

Please contact Heatflam Engineering if assistance or clarification is required.

Purpose

The purpose of this manual is to make sure that you carry out the installation of a safe, effective and trouble-free system.

Burners are only one part of a complete combustion system. It is the responsibility of the user to ensure the larger scope of work is properly designed and executed.

Typical reviews include, but are not be limited to, burner sizing, compliance with codes, adjusting for site conditions, chamber design, variable operating conditions, flamemanagementsystem, fuel management system, operating interlocks, safety interlocks, site specifications, as well as installation, setup and testing.

AH Documents

- Operating Instruction
- Technical Information (this document)

Related Documents

- Applicable literature corresponding to various components such as flame rods, UV Scanners, spark igniters, etc.

Safety

Important notices which help provide safe burner operation will be found in this section. To avoid personal injury and damage to the property or facility, the following warnings must be observed. All involved personnel should read this entire manual carefully before attempting to start or operate this system. If any part of the information in this manual is not understood, contact Heatflam before continuing

Safety Warnings



- The burners covered in this manual are designed to mix fuel with air and burn the resulting mixture. All fuel burning devices are capable of producing fires and explosions when improperly applied, installed, adjusted, controlled or maintained.
- Do not bypass any safety feature; fire or explosion could result.
- Never try to light the burner if it shows signs of damage or malfunction.



- The burner is likely to have HOT surfaces. Always wear protective clothing when approaching the burner.

- Heatflam products are designed to minimize the use of materials that contain crystalline silica. Examples of these chemicals are: respirable crystalline silica from bricks, cement or other masonry products and respirable refractory ceramic fibers from insulating blankets, boards, or gaskets. Despite these efforts, dust created by sanding, sawing, grinding, cutting and other construction activities could release crystalline silica. Crystalline silica is known to cause cancer, and health risks from the exposure to these chemicals vary depending on the frequency and length of exposure to these chemicals. To reduce the risk, limit exposure to these chemicals, work in a well-ventilated area and wear approved personal protective safety equipment for these chemicals.

NOTICE

- This manual gives information for the use of these burners for their specific design purpose. Do not deviate from any instructions or application limits in this manual without written advice from Heatflam.

Capabilities

Only qualified personnel, with good mechanical aptitude and experience with combustion equipment, should adjust, maintain, or troubleshoot any mechanical or electrical part of this system.

Operator Training

The best safety precaution is an alert and trained operator. Train new operators thoroughly and have them demonstrate an adequate understanding of the equipment and its operation. A regular retraining schedule should be administered to ensure operators maintain a high degree of proficiency.

Replacement Parts

Order replacement parts from Heatflam only Any customer-supplied valves or switches should carry UL, FM, CSA, CGA and/or CE approval where applicable.

System Design

Design Structure

Designing a burner system is a straightforward exercise of combining modules that add up to a reliable and safe system.

The design process is divided into the following steps:

1. Burner Design
 - a. Calculating maximum input requirements
 - b. Choosing design heat input at high fire
 - c. Determining needed length of the burner
 - d. Calculating minimum input requirements
 - e. Layout of the burner sections
 - f. Sizing and layout of the gas manifold
 - g. Sizing the profile plates
 - h. Burner staging
2. Control Methodology
3. Ignition System
4. Flame Monitoring System
5. Gas Valve Train Selection

NOTE: Information in AH Datasheet is necessary to complete some of the procedures.

Step 1: Burner Design

Calculating maximum input requirements

To calculate the total burner maximum input required:

$$\text{Maximum Input (Btu/h)} = 1.3 \times \text{SCFM} \times \Delta T (\text{max})$$



CAUTION

- This is an approximation based on the gross heating value of the Heatflam Combustion Engineering Guide (EFE-825).

Choosing design heat input at high fire

See AH Datasheet for the following:

1. Use the “Operating Range” chart to determine the maximum and minimum heat inputs per foot of burner based on the known air pressure drop.
2. Use the “Flame Length” chart to check flame length versus available distance downstream of the burner for uniform temperature distribution.

Determining the length of the burner needed

$$\text{Burner length (ft)} = \frac{\text{total burner max. heat input (Btu/h)}}{\text{heat input per foot (Btu/h/ft)}}$$

NOTE: Round fractional lengths (in feet) up to the next half-foot

Calculating minimum input required

1. Minimum Input (Btu/h) = $1.3 \times \text{SCFM} \times \Delta T (\text{min})$
2. Minimum Heat Input per foot (Btu/h/ft) =
$$\frac{\text{total burner min. heat input (Btu/h)}}{\text{burner length (ft)}}$$
3. With the minimum heat input per foot, go to the “Operating Range” chart in AH Datasheet and confirm that the burner can operate at the input for the air pressure drop the burner will see. If the minimum input required is too low, there are two options to obtain this operating condition:
 - a. Use a staged burner control. See Burner Fuel Staging pg 15 and Control Methodology pg 14.
 - b. Modulate the air flow to a lower pressure drop, thus lowering the minimum input capability of the burner.

Example: A make-up air heat burner will be used to heat 60,000 SCFM air from 0°F to 80°F maximum, and from 75°F to 80°F minimum. Air ΔP across the burner is designed to be 0.7”w.c. at high fire. The fuel is natural gas.

1. Max. Input = $1.3 \times 60,000 \times 80 = 6,240,000 \text{ Btu/h}$
2. From the “Operating Range” chart in AH Datasheet, the maximum heat input at 0.7”w.c. air pressure drop is 800,000 Btu/h/ft. The flame length from the “Flame Length” chart in AH Datasheet is 30 inches .

$$\text{Burner length} = \frac{6,240,000 \text{ Btu/h}}{800,000 \text{ Btu/h/ft}} = 7.8 \text{ ft; round to 8 ft}$$
3. Min. Input = $1.3 \times 60,000 \times 5 = 390,000 \text{ Btu/h}$
4. Minimum per foot =
$$\frac{390,000 \text{ Btu/h}}{8 \text{ ft}} = 48,750 \text{ Btu/h/ft}$$
5. From the “Operating Range” chart in AH Datasheet, the minimum input at 0.7”w.c. is 20,000 Btu/h/ft. Therefore, the burner can operate over the desired input range.

