronic Supply Header Temperature Sensor (12k $\Omega$ Sensor)
7	HDR TEMP SENSOR	
6	SPARE ANALOG INPUT	Reserved for Future Use
5	SPARE ANALOG INPUT	
4	ANALOG INPUT [-]	4-20mA Analog Input Configurable for Setpoint or Firing Rate Control
3	4-20mA ANALOG INPUT [ + ]	
2	ENABLE / DISABLE	Contact Closure Enables Comfort Heat Operation Open Circuit Disables Comfort Heat Operation
1	ENABLE / DISABLE	



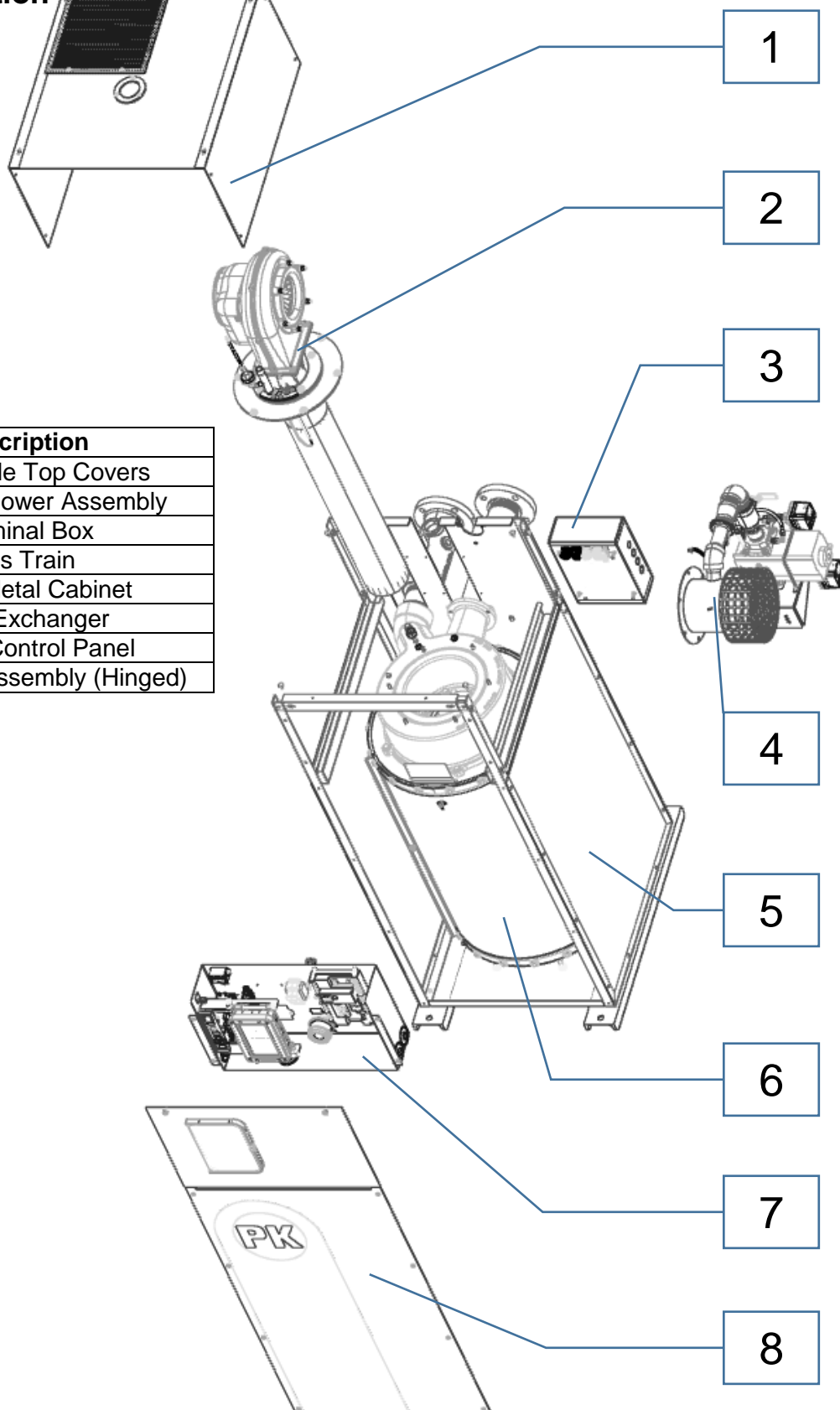




## 6.2 Parts Identification

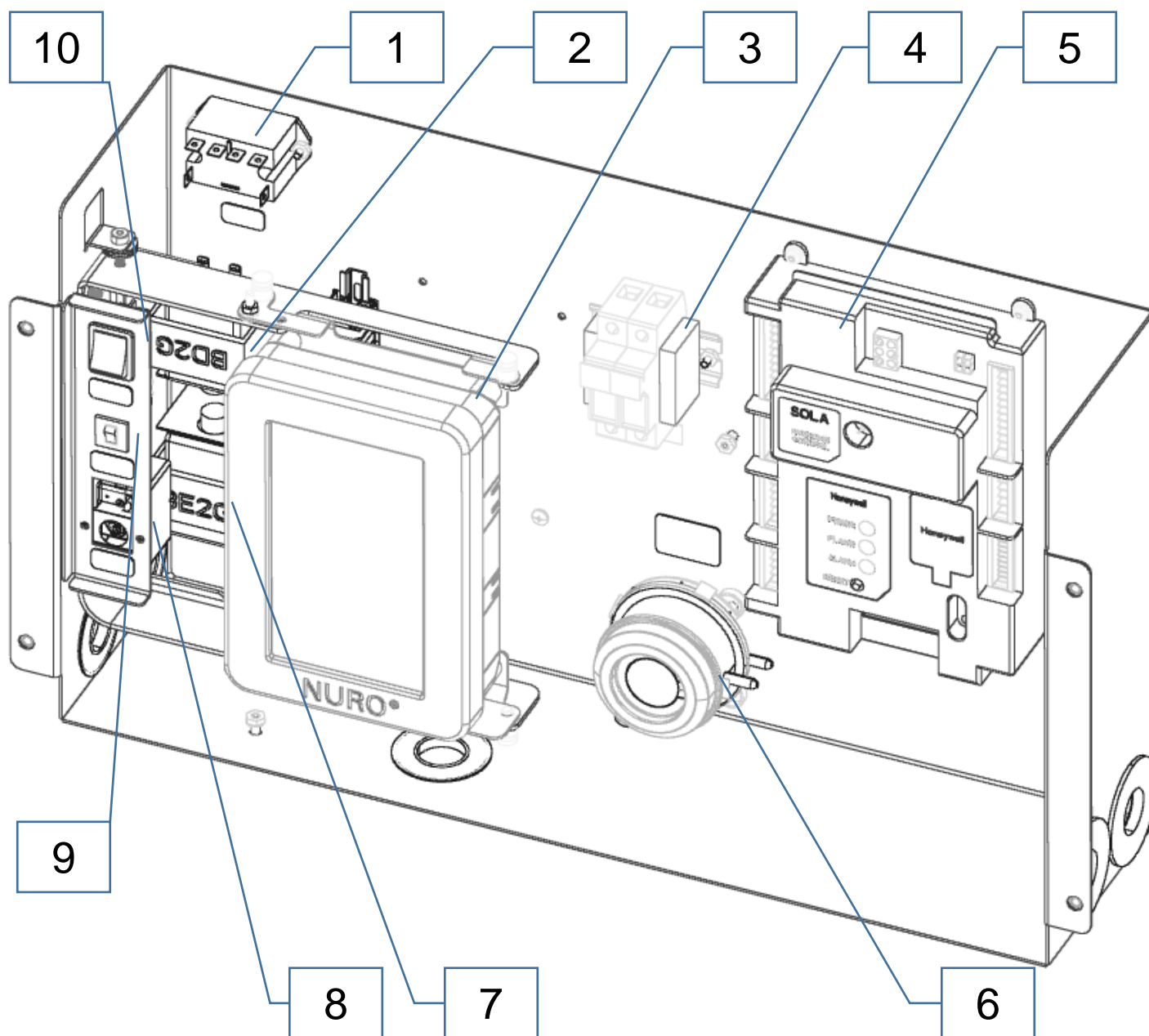
### 6.2.1 Main Assembly

Mark	Description
1	Removable Top Covers
2	Burner & Blower Assembly
3	Terminal Box
4	Gas Train
5	Sheet Metal Cabinet
6	Heat Exchanger
7	NURO Control Panel
8	Front Door Assembly (Hinged)





