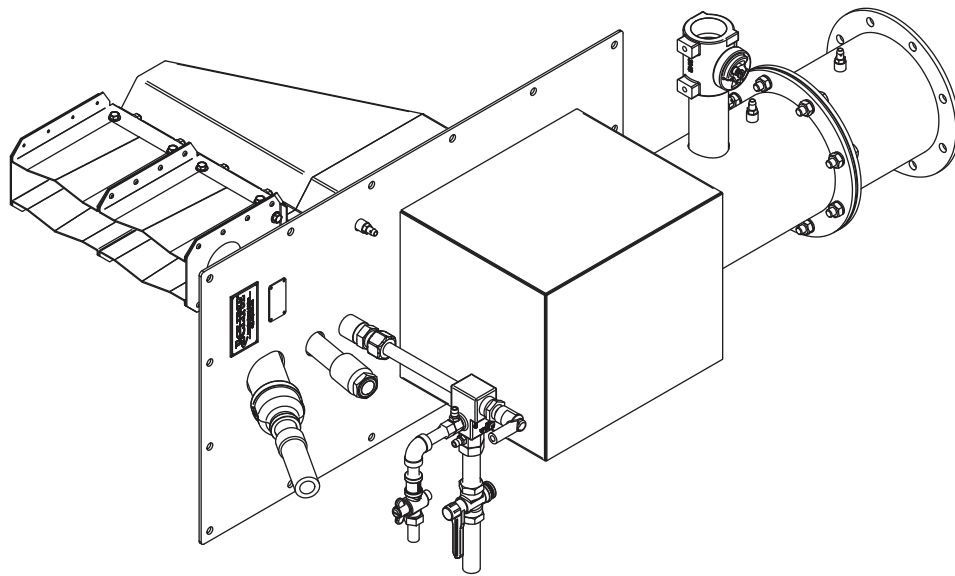


# *Eclipse Linnox*

# *Burners*

*Model ULE*

*Version 1*



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## **Document Conventions**

There are several special symbols in this document. You must know their meaning and importance.

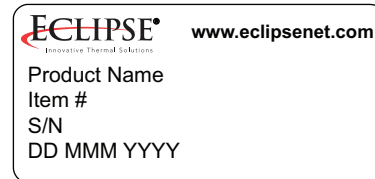
The explanation of these symbols follows below. Please read it thoroughly.

## **How To Get Help**

If you need help, contact your local Eclipse representative. You can also contact Eclipse at:

1665 Elmwood Rd.  
Rockford, Illinois 61103 U.S.A.  
Phone: 815-877-3031  
Fax: 815-877-3336  
<http://www.eclipsenet.com>

Please have the information on the product label available when contacting the factory so we may better serve you.



This is the safety alert symbol. It is used to alert you to potential personal injunt hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.



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



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



Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

**NOTICE**

Is used to address practices not related to personal injury.

**NOTE**

Indicates an important part of text. Read thoroughly.

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# Introduction

# 1

## **Product Description**

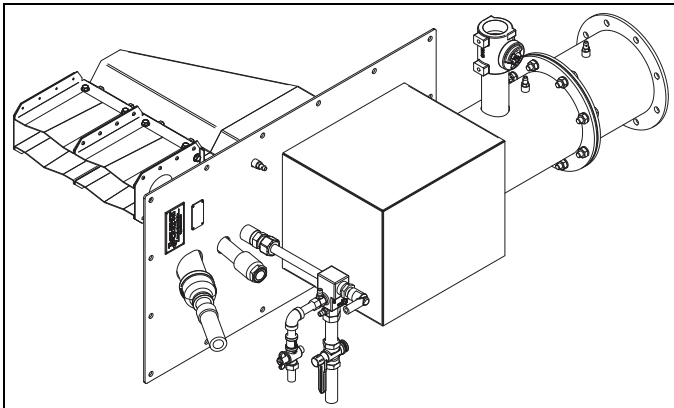
The Linnox burner is a pre-mix type line burner, designed for direct-air heating applications where the lowest achievable NO<sub>x</sub> and CO levels are required.