Fuel Type

Fuel	Symbol	Gross Heating Value	Specific Gravity	WOBBE Index
Natural Gas	CH ₄ 90%+	1000 BTU/ft ³ (40.1 MJ/m ³)	0.60	1290 BTU/ft ³
Propane	C ₃ H ₈	2525 BTU/ft ³ (101.2 MJ/m ³)	1.55	2028 BTU/ft ³
Butane	C ₄ H ₁₀	3330 BTU/ft ³ (133.7 MJ/m ³)	2.09	2303 BTU/ft ³
BTU/ft ³ @ standard conditions (MJ/m ³ @ normal conditions)				

Table 1. Fuel Type

If using an alternative fuel supply, contact Heatflam with an accurate breakdown of the fuel components

Layout of the burner sections

Once the lineal feet of the burner has been determined, use Figure 6 (Gas Manifold Sizing and Layout) and the criteria below to define the burner geometry.

For optimum burner performance and a uniform temperature profile, even gas and air flow throughout the burner is essential. The following guidelines should be used to lay out the burner:

- Optimal burner performance is predicated upon uniform air distribution across the burner. Accordingly, burner layout should be based on providing uniform profile gaps about the full burner. The gaps between internal sections of the burner should be similar in size to gaps on the top and bottom of the burner.
 - On burners with tee or cross construction, each should be separated by at least a 150mm (6 in.) straight section of burner, and profiled accordingly. Improper burner profiles can create uneven temperature distributions, abnormal operating, elevated emissions, longer flames, and/or premature burner degradation.
 - A minimum gap of 51mm (2 in.) should be provided at all endplates. Please note minimum dimensions in Figures 8 (Single burner profile plate) and 9 (Two-Stage Burner Profile Plates).
 - If these minimum gaps and distances cannot be held, consult with Heatflam engineering for assistance.
- Include the proper number of gas feed inlet sections. Use Table 2 (Gas Feed Inlet Capacities) as a guide to the number and size of gas feed inlets required based on the length of the burner.
- Space gas inlets equally to assure uniform gas distribution.

Gas Inlet Pipe Size	Direction	Section Type	Gas Pressure	Max. Burner Length Per Inlet*
1"	Side	300mm straight section	standard	1
1-1/2"	Rear	300mm straight section, cast iron	standard	4
1-1/2"	Side	300mm straight section	standard	3
2"	Rear	300mm straight section, aluminum	standard	4
2"	Rear	300mm x 300mm cross section	standard	6
2"	Side	300mm straight section	standard	4
1"	Side	300mm straight section	low	.5
1-1/2"	Rear	300mm straight section, cast iron	low	2
1-1/2"	Side	300mm straight section	low	1.5
2"	Rear	300mm straight section, aluminum	low	2
2"	Rear	300mm x 300mm cross section	low	4
2"	Side	300mm straight section	low	2

* Number of feet or 300mm sections

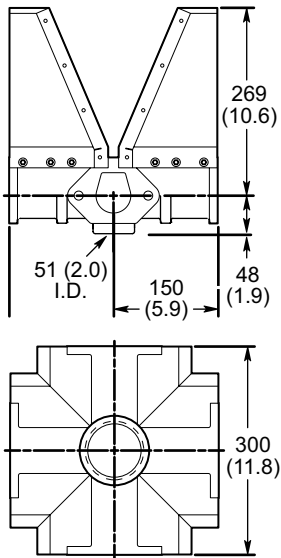
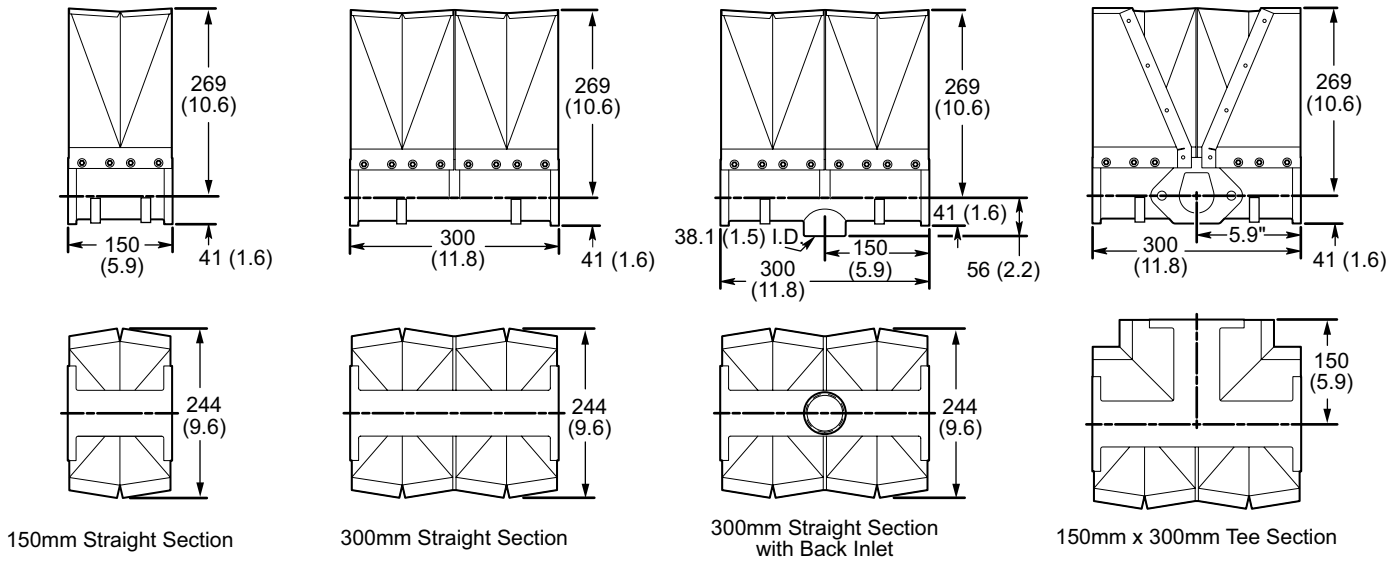
Table 2. Gas Feed Inlet Capacities

Example: A six-foot burner for standard gas pressure will use 2" NPT rear inlets to supply gas. How many gas inlets are required?