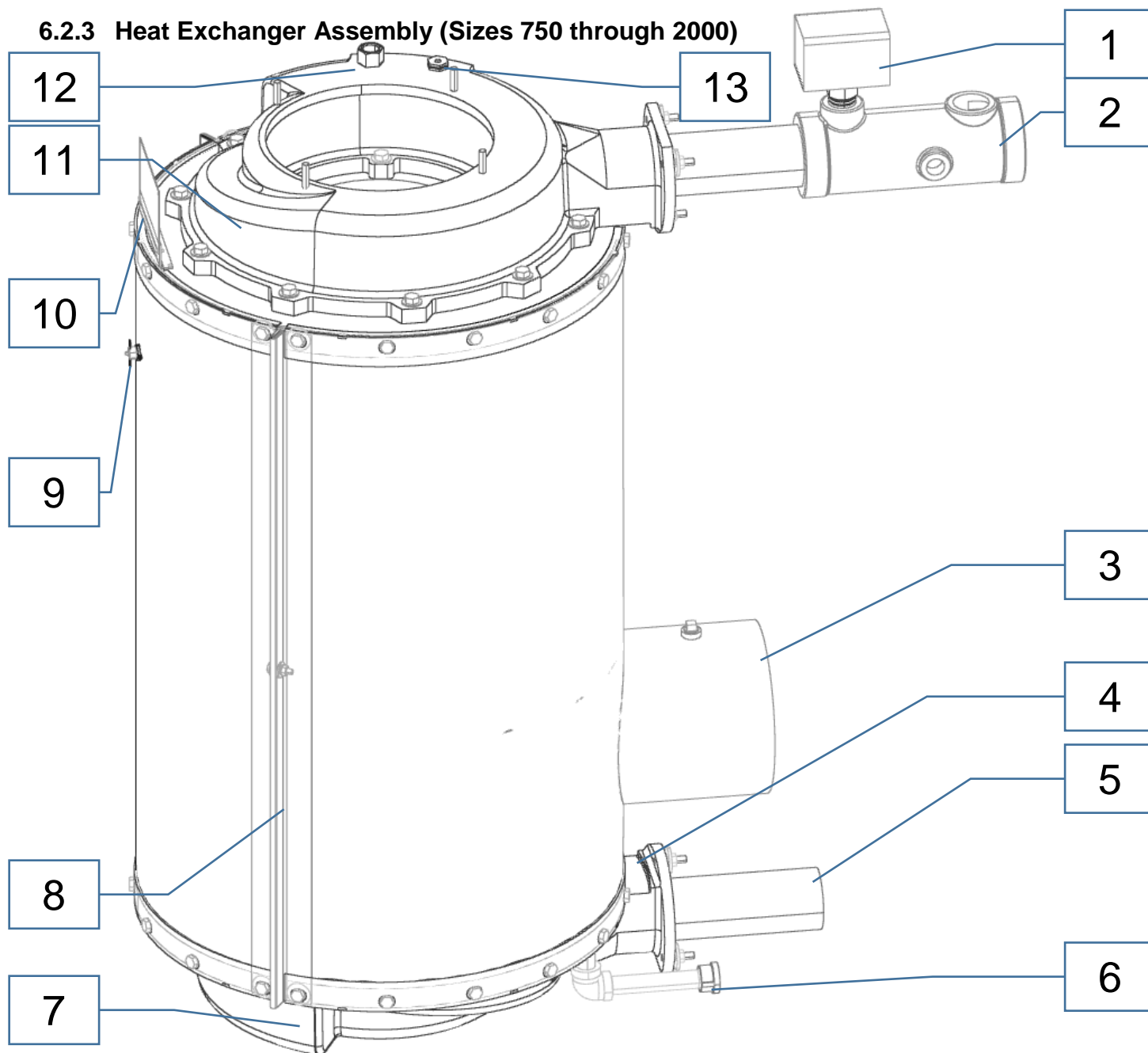
### 6.2.2 NURO Control Panel



Mark	Description	Mark	Description
1	Blower Motor Relay	6	Air Pressure Switch
2	Transformer XFMR3 (20VA)	7	Transformer XFMR2 (40VA)
3	NURO Touchscreen Assembly	8	Manual Reset Hi Temp Limit
4	Fuse Holder	9	Circuit Breaker
5	SOLA Mainboard	10	On/Off Switch



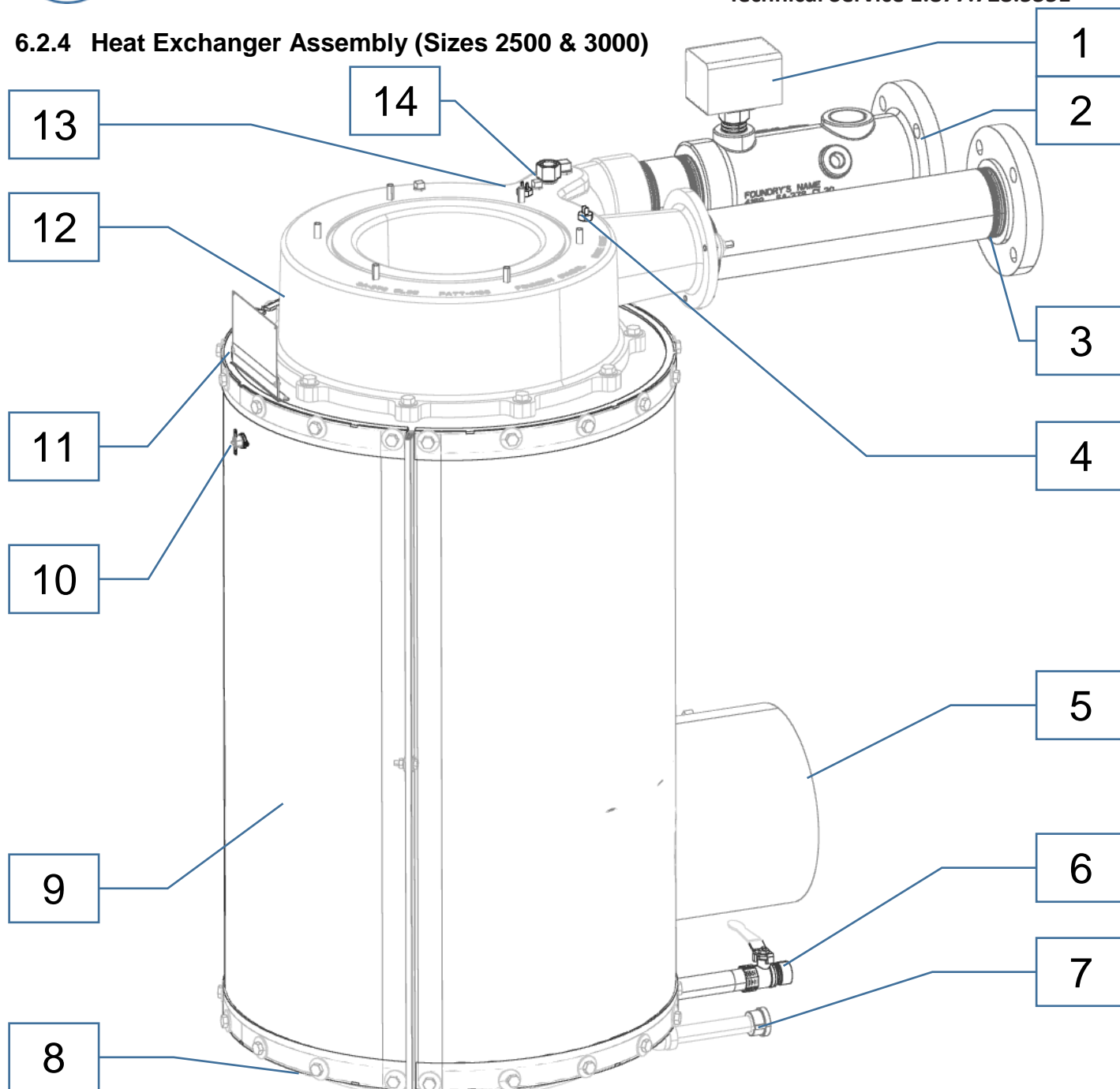
### 6.2.3 Heat Exchanger Assembly (Sizes 750 through 2000)



Mark	Description	Mark	Description
1	Water Flow Paddle Switch	8	Combustion Wrapper
2	Supply/Outlet Casting (2-1/2" NPT-F)	9	Flue Gas Temperature Switch
3	Flue Outlet	10	ASME Nameplate
4	Inlet/Return Temperature Sensor	11	Upper Head Casting
5	Inlet/Return Pipe (2-1/2" NPT-M)	12	Thermowell for Manual Reset High Temperature Limit
6	Condensate/Washout Drain Cap (3/4" NPT)	13	Outlet/Supply Temperature Sensor
7	Lower Head Casting		



## 6.2.4 Heat Exchanger Assembly (Sizes 2500 & 3000)

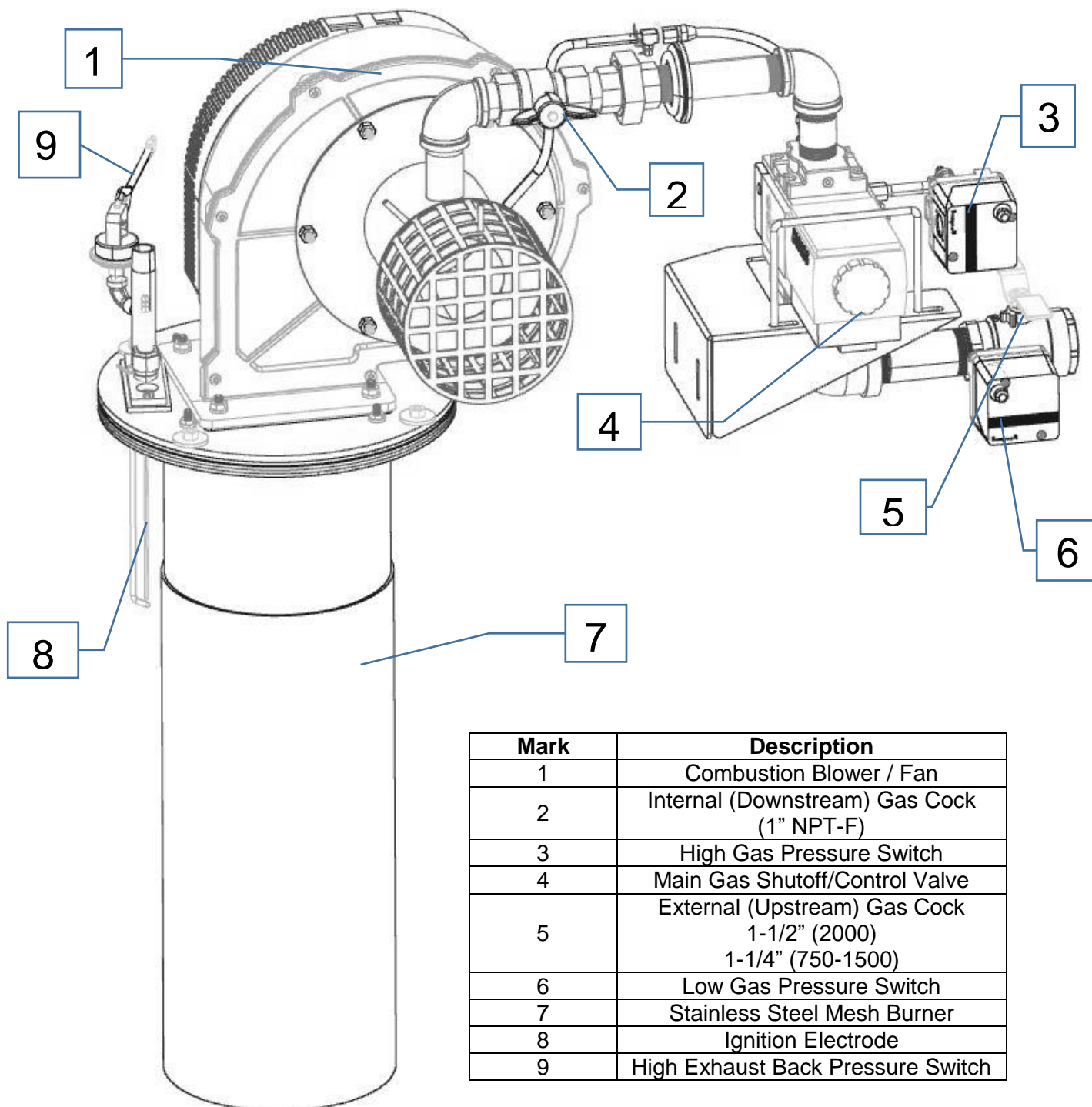


Mark	Description	Mark	Description
1	Water Flow Paddle Switch	8	Lower Head Casting
2	Supply/Outlet Casting (3" 150# Flange)	9	Combustion Wrapper
3	Inlet/Return (3" 150# Flange)	10	Flue Gas Temperature Switch
4	Inlet/Return Temperature Sensor	11	ASME Nameplate
5	Flue Outlet	12	Upper Head Casting
6	Manual Drain Valve (3/4" NPT)	13	Outlet/Supply Temperature Sensor
7	Condensate/Washout Drain (3/4" NPT)	14	Thermowell for Manual Reset High Temperature Limit