Linnox combustion is based on high excess air, pre-mix combustion to keep the flame temperatures low. At the same time, the burner geometry establishes an internal recirculating flame pattern. These two factors result in ultra low NO<sub>x</sub> and CO emissions across the turndown range while maintaining extremely stable combustion.

This burner may easily be configured for a variety of capacities by choosing from a wide range of burner modules each 1 ft (300 mm) in length.

The Linnox is designed to provide:

- Reliable operation
- Simple adjustments
- Modulating control (air and gas)
- Burner modules varying from 90 to 2700 kBtu/h (26 to 791 kW) per 1 ft (300 mm).



**Figure 1.1. Standard Linnox Burner**

## **Audience**

This manual has been written for personnel already familiar with all aspects of pre-mix burners.

These aspects include:

- Design/selection
- Use
- Maintenance
- Safety

The audience is expected to be qualified and have experience with this type of equipment and its working environment.

## **Purpose**

The purpose of this manual is to ensure an appropriate burner selection for your application.

## **Linnox Documents**

### **Design Guide No. 159**

- This document

### **Datasheet No. 159**

- Required to complete design and selection

### **Installation Guide No. 159**

- Used with datasheet to complete installation

### **Worksheet No. 159**

- Required to provide application information to Eclipse Engineering

### **Spare Parts List No. 159**

- Recommended replacement part information

## **Related Documents**

- EFE 825 (Combustion Engineering Guide)
- Eclipse Bulletins and Information Guides: 610, 710, 720, 730, 742, 744, 760, 930

# 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 Eclipse before continuing.

## Safety Warnings



### **DANGER**

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



### **WARNING**

- **The burner and duct sections are likely to have HOT surfaces. Always wear the appropriate protective equipment when approaching the burner.**
- **Eclipse 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 provides information regarding the use of these burners for their specific design purpose. Do not deviate from any instructions or application limits described herein without written approval from Eclipse.**

## Capabilities

Only qualified personnel, with sufficient 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 Eclipse only. All Eclipse approved valves or switches should carry UL, FM, CSA, CGA and/or CE approval where applicable.

# System Design

# 3

## Design

The design process is divided into the following steps:

### 1. Burner Option Selection:

- Required Heat Input
- Burner Length
- Input per Module
- Burner Configuration
- Burner Ignition

### 2. Blower Option Selection:

- Pressure & Flow

### 3. Control Methodology:

- Gas/Air Ratio
- Burner Input Control

### 4. Valve Train Design:

- Component Selection
- Valve Train Size

### 5. Process Air Duct Design:

- Firing Arrangements
- Good Duct Design
- Duct Size
- Peep Sights

## Step 1: Burner Option Selection

Step 1 describes how to select burner options to suit an application. Use Worksheet 159 and Datasheet Series 159 when following this selection process.



- Consult EFE-825 Eclipse Engineering Guide or contact Eclipse if you have special conditions or questions.

## **Burner Model / Size Selection**

Consider the following when selecting the burner size:

- **Heat Input:** Calculate the required heat input to achieve the required heat balance.

- **Burner Length:** Define the necessary burner length. The burner consists of modules of 1 ft (300 mm) in length, so the length of the burner must be a multiple of 1 ft (300 mm). The maximum standard length is 9 ft (2700 mm). Longer burners are available as engineered orders. The duct size must be determined, before defining the burner length.

- **Input per Module:** The design of the burner is flexible and multiple inputs per module are available. Calculate the heat input per module and then select one of the applicable modules.

Select a module which is closest to the calculated heat input per module. The exact input per module will probably not match the calculated value. To achieve the required total heat input, the next higher module must be selected. Refer to the datasheet to determine the correct module.

- **Burner Configuration:** The Linnox is used for direct-fired air heat applications. The standard configuration is on a mounting plate as shown in Figure 3.2 on page 7.