Solution: Each 2" back inlet can supply 4 feet of burner. Therefore, $6/4 = 1.5$, or 2 inlets are required

Cast Iron Burner Section

Dimensions in mm (inches)



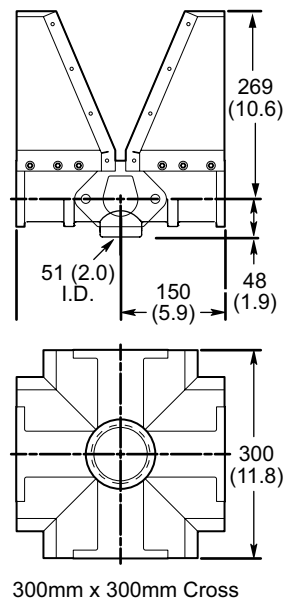
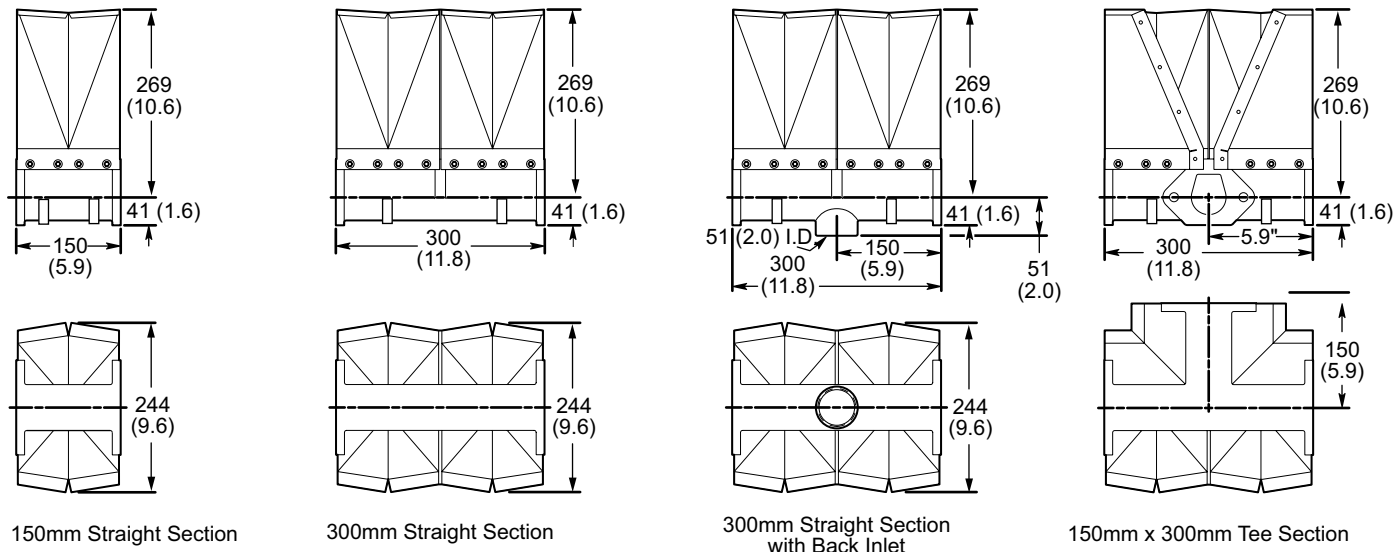
Burner Sections Assembly Numbers, Dimensions & Weights

Description	Assembly Numbers			Weight, lbs (kg)
	Cast Iron Burner Bodies	Corrosion Resistant Burner Bodies	Low Pressure Cast Iron Burner Bodies	
150mm Straight Section	102250	102250-1	102250-2	7.0 (3.2)
300mm Straight Section	102238	102238-1	102238-2	14.0 (6.4)
300mm Straight Section w/Back Inlet, BSP	102240	102240-1	102240-2	16.0 (7.3)
300mm Straight Section w/Back Inlet, NPT	102239	102239-1	102239-2	16.0 (7.3)
300mm x 150mm Tee Section	102251	102251-1	102251-2	19.0 (8.6)
300mm x 300mm Cross Section, BSP	102255	102255-1	102255-2	30.0 (13.6)
300mm x 300mm Cross Section, NPT	102254	102254-1	102254-2	30.0 (13.6)

Fig. 2. Cast iron burner section

Aluminum Burner Section

Dimensions in mm (inches)



Burner Sections Assembly Numbers, Dimensions & Weights

Description	Assembly Numbers		Weight, lbs (kg)
	Aluminum Burner Bodies	Low Pressure Aluminum Burner Bodies	
150mm Straight Section	102250-3	102250-4	3.5 (1.6)
300mm Straight Section	102238-3	102238-4	7.0 (3.2)
300mm Straight Section w/Back Inlet, BSP	102240-3	102240-4	8.0 (3.6)
300mm Straight Section w/Back Inlet, NPT	102239-3	102239-4	8.0 (3.6)
300mm x 150mm Tee Section	102251-3	102251-4	9.0 (4.1)
300mm x 300mm Cross Section, BSP	102255-3	102255-4	14.0 (6.4)
300mm x 300mm Cross Section, NPT	102254-3	102254-4	14.0 (6.4)

300mm x 300mm Cross

Fig. 3. Aluminum burner Section

End Plate Assemblies

Dimensions in mm (inches)