## 6.2.5 Gas Train, Burner & Blower Assembly (Sizes 750 through 2000)

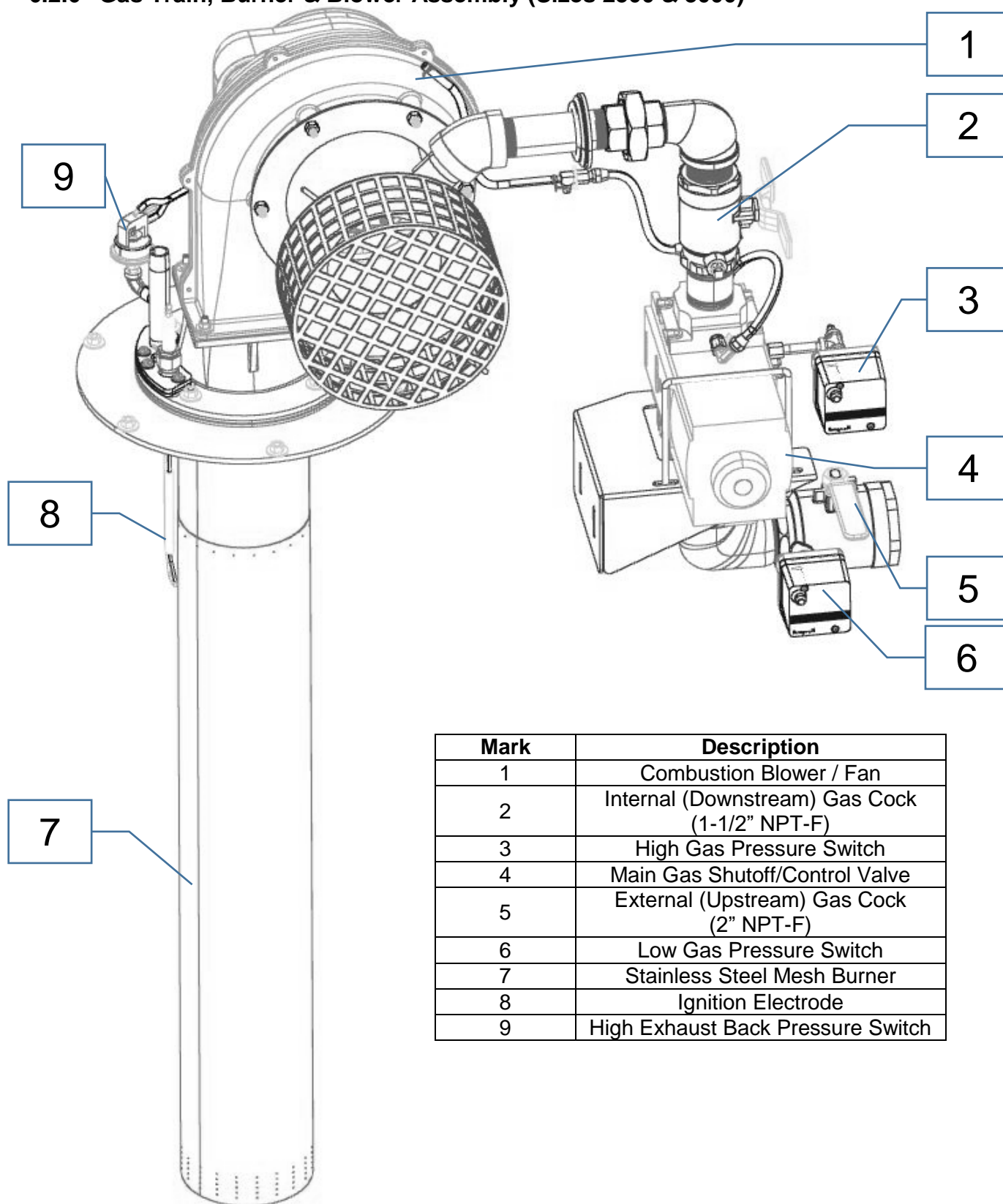


Mark	Description
1	Combustion Blower / Fan
2	Internal (Downstream) Gas Cock (1" NPT-F)
3	High Gas Pressure Switch
4	Main Gas Shutoff/Control Valve
5	External (Upstream) Gas Cock 1-1/2" (2000) 1-1/4" (750-1500)
6	Low Gas Pressure Switch
7	Stainless Steel Mesh Burner
8	Ignition Electrode
9	High Exhaust Back Pressure Switch





## 6.2.6 Gas Train, Burner & Blower Assembly (Sizes 2500 & 3000)



Mark	Description
1	Combustion Blower / Fan
2	Internal (Downstream) Gas Cock (1-1/2" NPT-F)
3	High Gas Pressure Switch
4	Main Gas Shutoff/Control Valve
5	External (Upstream) Gas Cock (2" NPT-F)
6	Low Gas Pressure Switch
7	Stainless Steel Mesh Burner
8	Ignition Electrode
9	High Exhaust Back Pressure Switch



## 7 MODU-FIRE FORCED DRAFT® SPECIFIC LIMITED WARRANTY

Last Updated 4/8/16

Subject to the terms and conditions herein and the Terms and Conditions of Sale (as defined herein), Patterson-Kelley ("Seller") warrants to the purchaser of the product ("Buyer") that the heat exchanger and burner are free of defects in material and workmanship, when operated in accordance with the conditions stated herein, for a period of five (5) years and a ten (10) year warranty against failure due to thermal shock commencing on the date of shipment or, if a start-up report is furnished to Seller, on the start-up date shown on the report furnished to Seller (the "Warranty Period"), provided that startup is completed within six (6) months of shipment and the start-up report is furnished to Seller within thirty (30) days of startup (this "Specific Limited Warranty"). The Exclusions and limitations of liability set forth in the Terms and Conditions of Sale (as defined herein) apply to this Specific Limited Warranty. Capitalized terms used but not defined herein have the meanings ascribed to them under Seller's terms and conditions of sale for the product, which can be found at

<http://pattersonkelley.com/warranty.php> (the "Terms and Conditions of Sale"). This Specific Limited Warranty is transferrable to the owner that utilizes the product(s) purchased hereunder for its intended use at the original installation site (the "Original Owner"). This Specific Limited Warranty is non-transferable to anyone who subsequently receives or purchases products from the Original Owner. If the Original Owner did not purchase the product directly from Seller, the Original Owner should contact the reseller from whom it purchased the product for a copy of the Terms and Conditions of Sale attached to the Order Acknowledgement received by the original purchaser of the product from Seller.

### I. REMEDY

Seller's obligations under this Specific Limited Warranty is limited to repairing or, if in Seller's judgment it seems more appropriate, to furnishing without charge (installation not included), FCA Seller's factory (Incoterms 2010), a similar part to replace any part which after examination shall, to Seller's own satisfaction be determined to have been defective at the time it was shipped. In the event that a replacement is provided by Seller, the defective item will become the property of Seller. Transportation to Seller's facility or other designated facility for repairs of any products or party alleged defective shall, in all events, be at Buyer's sole risk and cost. This warranty applies only if the original installer and Seller (Attention: Patterson-Kelley, 155 Burson Street, East Stroudsburg, PA 18301) receive, within the Warranty Period, an immediate written notice, providing a detailed description of all claimed defects, upon discovery of such defects together with proof of purchase (invoice or Order Acknowledgment) and a copy of the start-up report for the affected product. Seller may seek reimbursement of any costs incurred by Seller where the product is found to be in good working order, or when it has been determined that this Specific Limited Warranty does not apply as per the exclusions set forth below. The remedies available to Buyer set forth herein are exclusive remedies, and all other remedies, statutory or otherwise, including but not limited to the right of redhibition, are waived by Buyer. Buyer acknowledges that the exclusion of remedies is neither unreasonable nor unconscionable. Buyer shall indemnify and hold Seller harmless against, any claim due to any injury or death to any person or damage to any property resulting in whole or in part from any modification or alteration Buyer makes to any product sold hereunder.