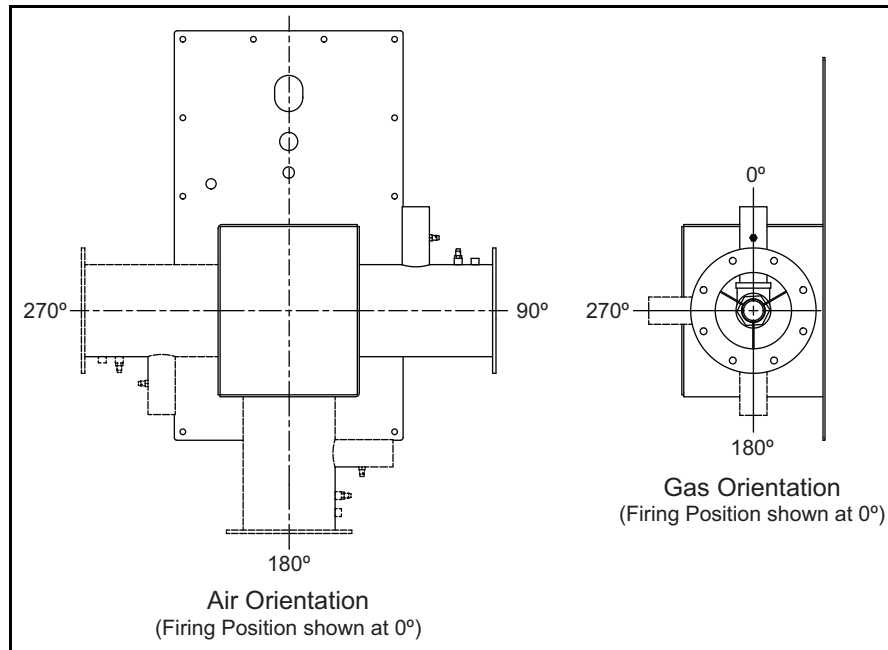
- **Burner Ignition:** The burner is packaged with an integral direct pilot. Direct spark ignition is not available. Make sure the burner control system operates under interrupted pilot timing; i.e. the controller should shut the pilot off after the trial for ignition period.

- **Flame Supervision:** The flame supervision device available for the Linnox is a UV-Scanner.

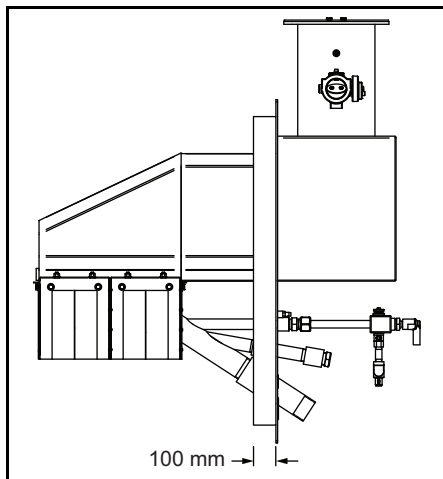
- **Mounting Plate:**

- Non-Insulated
- Insulated (100mm)

- **Air and Gas Inlet Orientation:** The burner can be provided with air and gas inlet positions as shown in Figure 3.1 on page 7.



**Figure 3.1 Air and Gas Inlet Orientation**



**Figure 3.2. Mounting Plate Options**

**Fuel Type**

Fuel	Symbol	Gross Heating Value	Specific Gravity	WOBBE Index
Natural Gas	CH <sub>4</sub> 90%+	1000 BTU/ft <sup>3</sup> (40.1 MJ/m <sup>3</sup> )	0.60	1290 BTU/ft <sup>3</sup>
BTU/ft <sup>3</sup> @ standard conditions (MJ/m <sup>3</sup> @ normal conditions)				

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

**Step 2: Blower Design**

**Pressure & Flow**

The Linnox burner is designed for 20 "w.c. (50 mbar) of combustion air at the burner inlet at maximum input. This applies regardless of module or length. Both the process air pressure and pressure losses due to the piping from blower to burner need to be added to that 20 "w.c. (50 mbar).