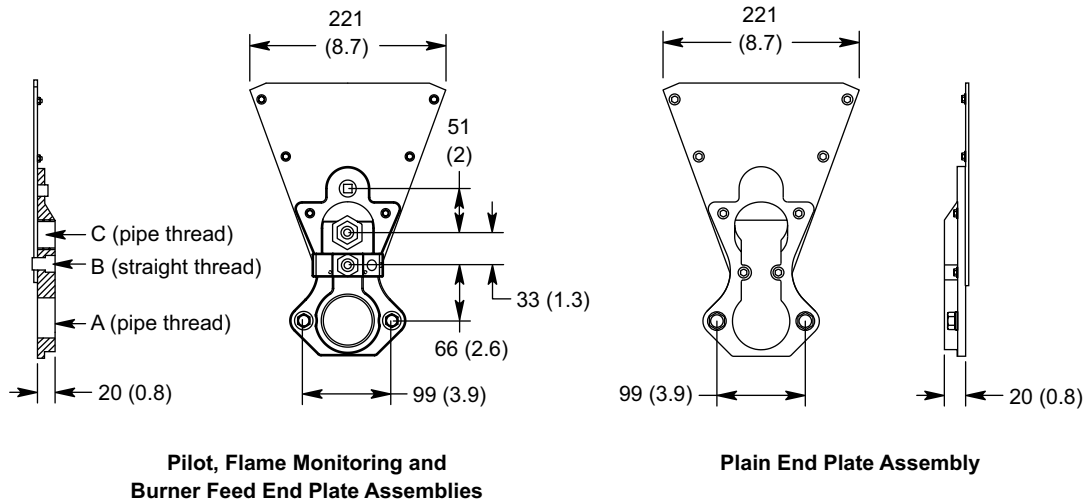


Fig. 4. End plate assemblies

End Plate Examples

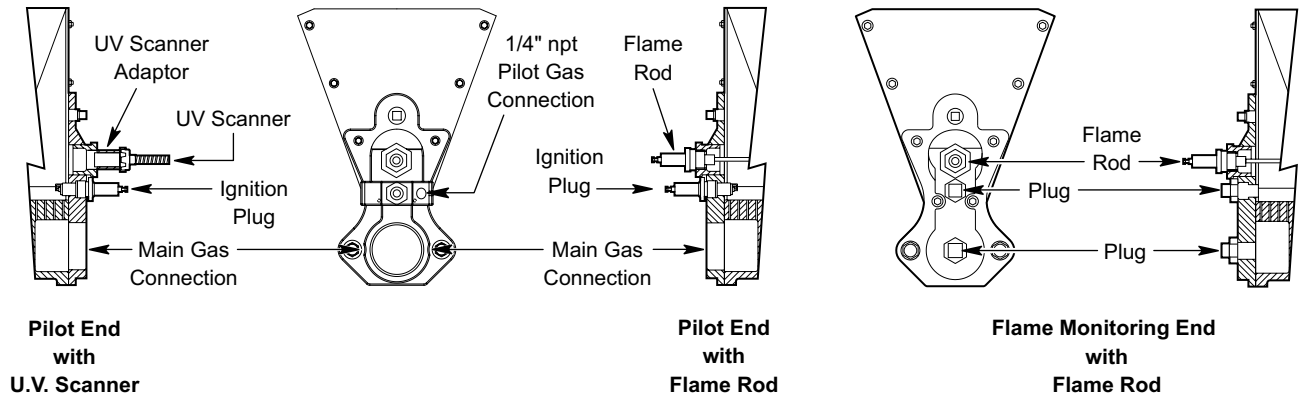


Fig. 5. End plate examples

End Plate Assembly Numbers, Dimensions and Weights

Description	Assembly Numbers		Dimensions			Weight, lbs (kg)
	Cast Iron End Plates*	Corrosion Resistant End Plates	A	B, mm (inches)	C	
Plain End Plate	102257	102257-1	-	-	-	4 (1.8)
Pilot End Plate, No Gas Feed	10010970	10010970-1	-	14 (0.6)	1" NPT	4 (1.8)
Pilot End Plate, 1" Gas Feed NPT	10010972	10010972-1	1" NPT	14 (0.6)	1" NPT	4 (1.8)
Pilot End Plate, 1" Gas Feed BSP	10010974	10010974-1	1" BSP	14 (0.6)	1" BSP	4 (1.8)
Pilot End Plate, 1.5" Gas Feed NPT	10010975	10010975-1	1.5" NPT	14 (0.6)	1" NPT	4 (1.8)
Pilot End Plate, 1.5" Gas Feed BSP	10010976	10010976-1	1.5" BSP	14 (0.6)	1" BSP	4 (1.8)
Pilot End Plate, 2" Gas Feed NPT	10010977	10010977-1	2" NPT	14 (0.6)	1" NPT	4 (1.8)
Pilot End Plate, 2" Gas Feed BSP	10010978	10010978-1	2" BSP	14 (0.6)	1" BSP	4 (1.8)
Pilot End Plate, Angled Flame Monitor NPT	10010979	10010979-1	-	14 (0.6)	1" NPT	4 (1.8)
Pilot End Plate, Angled Flame Monitor BSP	10010980	10010980-1	-	14 (0.6)	1" BSP	4 (1.8)
Flame Monitoring End Plate, BSP	101237	101237-1	-	-	1" BSP	4 (1.8)
Flame Monitoring End Plate, NPT	101238	101238-1	-	-	1" NPT	4 (1.8)
Burner Feed/Flame Monitoring End Plate, BSP	101233	101233-1	1-1/2" BSP	**	1" BSP	4 (1.8)
Burner Feed/Flame Monitoring End Plate, NPT	101234	101234-1	1-1/2" NPT	**	1" NPT	4 (1.8)
Burner Feed End Plate, BSP	101235	101235-1	1-1/2" BSP	-	-	4 (1.8)
Burner Feed End Plate, NPT	101236	101236-1	1-1/2" NPT	-	-	4 (1.8)

* Standard cast iron end plates with powder coated surface finish are supplied on burners with aluminum gas manifolds.

** 14mm (0.6") plug may be replaced by an ignition plug for direct spark ignition of burners 450mm (18") or less.

Table 3. End Plate Assembly Numbers

Accessories

Description	Part Number
Mtg. Brkt. for Hanger Rods	21509
Ignition Plug	13047-1
Flame Rod1	13093
Divider Plate for Staging	76506
UV Scanner Adapter - 1/2" NPT2	202010
UV Scanner Adapter - 3/4" NPT	202011
UV Scanner Adapter - 1" NPT3	18767
Pilot Gas Cock	12659

1 Flame rod ordered with burner includes adapter to pilot or flame monitoring endplate

2 Adapter fits Heatflam straight, Heatflam 90 and Heatflam C7027A UV scanners

3 Adapter fits Heatflam self-check and Heatflam C7035A UV scanners

Table 4. Accessories

Sizing and layout of the gas manifold

Choose the gas manifold size to evenly supply gas to each of the sections, using Table 5 and Figure 3 - 5.

Maximum Gas Input, MMBtu/h (MW)	Manifold Pipe Size	Maximum Gas Input, MMBtu/h (MW)	Main Gas Pipe Size
1.4 (0.4)	1-1/2"	0.3 (0.1)	1/2"
2.5 (0.7)	2"	0.6 (0.2)	3/4"
5.2 (1.5)	2-1/2"	1.1 (0.3)	1"
8.0 (2.3)	3"	3.2 (0.9)	1-1/2"
14.0 (4.1)	4"	6.6 (1.9)	2"
45.0 (13.2)	6"	13.0 (3.8)	2-1/2"
80.0 (23.4)	8"	20.0 (5.9)	3"

Table 5. Gas Pipe Sizing and Layout

NOTE: Maximum inputs shown for natural gas only. For propane, multiply inputs by 1.5; for butane, multiply inputs by 1.7.