### II. EXCLUSIONS

To the full extent permitted by law, Seller shall have no liability for and the Warranties do not cover:

- (A) any product which has been altered or repaired by other than Seller's personnel;
- (B) deterioration or failure of any product due to
  - (i) abrasion, corrosion, erosion or fouling,
  - (ii) misuse,
  - (iii) modification not authorized by Seller in writing or
  - (iv) improper installation, lack of or improper maintenance or operation;
- (C) equipment not furnished by Seller by the owner, either mounted or unmounted, or when contracted for by a party or parties other than Seller to be installed or handled;
- (D) the suitability of any product for any particular application;
- (E) the design or operation of owner's plant or equipment or of any facility or system of which any product may be made a part;
- (F) any damage to the product due to abrasion, erosion, corrosion, deterioration, abnormal temperatures or the influence of foreign matter or energy;
- (G) the performance of any product under conditions varying materially from those under which such product is usually tested under industry standards at the time of shipment;
- (H) leakage or other malfunction caused by:
  - (i) defective installations in general and specifically, any installation which is made
    - (a) in violation of applicable state or local plumbing, housing or building codes or
    - (b) contrary to the written instructions furnished with the product,
  - (ii) adverse local conditions in general and, specifically, sediment or lime precipitation in the tubes, headers and/or shells or corrosive elements in the water, heating medium or atmosphere, or



- (iii) misuse in general and, specifically, operation and maintenance contrary to the written instructions furnished with the unit, disconnection, alteration or addition of components or apparatus, not approved by Seller, operation with heating media, fuels or settings other than those set forth on the rating plate or accidental or exterior damage;
- (I) production of noise, odors, discoloration or rusty water;
- (J) damage to surrounding area or property caused by leakage or malfunction;
- (K) costs associated with the replacement and/or repair of the unit including: any freight, shipping or delivery charges, any removal, installation or reinstallation charges, any material and/or permits required for installation, reinstallation or repair, charges to return the boiler and/or components;
- (L) INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES, SUCH AS LOSS OF THE USE OF PRODUCTS, FACILITIES OR PRODUCTION, INCONVENIENCE, LOSS OF TIME OR LABOR EXPENSE INVOLVED IN REPAIRING OR REPLACING THE ALLEGED DEFECTIVE PRODUCT;
- (M) any claim due to any injury or death to any person or damage to any property resulting in whole or in part from any modification or alteration Buyer makes to any product sold hereunder; and
- (N) Design defects where Seller has complied with Buyer's design specifications.

### **III. PROOF OF PURCHASE**

Proof of purchase (invoice or Order Acknowledgement) and a copy of the start-up report for the affected product must be provided to Seller when requesting service under this Specific Limited Warranty.

### **IV. ORDER OF PRECEDENCE**

The Standard Limited Warranty set forth in the Terms and Conditions of Sale, (b) this Specific Limited Warranty and (c) any applicable Extended Limited Warranty exclusively govern and control Seller's and Buyer's respective rights and obligations regarding the warranty of the product. In case of any inconsistency, conflict, or ambiguity between the Standard Limited Warranty, this Specific Limited Warranty and any applicable Extended Limited Warranty (collectively, the "Warranty Documents"), the documents shall govern in the following order: (w) any applicable Extended Limited Warranty; (x) this Specific Limited Warranty; (y) the Standard Limited Warranty and (z) other provisions in the Terms and Conditions of Sale. Information identified in one Warranty Document and not identified in another shall not be considered a conflict or inconsistency. No sales representative, agent, or employee of Seller or any reseller in the chain of sale of the product is authorized to make any modification, extension, or addition to this Specific Limited Warranty, unless agreed to in writing by Seller.



## 8 Fire-Test Report

Date: \_\_\_\_\_

Appliance Serial # \_\_\_\_\_ Model # \_\_\_\_\_

Installation: Name: \_\_\_\_\_ City: \_\_\_\_\_

State: \_\_\_\_\_ Zip: \_\_\_\_\_ Contact \_\_\_\_\_ Phone: \_\_\_\_\_

Installer Name: \_\_\_\_\_ Type of Installation: \_\_\_\_\_ (Hotel, School, etc.)

Fuel: Natural Gas \_\_\_\_\_ Propane \_\_\_\_\_

Outdoor Temperature Sensor Connected Yes: \_\_\_\_\_ No: \_\_\_\_\_

Field Fire-Test	High	Low	DATE:
Inlet Gas	_____ "w.c.	_____ "w.c.	
Oxygen (O2)	_____ %	_____ %	
Carbon Dioxide (CO2)	_____ %	_____ %	
Carbon Monoxide (CO)	_____ ppm	_____ ppm	
Nox	_____ ppm	_____ ppm	
Gross Stack Temp.	_____ ° F	_____ ° F	
Combustion Air Temp.	_____ ° F	_____ ° F	
Stack Press.(exhaust)	_____ "w.c.	_____ "w.c.	
Main Flame Signal	_____ Volts or uV	_____ Volts or uA	
Efficiency	_____ %	_____ %	
Comb. Air Pres. (intake)	_____ "w.c.	_____ "w.c.	

### Lockup/Static Gas pressure

Gas pressure drop @ ignition \_\_\_\_\_

2. Water Inlet temperature: \_\_\_\_\_ ° F

3. Water Outlet temperature: \_\_\_\_\_ ° F

4. Flow through boiler: \_\_\_\_\_ GPM

5. Operating Temperature Setpoint: \_\_\_\_\_ ° F (from internal OR external control)

6. Approximate stack lengths: \_\_\_\_\_ Ft. Horizontal \_\_\_\_\_ Ft. Vertical \_\_\_\_\_ Flue Pipe Diameter

7. Incoming Electrical Power \_\_\_\_\_ Volts a.c. ☐ Less than 1 volt between neutral and ground

8. Sytem Water pH level \_\_\_\_\_

9. Comments:


Performed by PK

Certified Agent: \_\_\_\_\_  
(Print Name)

Start Up Certification # \_\_\_\_\_

A copy must be returned within 30 days of startup to Patterson Kelley  
Patterson Kelley • 155 Burson Street • E. Stroudsburg, PA 18301  
P) 570-476-7261 F) 570-476-7247 pkboilers@harsco.com



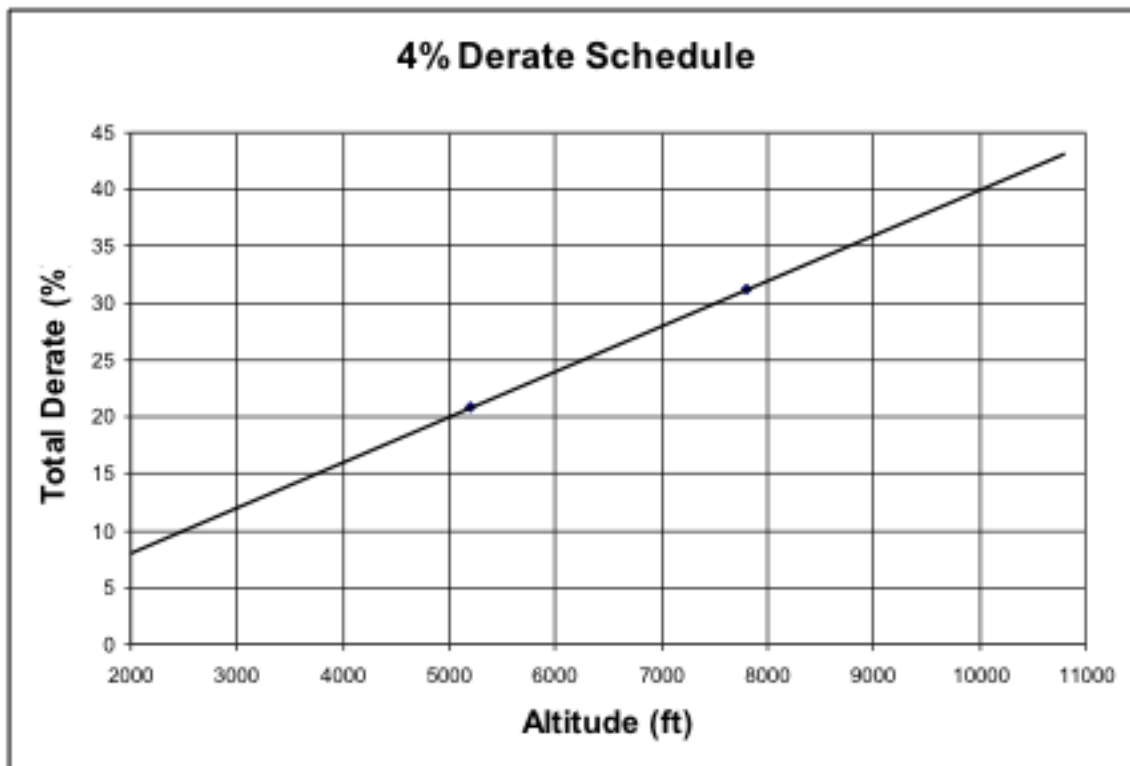
## Appendix A – Maintenance Log

Date	Hi Fire / Low Fire	O <sub>2</sub>	CO	CO <sub>2</sub>	Stack Temp	pH	Action	By



## Appendix B –Altitude Derate Schedule

For installations over 2,000 ft. elevation, a derate schedule is applied. The appliance's input rating must be reduced by 4% per 1,000 ft. which is illustrated in the graph below:



Although the appliance's capacity is reduced due to the lower air density, the combustion tuning should follow the standard combustion guidelines of [Section 3.11](#). Tune the combustion for the same O<sub>2</sub> and CO<sub>2</sub> levels as discussed in [Section 3.11](#).





## Appendix C –Water Quality Standard for Hydronic Boilers in Multi-Metal Systems

Patterson Kelley boilers are designed to be incorporated into any multi-metal hydronic heating system. All multi-metal hydronic systems require that attention be paid to water treatment. The chemical additives for any multi-metal system must be specifically formulated for use with all the various metals used in that system

system. All multi-metal hydronic systems require that attention be paid to water treatment. The chemical additives for any multi-metal system must be specifically formulated for use with all the various metals used in that system.

Any closed, hydronic heating systems should include a meter, to monitor water addition to the recirculating loop, and a filter, pursuant to ASHRAE Standard 189.1 and the AWT Handbook. Water added to a closed hydronic system should not exceed more than 10% of the system volume per year and meter readings should be recorded, at least monthly, to ensure system losses are minimized and corrective actions shall be taken when needed.

Treatment programs for multi-metal systems should meet or exceed the following generally accepted best practices water quality guidelines:

1. Proper cleaning and surface preparation must be completed prior to system start-up.
2. pH must be maintained in a range that is appropriate for the metals contained in the system (see chart below).
3. Total Alkalinity between 100-500 ppm as CaCO<sub>3</sub>.
4. Filtration as per industry best practices.
5. Total suspended solids below 10 ppm.
6. Corrosion inhibiting compounds to protect metals at or below:
  - a. Aluminum <0.25 MPY
  - b. Copper <0.1 MPY, soluble copper <0.25 ppm
  - c. Steel <3.0 MPY According to ASTM D 2688
7. Addition of strong acids is not recommended.
8. Maintain Chlorides < 125 mg/l.