The flow of combustion air, however, is dependent on the capacity of the burner. The burner operates with 40% excess air. The total flow is calculated as follows:

$$\text{Airflow (SCFH)} = \text{Gasflow (SCFH)} \times \text{stoichiometric air requirement (SCF air / SCF gas)} \times 1.4.$$

Or

$$\text{Airflow (m}^3/\text{h)} = \text{Gasflow (m}^3/\text{h)} \times \text{stoichiometric air requirement (m}^3 \text{ air / m}^3 \text{ gas)} \times 1.4$$

**Sideplate Burner Dimensions**

Sideplates are arranged for mounting to an opening in the process air ducting. The sideplate is manufactured from sheet metal and is painted with a heat resistant coating. Sideplate dimensions vary due to mixer chamber sizing (dependent on total input).

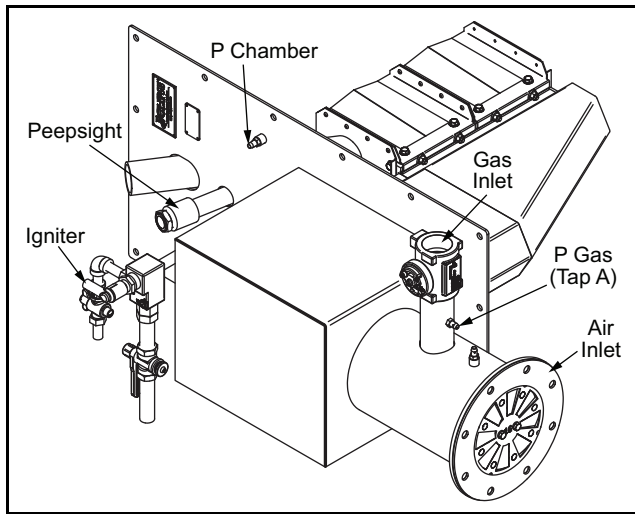


Figure 3.3. SidePlate Burner Dimensions

### Step 3: Control Methodology

#### Gas/Air Ratio

The gas/air ratio is critical for the Linnox burner. The gas/air ratio should remain constant with lambda 1.4, 40% excess air, over the full turndown.

Deviation from this gas/air ratio is not suggested. At lambda 1.3, 30% excess air, the burner may be damaged by overheating. If lambda is higher than 1.5, 50% excess air, the flame will blow off.

To maintain the proper air/gas ratio, the Eclipse-supplied ratio control device must be used.

#### Burner input control

The fuel is controlled by a proportionator (ratio regulator), and the analog input drives the air control valve.

### Step 4: Valve Train Design

#### Component Selection

Eclipse can supply a main gas valve train that satisfies the customer and complies with all local safety standards and codes set by the authorities within jurisdiction. Valve trains are available to accomplish 8:1 or 10:1 turndown, based on the customer's needs. Contact Eclipse for further information.



- The shut-off valves must be opened slowly to provide a gradually increasing gas pressure for the main burner control. If the shut-off valves are opened too quickly, the gas pressure may surge.

#### Valve Train Size

The minimum fuel pressure supplied to the burner inlet must meet the requirement specified in Datasheet 159. The valve train should be designed sufficiently to provide the specified pressure. A second main gas pressure regulator immediately upstream from the valve train gas inlet may be necessary to maintain inlet pressure to the burner.