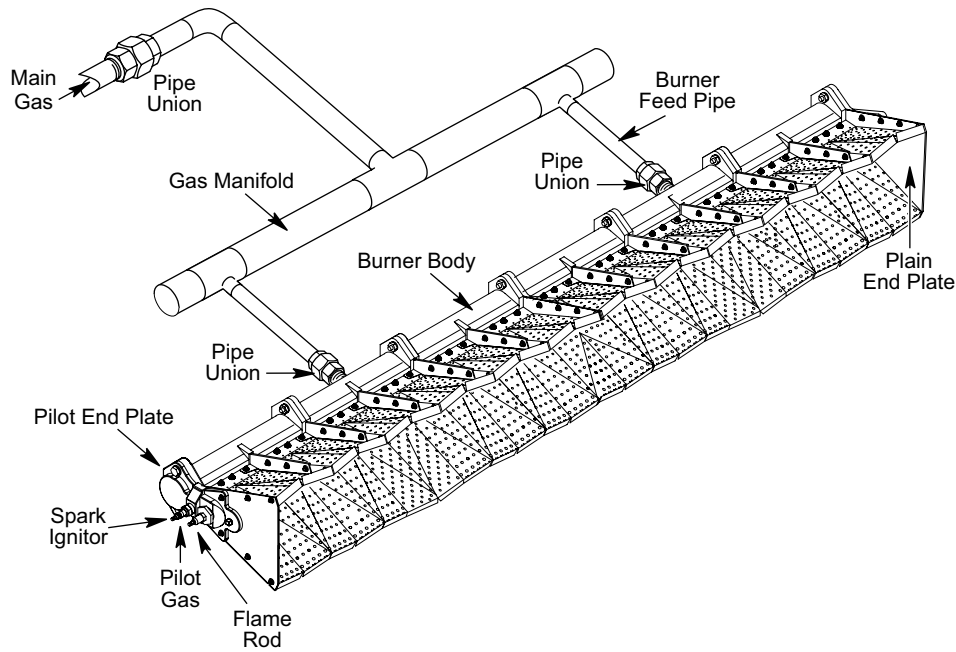


Fig. 6. Gas Manifold Sizing and Layout

Example: A gas manifold is supplying gas to two 1-1/2” NPT rear inlets on a burner. Each of the rear inlets supplies a maximum of 2,000,000 Btu/h.

Solution: The total fuel supplied is 2 x 2,000,000 = 4,000,000 Btu/h.

Referring to Table 5 (Gas Pipe Sizing and Layout), the choice for manifold size is 2-1/2”; the choice for main gas pipe size is 2”.

Profile plate sizing

Profile plates are required to ensure sufficient air pressure drop across the burner. An example of profile plate layout is shown in Figure 8 (Single burner profile plate) on the next page.

CAUTION

- It is essential that even air flow is delivered to the burner to obtain optimum performance.

To calculate the profile gap sizes, you will need to know the following:

1. SCFM = Total air flow around and through the burner in cubic feet per minute.
2. Design pressure drop across the burner.
3. Gp = Profile gap area required per flow from Figure 7 (Profile Gap Area vs. Air Pressure Gap); see Table 6 and 7 (Profile Gap Correction Factors) for corrections at other Temperature (Tp) and Elevation (Ep) conditions.

$$\text{Profile area (Ag)} = \frac{\text{SCFM} \times G_p \times T_p \times E_p}{1000}$$

Where: Ag = Area in square inches of the gap between the

profile plates and the burner.

The areas on the sides of the burners should first be calculated based on a fixed gap of 2 inches. Next, calculate the gap size required on the top and bottom to obtain the required profile gap area.

Example: Size a profile plate for a seven-foot long AH-MA v2.0 burner. Air flow around and through the burner will be 60,000 SCFM. The design pressure drop is 0.7”w.c. NOTE: Use a burner wing width of 9.6 inches (226 mm) for profile end gap sizing on top and bottom.

From Figure 7 (Profile Gap Area vs. Air Pressure Gap: Gp = 47.7, Tp = 1.0, Ep = 1.0

$$A_g = \frac{60,000 \times 47.7 \times 1.0 \times 1.0}{1000} = 2862 \text{ in}^2$$

Calculate gap sizes:

$$\text{End Area} = 2 \times 2" \times 9.6" = 38 \text{ in}^2$$

$$\text{Area Top and Bottom} = 2862 - 38 = 2824 \text{ in}^2$$

Therefore, Top and Bottom Gap

$$\frac{2824 \text{ in}^2}{(7 \text{ ft} \times 12 \text{ in/ft})^* \times 2 \text{ gaps}} = 16.8 \text{ in}$$