Prior to initiating any treatment program, a water sample of the proposed fill water should be sampled for analysis. Once filled and bled of air, a pH neutral, industrial cleaner for use in multi-metal systems should be used to clean the entire hydronic system. Samples of the system water with cleaner should be taken and analyzed to ensure proper cleaner strength. Once cleaned, the system should be flushed with fresh (fill) water until the system water is within 100 micro Siemens in conductivity of the fresh water. When flushing is complete, a treatment program that is designed for use in that multi-metal system, after consideration of the metals it contains, must be used. Treatment programs should also comply with the standard water quality guidelines listed above.

Multi-Metal Systems with Aluminum	Multi-Metal Systems with Stainless Steel	Multi-Metal Systems with Copper
Proper surface cleaning required	Proper surface cleaning required	Proper surface cleaning required.
pH maintained between 6.0-8.5*	pH maintained between 6.6-8.5** <sup>□</sup>	pH range may vary ***
Total Alkalinity 100-500 ppm as CaCO <sub>3</sub>	Total Alkalinity 100-500 ppm as CaCO <sub>3</sub>	Total Alkalinity 100-500 ppm as CaCO <sub>3</sub>
Best Practices Filtration	Best Practices Filtration	Best Practices Filtration
Suspended solids below 10 ppm	Suspended solids below 10 ppm	Suspended solids below 10 ppm
Corrosion rates below: 0.1 MPY copper 3.0 MPY steel 0.25 MPY aluminum	Corrosion rates below: 0.1 MPY copper 3.0 MPY steel 0.1 MPY sst <sup>^</sup>	Corrosion rates below: 0.1 MPY copper 3.0 MPY steel Max. MPY other metals
Addition of strong acid not recommended	Addition of strong acids not recommended	Addition of strong acids not recommended
When freeze protection is required, automotive grade glycols are not recommended and decomposition products should be monitored and maintained below concentrations that present corrosive conditions. For existing boiler water systems, additional requirements and operational conditions may be required to mitigate pre-existing conditions.		
* Other system components may have more restrictive ranges.		
<sup>□</sup> Per Industry SST Heat Exchanger Manufacturers		
** Copper has a broad range of acceptable pH and the other metallic components may require a tighter range		
<sup>^</sup> Per ASHRAE/AIA Presentation # 6017 2012 Winter Conference		



## Appendix D – Best Practices For New & Retrofit Systems

### BEST PRACTICES FOR ALL BOILER INSTALLATIONS

1. Patterson-Kelley recommends and most installation codes require isolation valves on both the boiler's inlet (return) and outlet (supply) pipe runs. These are used to hydraulically isolate the boiler from the hydronic system, which should be standard practice when flushing or adding concentrated cleaning chemicals.
2. Patterson-Kelley recommends installing purge valves on the system side of the boiler's isolation valves. These valves should be used to purge the hydronic system of debris and sediment prior to the initial startup of the boiler equipment. Since the purge valves are located on the system side of the boiler's isolation valves, the debris and sediment will not be routed in direct proximity to the boiler's heat exchanger.
3. Patterson-Kelley recommends installing a standard mesh strainer (maximum 20 mesh) on the each boiler's return (inlet) piping. This is intended to prevent large particles, foreign debris, etc. from entering and obstructing flow or heat transfer through the boiler's heat exchanger. Each strainer should feature a manual blow-down valve in order to purge the debris from the strainer.  
**NOTE:** This strainer is not intended to remove fine particulate matter from the boiler system which will be discussed later in this appendix.
4. Patterson-Kelley recommends installing a water meter on the cold water fill piping. The intention of this device is to periodically monitor the amount of fresh water introduced into the system piping. It can also be used to establish a rough estimate of the total system volume during the initial fill. In general, the annual amount of fresh water make-up should be less than 10% of the total system volume. A water meter can also be useful to detect a leak in the hydronic system if you notice an unexpected increase in the volume of fill water.
5. Oxygen (O<sub>2</sub>) elimination is critical to the longevity of any hydronic system. Patterson-Kelley recommends installing an Air Separator (micro-bubbler style) that is capable of eliminating the dissolved Oxygen levels introduced from the cold water fill. In general, air separators are most effective when the boiler water is at highest temperature and lowest pressure.
6. Patterson-Kelley recommends installing an Automatic Air Vent on the Air Separator. In order for the Air Separator to continually purge the system of dissolved Oxygen, an Automatic Air Vent is preferred over a manual air vent.
7. The maximum flow rate requirements vary between Patterson-Kelley boiler models. Please refer to [Appendix E – Installation and Quick Reference](#) for a complete listing of the maximum flow rates per boiler model. Exceeding the maximum flow rate of a boiler can cause erosion of the boiler's heat exchanger or piping materials and can damage the paddle type flow switch.
8. The minimum flow rate requirements vary between Patterson-Kelley boiler models. Please refer to [Appendix E – Installation and Quick Reference](#) for a complete listing of the minimum flow rates per boiler model. Flowing below the minimum flow rates can lead to overheating of the boiler's heat exchanger materials and the formation of steam bubbles within the water passages.
9. Well in advance of the equipment startup, turn off all circulation pumps and close the isolation valves on each boiler's inlet (return) and outlet (supply) pipe runs. Connect a hose to the purge valves and run this hose to a nearby floor drain. Open each purge valve to flush out debris that is present in the water. This process may take several attempts until the discharge water is



sufficiently clean. After successfully purging the system, make sure to open the boiler's isolation valves and turn on the circulation pumps.

10. Upon startup, Patterson-Kelley recommends collecting two water samples: one from the hydronic system and another from the cold water fill. It is best practice to circulate the hydronic system for at least one hour prior to collecting this initial water in order to acquire a representative (blended) sample.
11. Within the first three months after startup, Patterson-Kelley recommends collecting a follow-up water sample from the hydronic system. This should be compared to the initial startup sample in order to determine any changes in pH, Alkalinity, conductivity, etc. that may adversely affect the system performance.
12. Although the ongoing water treatment regimen will vary based on the supplier and application, Patterson-Kelley recommends a minimum annual water sample rate. The results of the annual water tests should be compared to past tests in order to determine any changes in pH, Alkalinity, conductivity, etc. that may adversely affect the system performance. Refer to [Appendix C –Water Quality Standard for Hydronic Boilers in Multi-Metal Systems](#) for the water quality standard.

#### **BEST PRACTICES FOR RETROFIT BOILER INSTALLATIONS**

1. The primary concern in retrofit installations into existing boiler systems is the presence of suspended and dissolved solids. These are typically a result of deteriorating piping, fittings, or legacy boiler's heat exchangers. Patterson-Kelley recommends installing a side-stream filter (maximum 10 micron) to remove this existing particulate, sediment, etc. There are many different types of side-stream filters available, Patterson-Kelley recommends consulting your local water treatment provider in order to determine the best method for your particular application.
2. If the existing hydronic system contains a significant amount of suspended and dissolved Iron, Patterson-Kelley recommends the use of a side-stream filter with built-in magnet. This magnet helps attract and eliminate the Iron particulate.
3. Some water treatment additives/chemicals may cause leeching from the existing system piping. As more contaminants leech from the walls of the piping into the system water, the pH and the level of Total Dissolved Solids (TDS) may gradually climb to levels that will adversely affect the system performance. A side-stream filter will accommodate the increased TDS, but you may need to consult your local water treatment provider in order to combat the increased pH.

#### **BEST PRACTICES FOR NEW BOILER INSTALLATIONS**

1. The construction of the hydronic system piping involves many different operations that can introduce contaminants (weld slag, solder, flux, pipe dope, cutting oils, metal shavings, etc.) It is critical to properly flush the system well in advance of startup of the boiler equipment.
2. In order to locate loose pipe connections, leaks, etc. after the initial construction of the hydronic system piping, the Mechanical Contractor may fill and drain the system several times. During these initial fill-ups and drains, Patterson-Kelley recommends closing the boiler's isolation valves in order to separate them from the hydronic system. This will help limit the amount of dissolved Oxygen and particulates that are brought in direct contact with the boiler's heat exchanger.



## **BEST PRACTICES FOR ALL WATER HEATER INSTALLATIONS**

1. Patterson-Kelley recommends and most installation codes require isolation valves on both the water heater's inlet (return) and outlet (supply) pipe runs. These are used to hydraulically isolate the water heater from the system, which should be standard practice when flushing.
2. Patterson-Kelley recommends installing purge valves on the system side of the water heater's isolation valves. These valves should be used to purge the domestic hot water system of debris and sediment prior to the initial startup of the water heater equipment. Since the purge valves are located on the system side of the water heater's isolation valves, the debris and sediment will not be routed in direct proximity to the water heater's heat exchanger.
3. Patterson-Kelley recommends installing a standard mesh strainer (maximum 20 mesh) on each water heater's inlet (return) piping. This is intended to prevent large particles, foreign debris, etc. from entering and obstructing flow or heat transfer through the water heater's heat exchanger. Each strainer should feature a manual blow-down valve in order to purge the debris from the strainer. **NOTE:** This strainer is not intended to remove fine particulate matter from the domestic water system.
4. Oxygen (O<sub>2</sub>) elimination is critical to the longevity of any domestic water system. Patterson-Kelley recommends installing Automatic Air Vents in the "high points" of the piping in order to purge the system of dissolved Oxygen and air. Automatic Air Vents are preferred over manual air vents in order to continually purge the domestic water system.
5. The maximum flow rate requirements vary between Patterson-Kelley water heater models. Please refer to [Appendix E – Installation and Quick Reference](#) for a complete listing of the maximum flow rates per water heater model. Exceeding the maximum flow rate of a water heater can cause erosion of the heat exchanger or piping materials and can damage the paddle type flow switch.
6. The minimum flow rate requirements vary between Patterson-Kelley water heater models. Please refer to [Appendix E – Installation and Quick Reference](#) for a complete listing of the minimum flow rates per water heater model. Flowing below the minimum flow rates can lead to overheating of the heat exchanger materials and the formation of steam bubbles within the water passages.
7. Well in advance of the equipment startup, turn off all circulation pumps and close the isolation valves on each water heater's inlet (return) and outlet (supply) pipe runs. Connect a hose to the purge valves and run this hose to a nearby floor drain. Open each purge valve to flush out debris that is present in the water. This process may take several attempts until the discharge water is sufficiently clean. After successfully purging the system, make sure to open the water heater's isolation valves and turn on the circulation pumps.
8. Upon startup, Patterson-Kelley recommends collecting two water samples: one from the domestic hot water system and another from the cold water fill. **NOTE:** Water softening may be required if the water samples indicate high levels of hardness.
9. Patterson-Kelley recommends a minimum annual water sample rate to determine any changes in pH, Alkalinity, conductivity, etc. that may adversely affect the system performance.