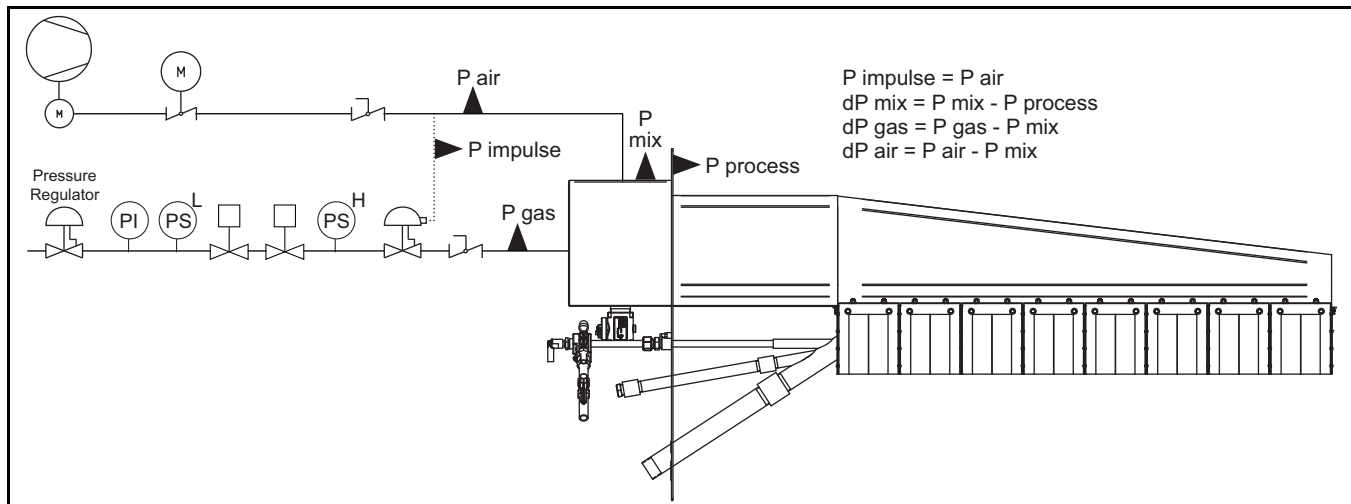


Figure 3.4. Basic Example of Control Method



## Step 5: Process Air Duct Design

### Firing Arrangements

Burners can be configured to fire vertically (up or down) or horizontally (left or right). Systems can include complete duct mounted sections or side-plate assemblies for insertion into an existing duct.

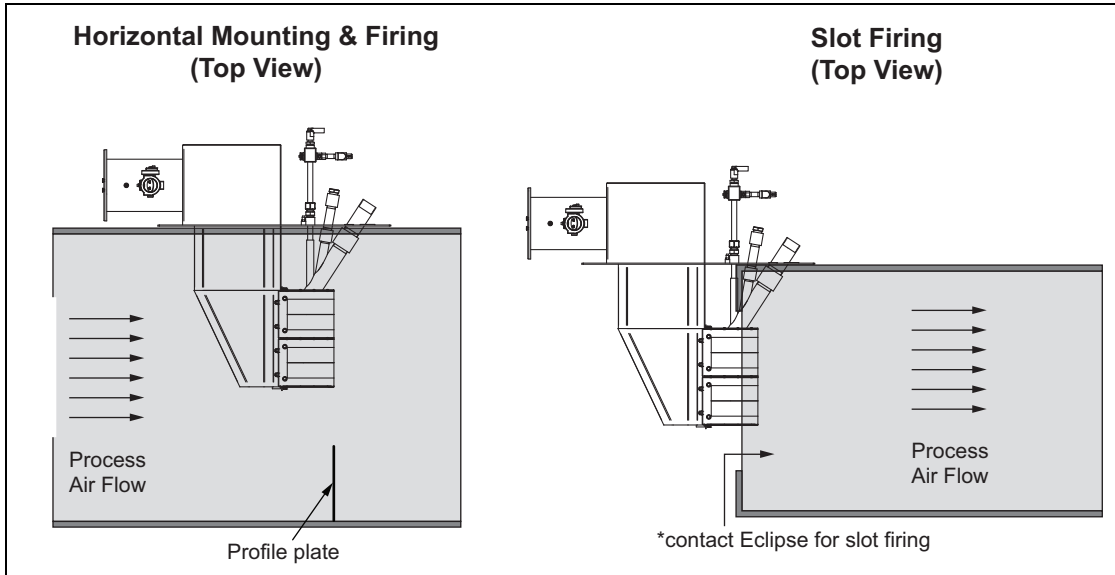


Figure 3.5.