*where 7x12 = burner length

Burner Performance for Inlet Air Density 0.075 lbm/CuFt

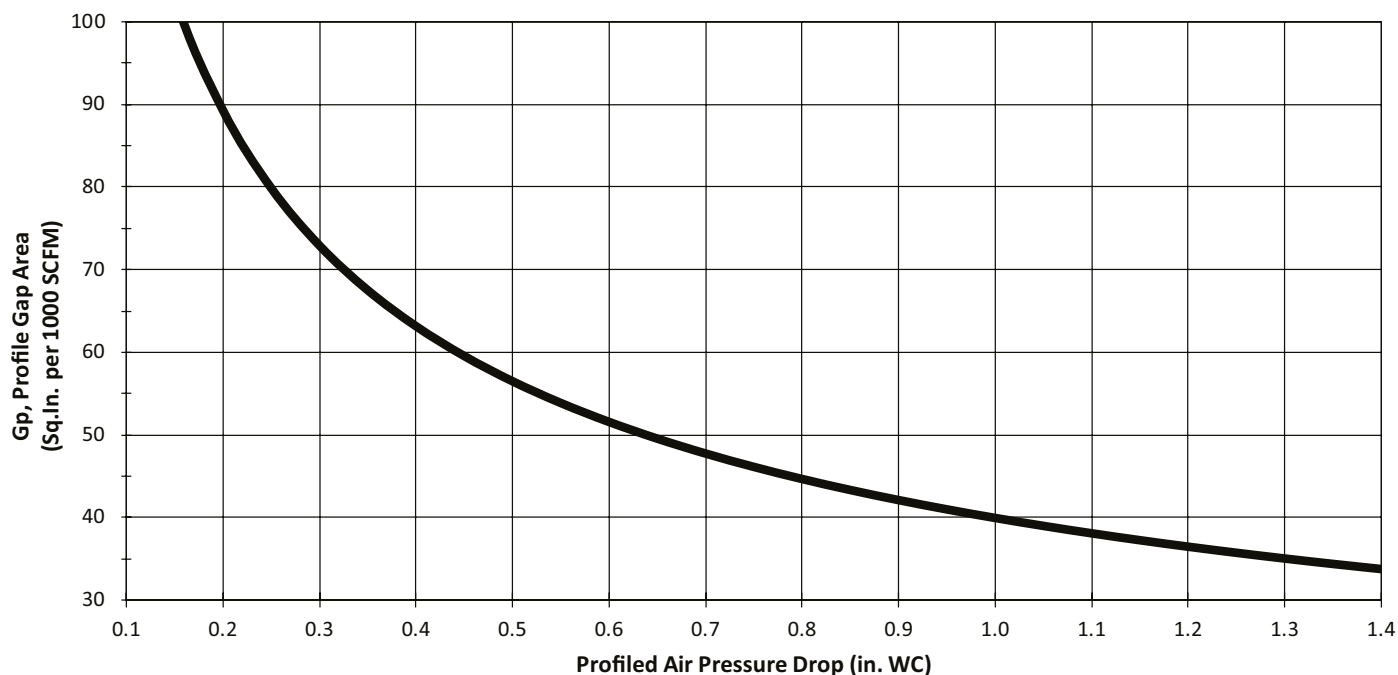


Fig. 7. Profile Gap Area vs. Air Pressure Gap

T_p, Area Correction Factor for Temperature										
Air Temperature, °F (°C)	0 (-18)	30 (-1)	70 (21)	150 (66)	200 (94)	250 (121)	300 (149)	350 (177)	400 (204)	450 (232)
Correction Factor, T _p	0.87	0.92	1.00	1.15	1.25	1.34	1.43	1.53	1.62	1.72

Table 6. Profile Gap Correction Factors

E_p, Area Correction Factor for Elevation											
Elevation, Feet (Meters)	0 (0)	500 (1640)	1000 (3281)	1500 (4921)	2000 (6562)	2500 (8202)	3000 (9842)	3500 (11483)	4000 (13123)	5000 (16404)	6000 (19685)
Correction Factor, E _p	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.20	1.25

Table 7. Profile Gap Correction Factors

Single Burner Profile Plates
Dimensions in mm (inches)

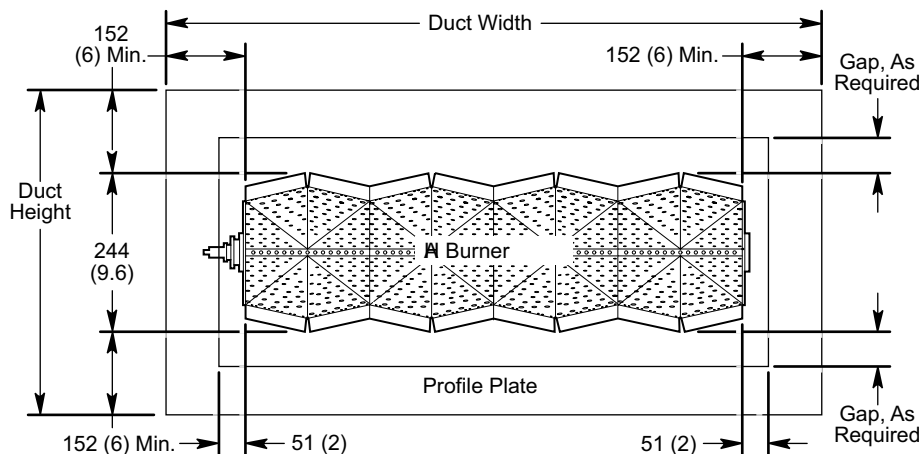
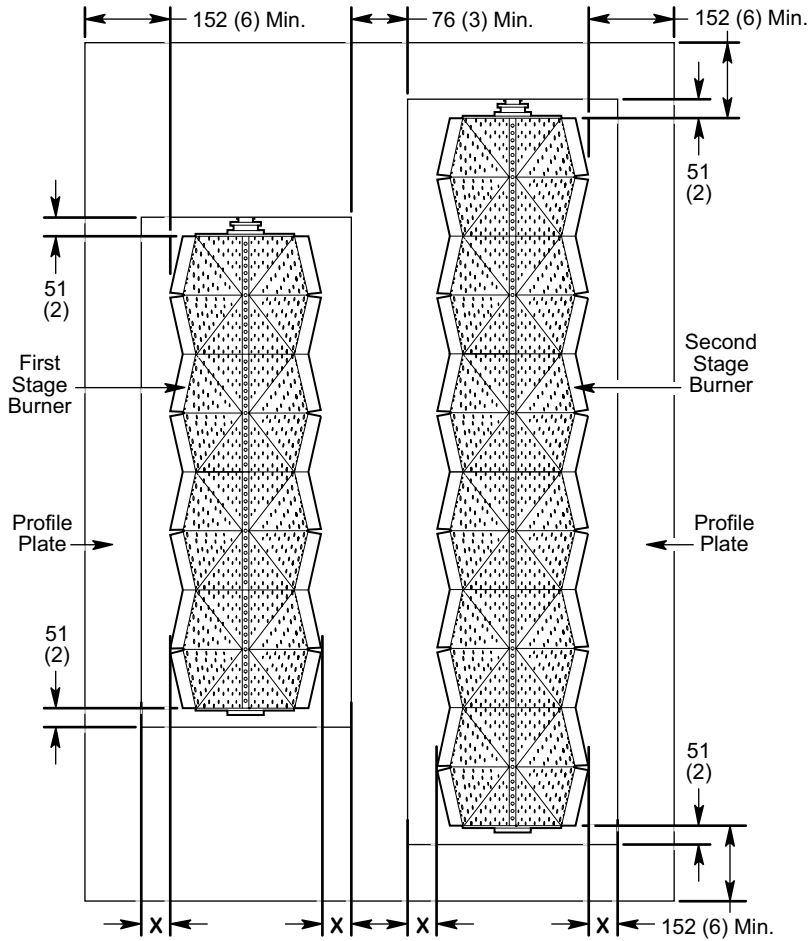


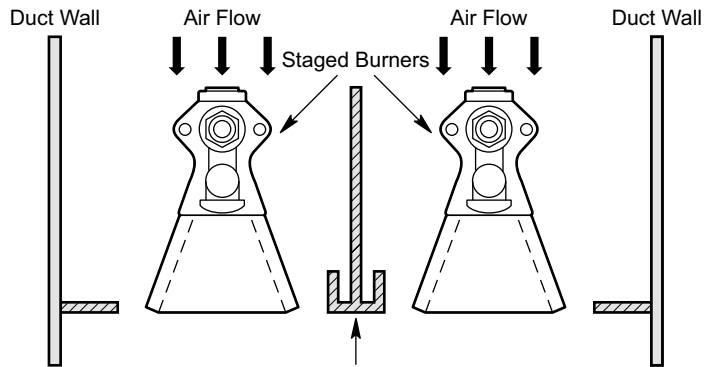
Fig. 8. Single burner profile plate

Two-Stage Burner Profile Plates

Dimensions in mm (inches)



NOTE: Make all profile gaps equal (shown as "X" above); profile plate width between the burners should be at least 3" (76mm).