## Appendix E – Installation and Quick Reference

### Fuel/Gas Supply

- Refer to [Section 3.7](#) for information on proper sizing of the gas supply piping. Undersized gas piping with too much pressure drop will negatively impact the boiler's performance.
- Install a lock-up type gas regulator to supply an appropriate gas pressure as described below:

Natural Gas	Propane Gas
Minimum Inlet Pressure = 3.5" W.C. to 4.0" W.C. Maximum Inlet Pressure = 14.0" W.C.	Minimum Inlet Pressure = 11.0" W.C. Maximum Inlet Pressure = 14.0" W.C.

**NOTE:** Patterson-Kelley recommends installing an individual lock-up type gas regulator in the gas supply piping to each boiler. For installations where one master lock-up type gas pressure regulator will service multiple boilers, Patterson-Kelley recommends contacting the local regulator representative for application assistance specifying the appropriate lock-up type regulator and gas pipe sizing.

### Electrical/Power Supply

- Carefully inspect the boiler's nameplate labels which describe the power supply requirements.
- Provide an appropriate power feed to the boiler with overcurrent protection as described below:

Appliance Size	Power Supply Requirements
750 - 1000	208-240VAC, <u>single phase</u> , 60Hz sized for 10 Amps.
1500 - 2000	208-240VAC, <u>single phase</u> , 60Hz sized for 15 Amps.
2500 - 3000	208-240VAC, <u>single phase</u> , 60Hz sized for 20 Amps.

- Prior to startup, carefully check all electrical connections for tightness as connections can come loose during shipping.

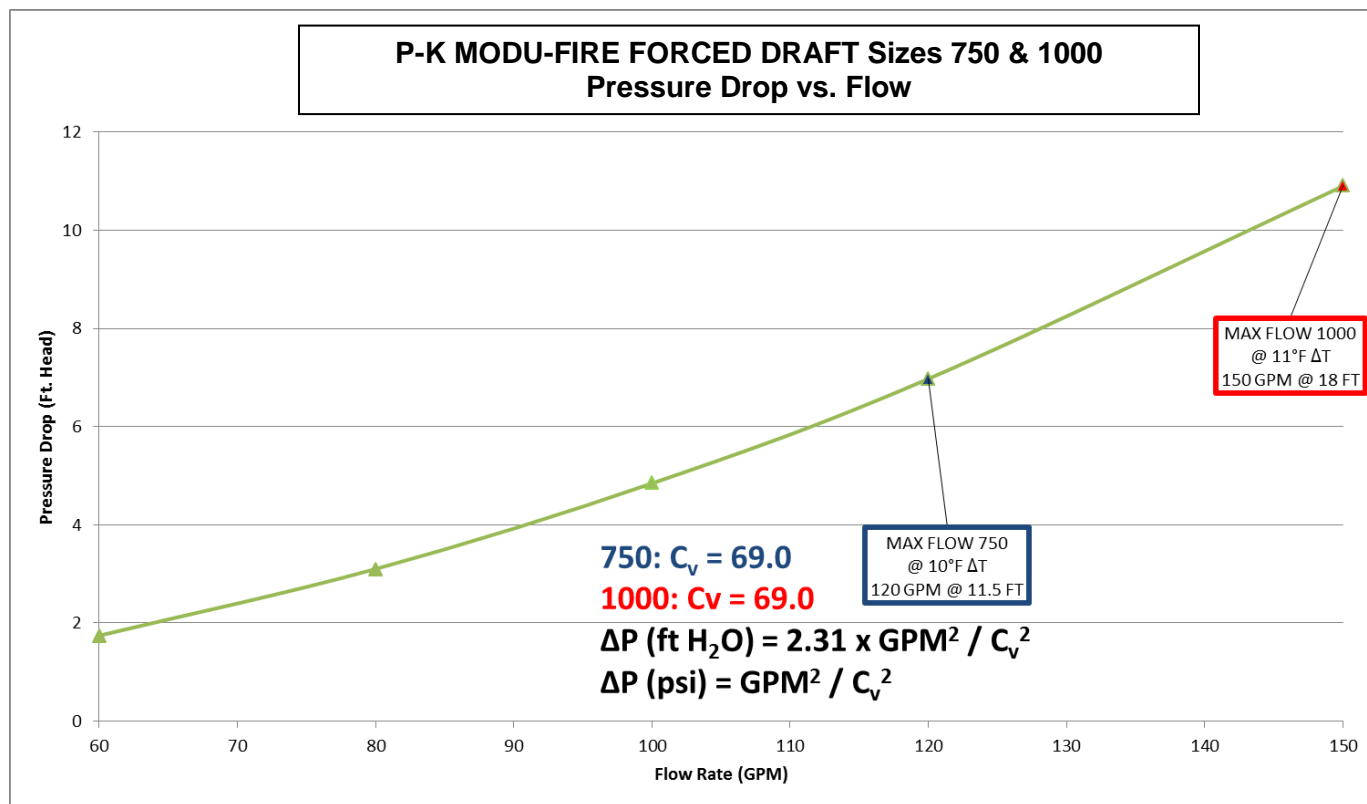
### Exhaust Venting

- The P-K MODU-FIRE Forced Draft boilers and water heaters are dual-certified as Category II & Category IV appliances, capable of operating with slightly negative to slightly positive exhaust pressure. It is critical to ensure the flue venting material is suitable for use with the appliance.
  - For Category II installations, ensure the flue venting system is designed to maintain a slightly negative exhaust pressure **between -0.01" W.C. and -0.05" W.C.**
  - For Category IV installations, ensure the flue venting system is designed to maintain a positive exhaust pressure which must be in the following ranges:
    - +0.01" W.C. and +1.5" W.C.** (MFD Sizes 750 through 2000)
    - +0.01" W.C. and +1.0" W.C.** (MFD Sizes 2500 through 3000)





## Hydronics/Water Flow (MFD 750 - 1000 Sizes)



### MODU-FIRE Forced Draft Boilers & Water Heaters: Minimum & Maximum Flow Rates

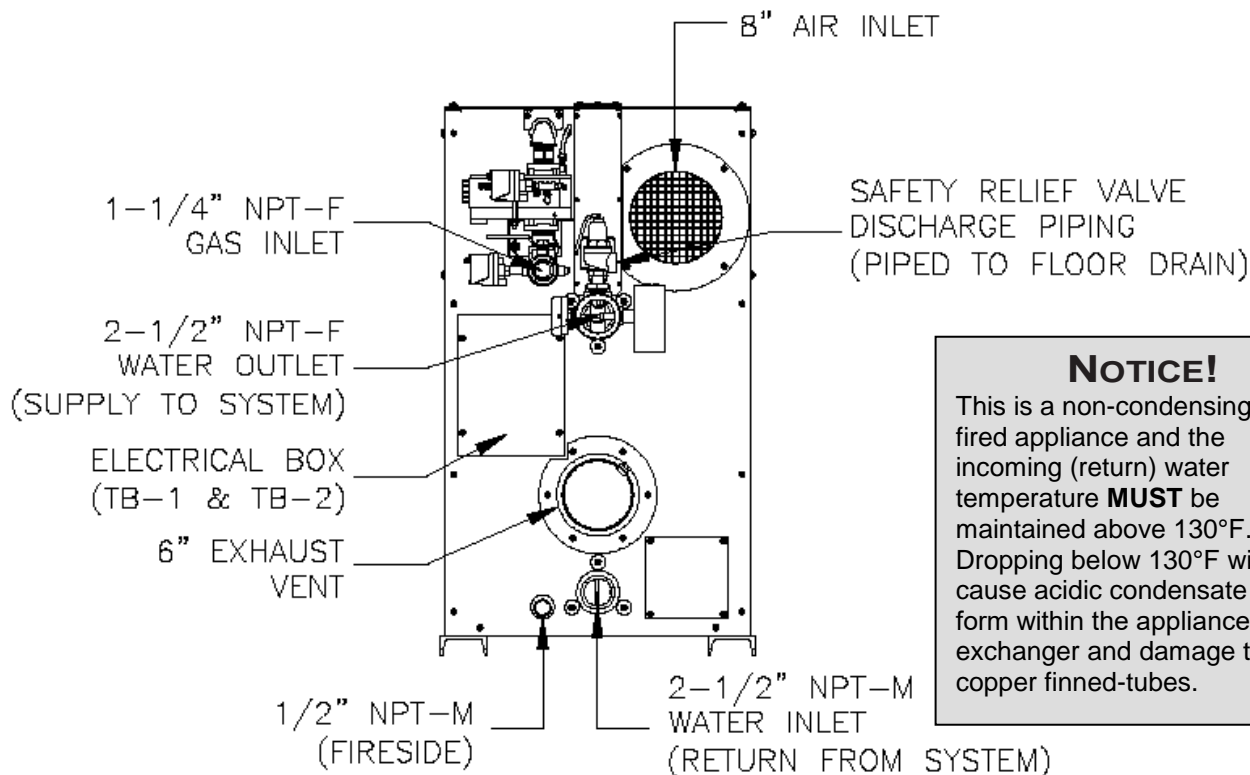
Flow Condition	Operation	N750-MFD W750-MFD (5:1)	Approx. ΔT	N1000-MFD W1000-MFD (6:1)	Approx. ΔT
Maximum Flow	High Fire	120 GPM	10 °F	150 GPM	11 °F
<b>Optimal Flow</b>	<b>High Fire</b>	<b>65 GPM</b>	<b>20 °F</b>	<b>85 GPM</b>	<b>20 °F</b>
Minimum Flow	High Fire	60 GPM	21 °F	80 GPM	21 °F
Minimum Flow	Ignition	60 GPM	10 °F	80 GPM	10 °F
Minimum Flow	Low Fire	60 GPM	4 °F	80 GPM	3 °F





## Appliance Connections (MFD 750 - 1000 Sizes)

All connections should be in compliance with national, state, and local code requirements.