Steel channel of the correct width can be used as the center profile plate. Install with the legs pointing toward the incoming air flow.

Fig. 9. Two-Stage Burner Profile Plates

Adjustable Profile Plates

NOTE: To compensate for changes in actual air flow versus calculated, provide adjustable profile plates so that final settings can be made in the field. Figure 10 (Adjustable Profile Plates) shows an example of an adjustable profile plate design.

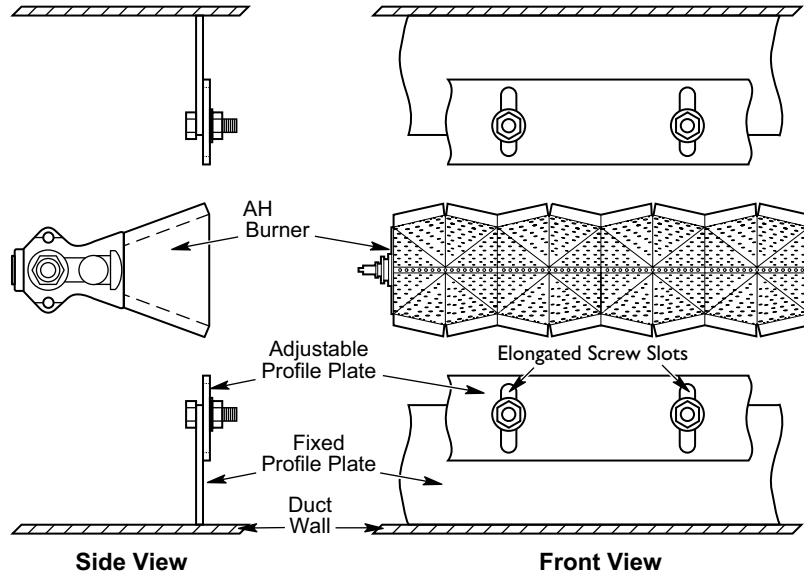
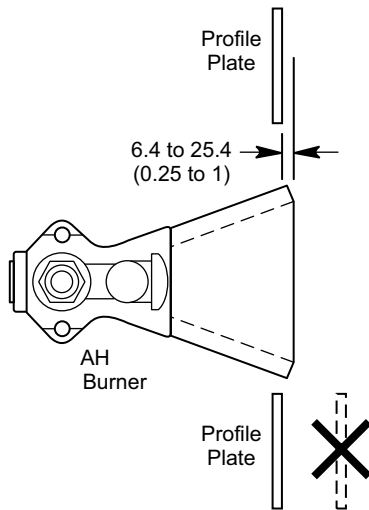


Fig. 10. Adjustable Profile Plates

Profile Plate Positioning

Dimensions in mm (inches)



Caution:
 Profiles plate should be positioned upstream of the firing end of the burner. If necessary, the plates can be located up to 1 inch back from the firing end, but under no circumstances should they be in front of the burner.

Fig. 11. Profile Plate Positioning

Step 2: Control Methodology

The simplest control method is fuel modulation at fixed air flow. If required turndown is greater than the burner's capabilities, there are two options, air modulation and burner fuel staging.

Air Modulation

To lower the minimum input of the burner, the air flow can be decreased as long as the pressure drop across the burner does not go outside of the operating limits given in the "Operating Ranges" chart in AH Datasheet. The air flow can be changed with a two-speed air handling system or a modulated system. As an example, the air flow could be turned down from a pressure drop of 1" w.c. to 0.25" w.c., giving a total air turndown of 2:1. This could extend the minimum input level from 20,000 to 13,000 Btu/h/ft.

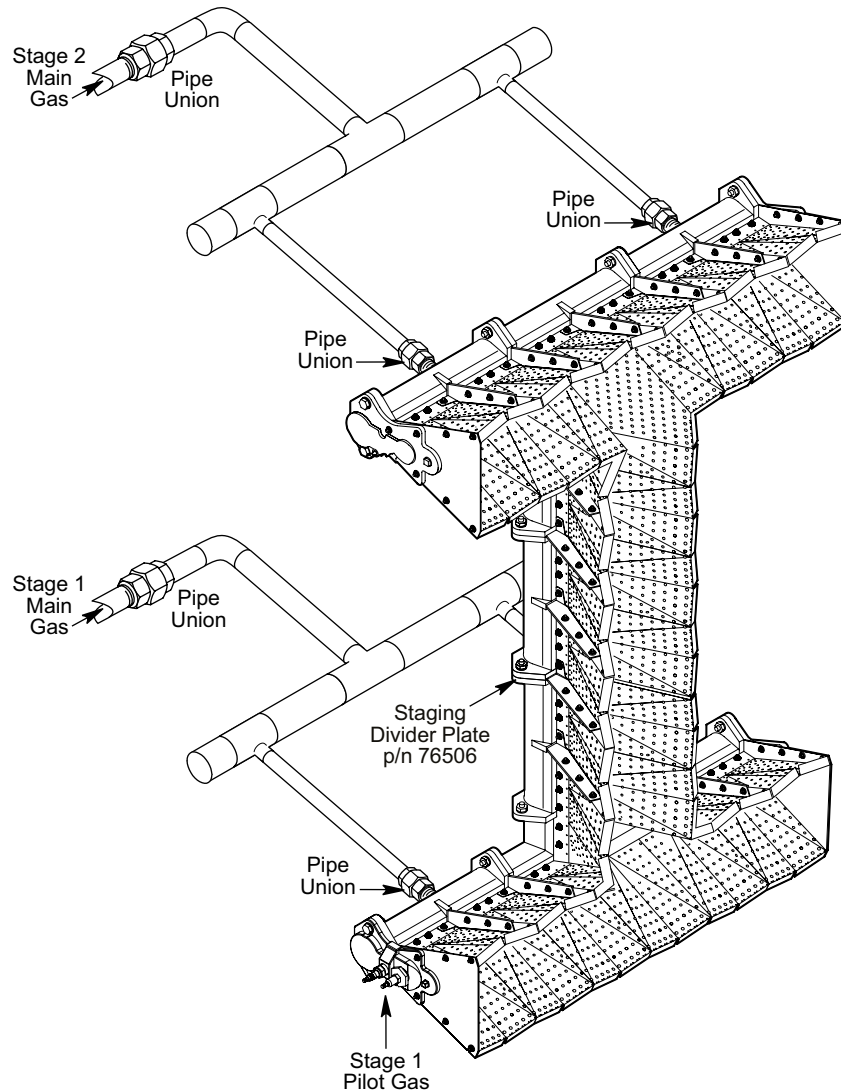


Fig. 12. Staged Burners

Burner Fuel Staging

To further increase the burner turndown, AH v2 10 Air Heat burners can be fuel staged. This can be done by installing two or more separate burners in a duct, each with its own gas control valve, or by dividing a single burner assembly into separate zoned sections. For example, to double the effective turndown, two burner sections may be “staged” as shown in Figure 12 (Staged Burners) on the previous page. If more heat is required, stage 2 is lit by simply supplying gas to it. It will pilot from the adjacent stage.