### NOTICE!

This is a non-condensing gas-fired appliance and the incoming (return) water temperature **MUST** be maintained above 130°F. Dropping below 130°F will cause acidic condensate to form within the appliance's heat exchanger and damage the copper finned-tubes.

### NOTICE!

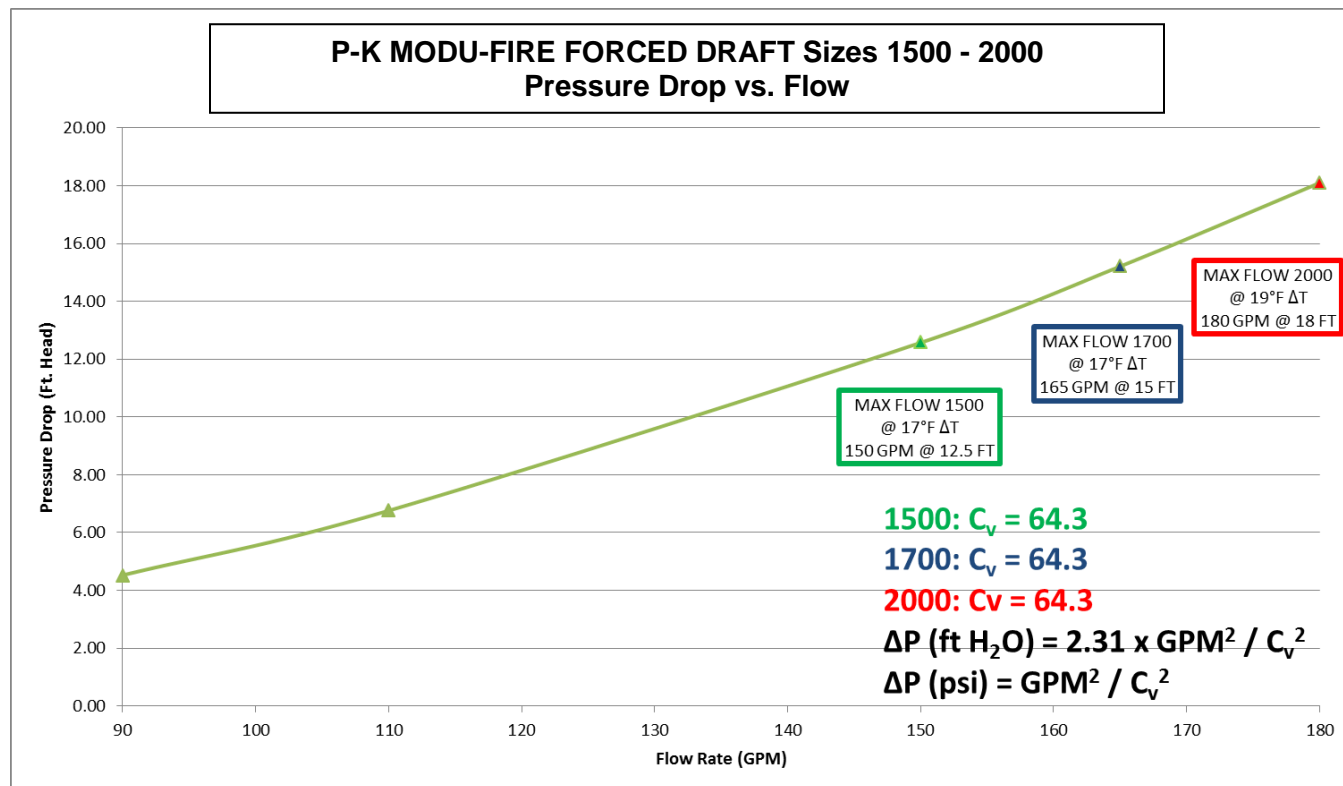
The appliance is furnished with a capped 3/4" drain pipe which is used to drain built-up condensation inside the appliance's combustion chamber. Connect this 3/4" drain pipe to the common drain piping.

### NOTICE!

Most installation codes require a 3/4" manual drain (ball) valve to be installed at the lowest point on the heat exchanger. Make sure the appliance is isolated from the heating system before using the manual drain valve.



## Hydronics/Water Flow (MFD 1500 - 2000 Sizes)



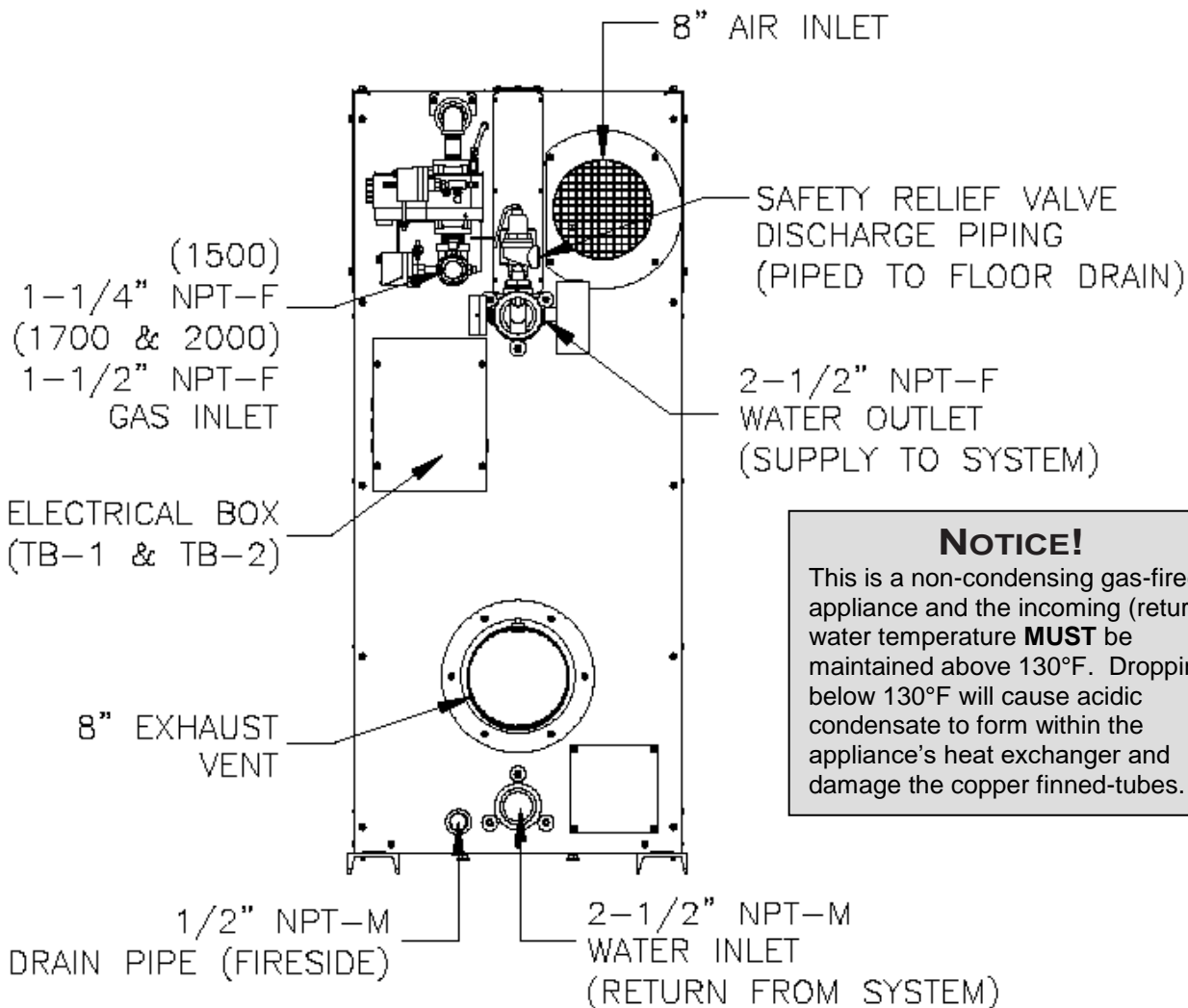
### MODU-FIRE Forced Draft Boilers & Water Heaters: Minimum & Maximum Flow Rates

Flow Condition	Operation	N1500-MFD W1500-MFD (6:1)	Approx. ΔT	N2000-MFD W2000-MFD (6:1)	Approx. ΔT
Maximum Flow	High Fire	150 GPM	17 °F	180 GPM	19 °F
<b>Optimal Flow</b>	<b>High Fire</b>	<b>130 GPM</b>	<b>20 °F</b>	<b>170 GPM</b>	<b>20 °F</b>
Minimum Flow	High Fire	90 GPM	28 °F	120 GPM	28 °F
Minimum Flow	Ignition	90 GPM	14 °F	120 GPM	14 °F
Minimum Flow	Low Fire	90 GPM	5 °F	120 GPM	5 °F



## Appliance Connections (MFD 1500 - 2000 Sizes)

All connections should be in compliance with national, state, and local code requirements.



### NOTICE!

This is a non-condensing gas-fired appliance and the incoming (return) water temperature **MUST** be maintained above 130°F. Dropping below 130°F will cause acidic condensate to form within the appliance's heat exchanger and damage the copper finned-tubes.

### NOTICE!

The appliance is furnished with a capped 3/4" drain pipe which is used to drain built-up condensation inside the appliance's combustion chamber. Connect this 3/4" drain pipe to the common drain piping.

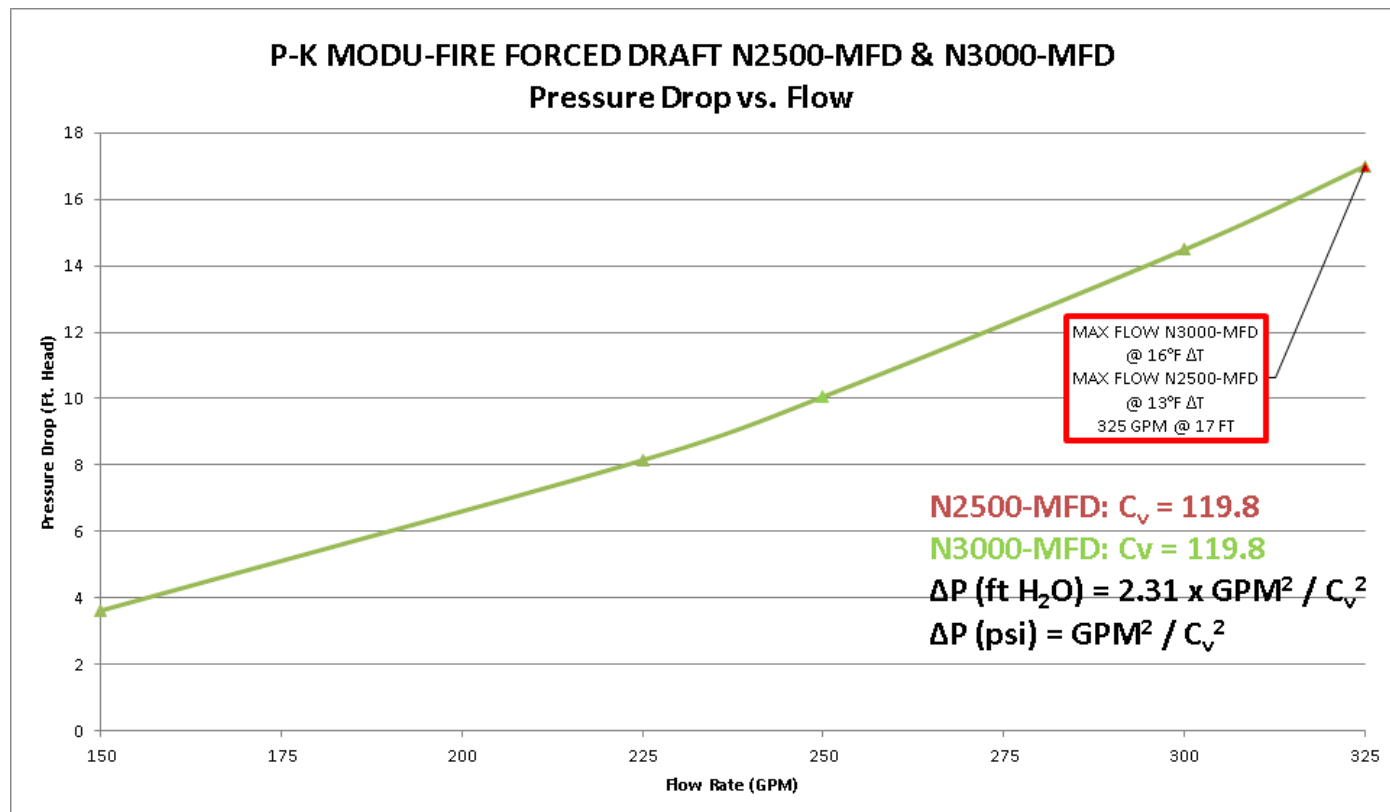
### NOTICE!

Most installation codes require a 3/4" manual drain (ball) valve to be installed at the lowest point on the heat exchanger. Make sure the appliance is isolated from the heating system before using the manual drain valve.



## Hydronics/Water Flow (N2500-MFD & N3000-MFD)

The chart below represents the pressure drop (Ft of Head) versus the water flow rate (GPM) for the MODU-FIRE Forced Draft boiler models N2500-MFD & N3000-MFD. This information is useful to help size an appropriate circulation pump. Keep in mind this pressure drop represents the boiler only, additional consideration is needed for any connecting piping, valves, strainers, couplings, flanges, etc.



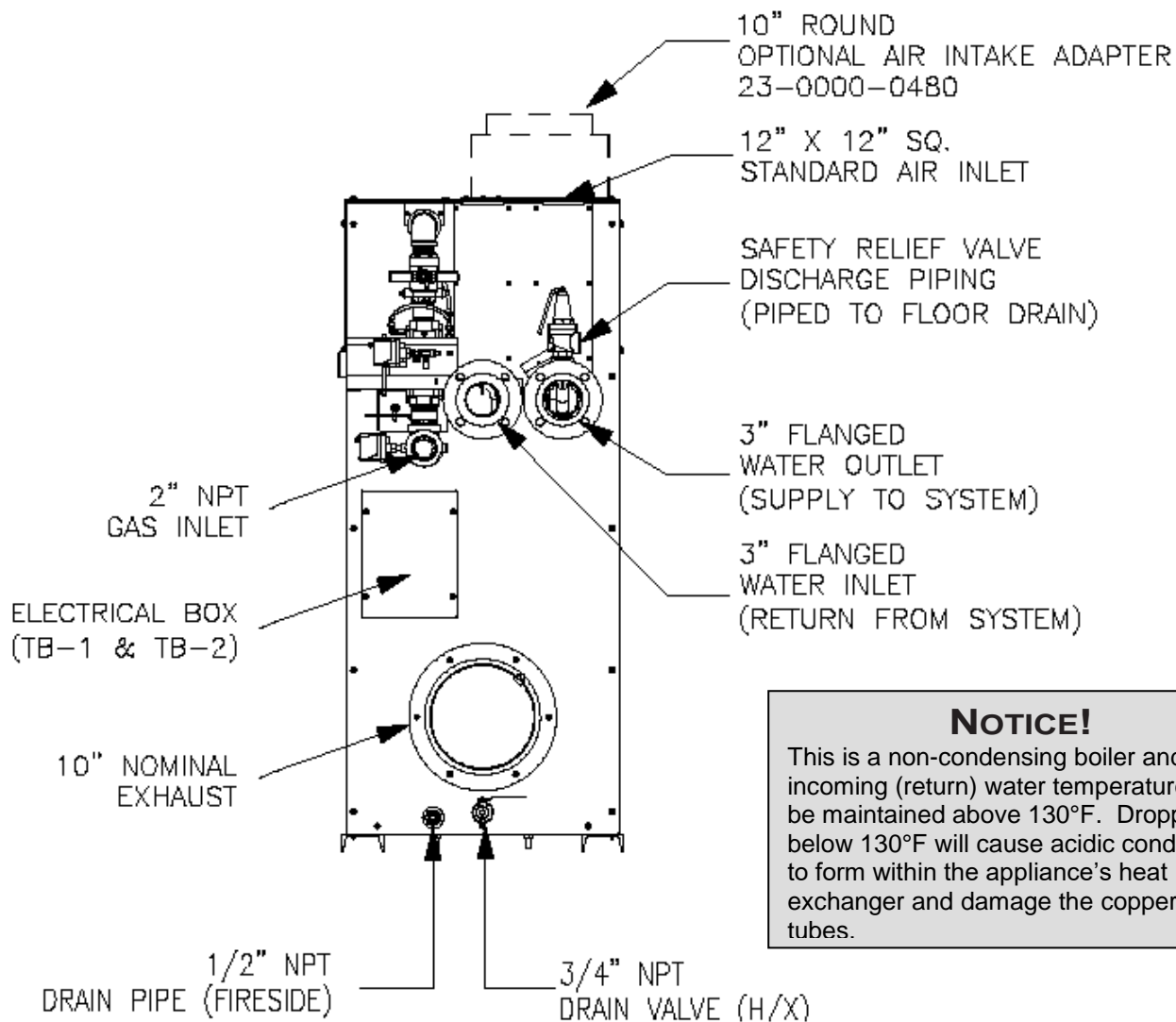
### MODU-FIRE Forced Draft Boilers & Water Heaters: Minimum & Maximum Flow Rates

Flow Condition	Operation	N2500-MFD (5:1)	Approx. ΔT	N3000-MFD (6:1)	Approx. ΔT
Maximum Flow	High Fire	270 GPM	16 °F	325 GPM	16 °F
<b>Optimal Flow</b>	<b>High Fire</b>	<b>220 GPM</b>	<b>20 °F</b>	<b>265 GPM</b>	<b>20 °F</b>
Minimum Flow	High Fire	165 GPM	27 °F	165 GPM	32 °F
Minimum Flow	Ignition	165 GPM	13 °F	165 GPM	16 °F
Minimum Flow	Low Fire	165 GPM	5 °F	165 GPM	6°F



## Appliance Connections (N2500-MFD & N3000-MFD)

All connections should be in compliance with national, state, and local code requirements.



### NOTICE!

This is a non-condensing boiler and the incoming (return) water temperature must be maintained above 130°F. Dropping below 130°F will cause acidic condensate to form within the appliance's heat exchanger and damage the copper finned tubes.

### NOTICE!

The appliance is furnished with a capped 3/4" drain pipe which is used to drain built-up condensation inside the appliance's combustion chamber. Connect this 3/4" drain pipe to the common drain piping.

### NOTICE!

The appliance is furnished with a 3/4" manual drain (ball) valve which allows the user to completely drain the heat exchanger. Make sure the appliance is isolated from the heating system before using the manual drain valve.



## Propylene Glycol Flow

The table below summarizes the flow for the MFD appliances with different Propylene Glycol mixtures:

Model →	MFD N750		MFD N1000		MFD N1500	
Mixture ↓	Flow (GPM)	Pressure	Flow (GPM)	Pressure	Flow (GPM)	Pressure
0%	63.8	3.3 ft	85	5.8 ft	127.6	6 ft
10%	64.6	3.4 ft	86.1	6.0 ft	129.1	6.1 ft
20%	65.3	3.4 ft	87.1	6.1 ft	130.6	6.3 ft
30%	66.5	3.6 ft	88.6	6.3 ft	133	6.5 ft
40%	68.9	3.8 ft	91.9	6.8 ft	137.8	7 ft
50%	72.1	4.2 ft	96.1	7.4 ft	144.1	7.6 ft
60%	75.7	4.6 ft	101	8.2 ft	151.5	8.4 ft

Model →	MFD N2000		MFD N2500		MFD N3000	
Mixture ↓	Flow (GPM)	Pressure	Flow (GPM)	Pressure	Flow (GPM)	Pressure
0%	170.1	10.6 ft	220.1	7.8 ft	264.1	11.2 ft
10%	172.2	10.9 ft	222.8	8 ft	267.4	11.5 ft
20%	174.2	11.1 ft	225.4	8.2 ft	270.5	11.8 ft
30%	177.3	11.5 ft	229.4	8.5 ft	275.3	12.2 ft
40%	183.8	12.4 ft	237.8	9.1 ft	285.4	13.1 ft
50%	192.2	13.6 ft	248.7	10 ft	298.5	14.3 ft
60%	202	15 ft	261.4	11 ft	313.7	15.8 ft