WARNING

- Lockouts must be provided to shut off gas flow to stage 2 unless flame is proven on stage 1.

A staging divider plate (p/n 76506) must be installed between the burner bodies to separate the different gas feed sections.

NOTE: Ignition performance is enhanced if the gas inlet to stage 2 is as close to the piloting section as possible.

Step 3: Ignition System

AH v2 10 Air Heat burners have an integral spark-ignited gas pilot for lighting the burner. The pilot fuel is fed into the pilot end casting, which is separate from the main fuel. A pilot adjusting valve is required to adjust the pilot gas flow (Heatflam p/n 12659 is recommended). The needed pilot capacity is 20,000 Btu/h, but the pilot will operate equally well at higher or lower inputs. The pilot is shut off after successfully igniting the main burner to protect the igniter.

Local safety and insurance requirements demand that you limit the maximum time that a burner takes to ignite. These time limits vary from country to country. For the USA, the time limit is 15 seconds; for Europe, it is typically 3 seconds. Local requirements may require shorter time limits. Verify local regulation and insurance requirements with the authorized jurisdiction.

The time that a burner takes to ignite depends on:

- The distance between the gas shut-off valve and the burner
- The air pressure drop across the burner
- The gas flow at start conditions.

Step 4: Flame Monitoring System

A flame monitoring system consists of two main parts, a flame sensor and a flame safeguard.

Flame Sensor

There are two types of flame sensors you can use for an AH v2 1 Air Heat burner, a UV scanner and a flame rod.

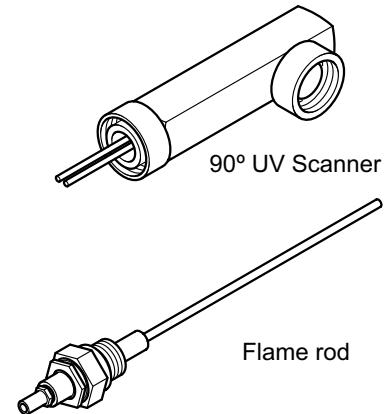


Fig. 13. UV scanner and flame rod

You can find information on UV scanners in:

- Instruction Manual No. 852; 90° UV scanner
- Instruction Manual No. 854; straight UV scanner
- Instruction Manual No. 855; solid state UV/IR scanner
- Instruction Manual No. 856; self-check UV scanner.

You can find information on flame rods in:

- Bulletin/Info Guide No. 832.

Flame Monitoring Control

The Flame Monitoring Control processes the signal from the flame rod or UV scanner and controls both the startup sequence and the main gas shut-off valve sequence.

For flame safeguard selection there are two options for staged burners depending on the application requirements:

- Flame safeguard for each burner: if one burner goes down, only that burner will be shut off
- Multiple burner flame safeguard: if one burner goes down, all burners will be shut off.

Heatflam recommends flame supervision to meet all applicable local codes and standards

Step 5: Gas Valve Train Selection

Figures 13 (UV scanner and flame rod) and 14 (Single-Stage Burner Valve Layout) illustrate gas valve trains for single and staged burner systems respectively.

The typical main gas valve train for a staged burner has the same valve layout as a single burner except each burner has an individual solenoid valve to independently shut down each section. A common gas shut-off valve train can be used.

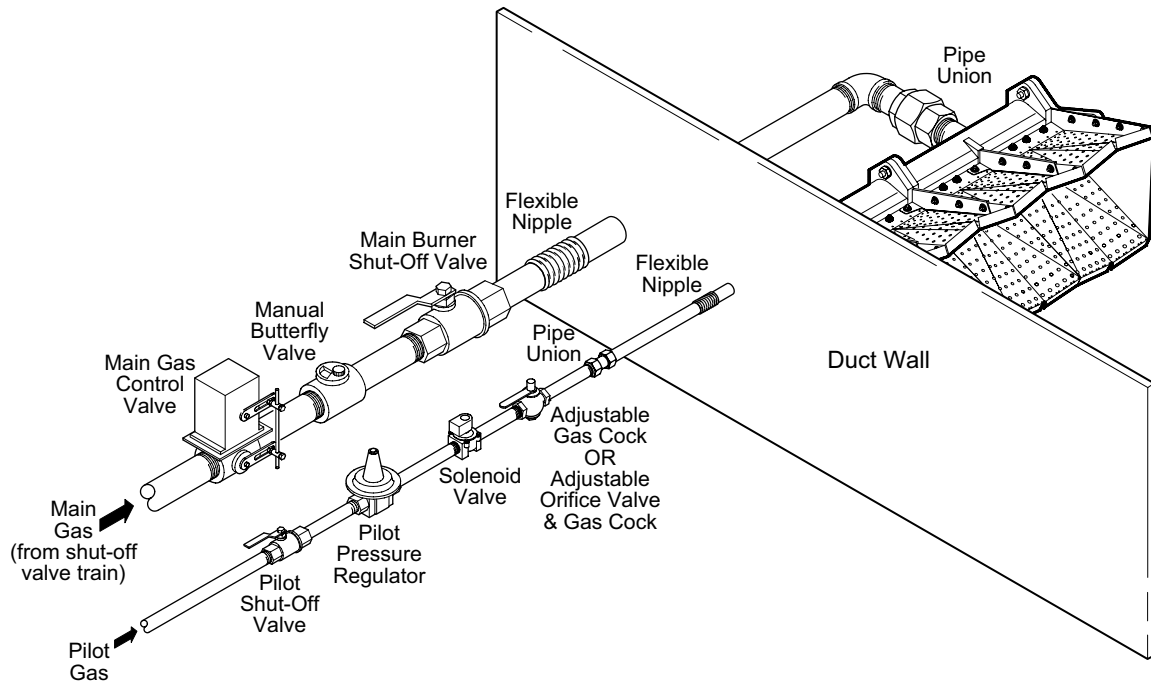


Fig. 14. Single-Stage Burner Valve Layout