### Good Duct Design

The Linnox burner must be properly installed in the process air duct system so that the flame fires in the same direction as the process flow. There can be no cross flow of process air to the burner. The process air flow must flow uniformly past the burner. The illustration below represents good duct designs, which will best maintain the process air velocity. See appropriate datasheet for additional design details

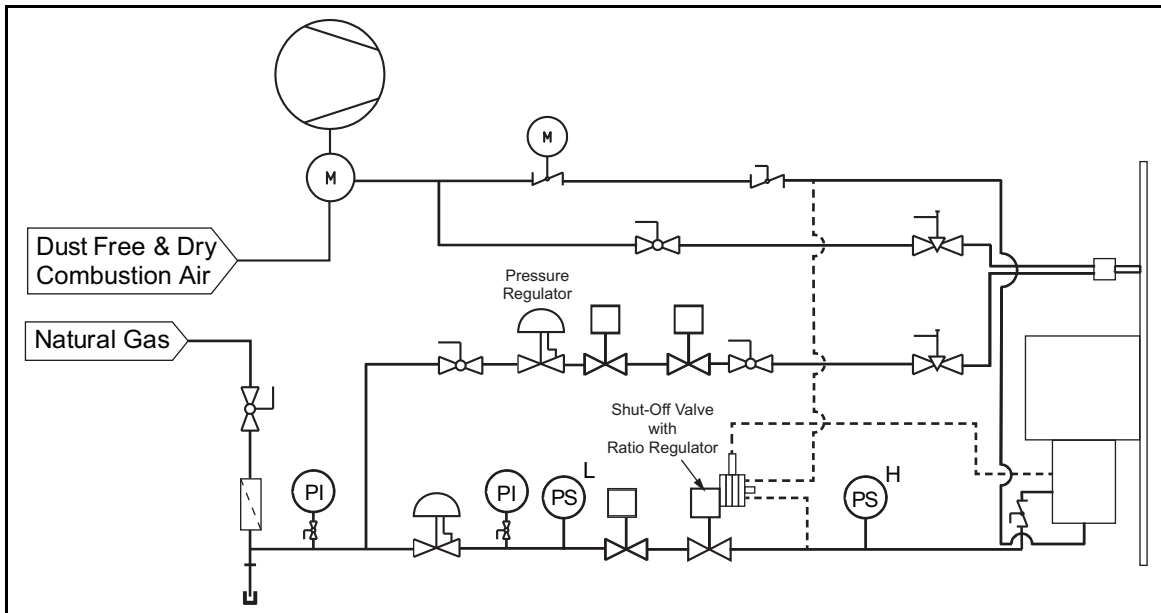
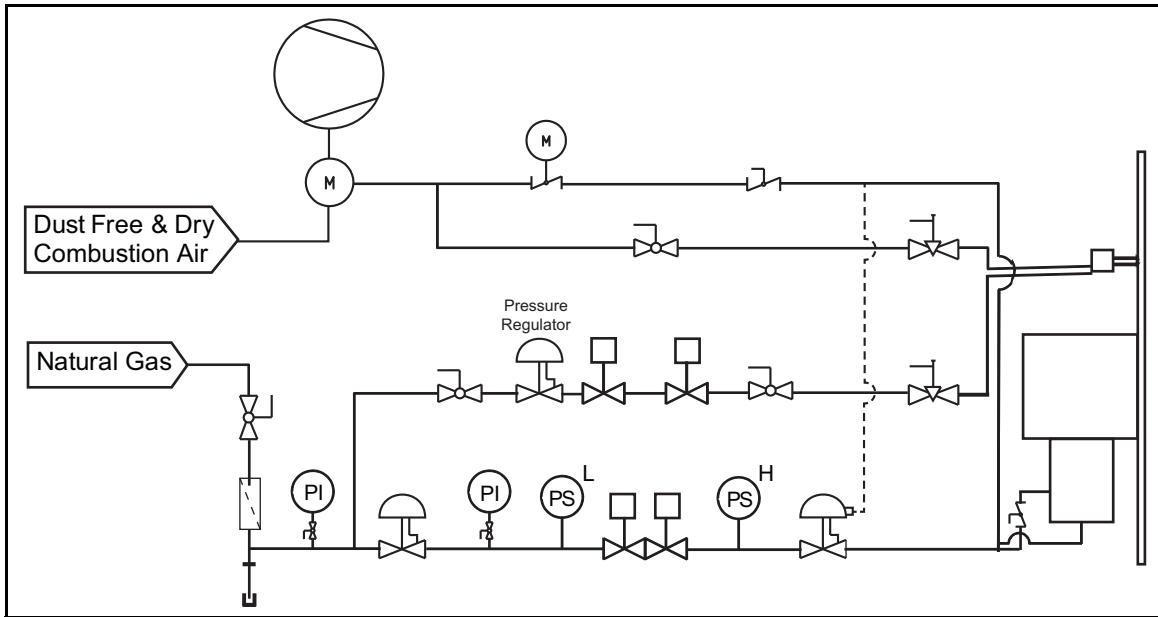
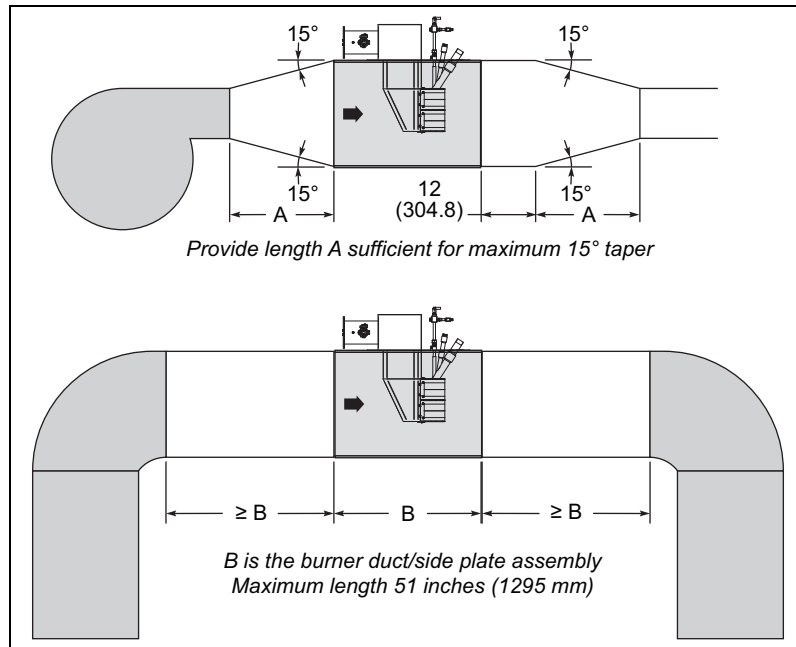


Figure 3.6. Linnox ULE PID 10:1 Turndown



**Figure 3.7. Linnox ULE PID 8:1 Turndown**



**Figure 3.8.**

### Module Cross-Sectional Area

Module ID	Input per Module, kBtu/h (kW)	Module Size, in (mm)	Module Cross-Sectional Area in Process Direction, in <sup>2</sup> (mm <sup>2</sup> )
24	90 (26)	2.1 x 11.8 (54 x 300)	25.1 (16,200)
36	135 (40)		
48	180 (53)		
60	225 (66)		
72	270 (79)		
96	361 (105)		
120	451 (132)		
144	541 (158)		
240	901 (264)	3.0 (75.5) x 11.8 (300)	35.1 (22, 650)
360	1352 (396)	4.6 (118) x 11.8 (300)	54.9 (35, 400)
480	1803 (527)	5.4 (138) x 11.8 (300)	64.2 (41, 400)
720	2704 (791)	7.4 (189) x 11.8 (300)	87.9 (56, 700)

Figure 3.9.

#### Duct Size

The sizing of the duct is based upon the process air velocity across the burner. A velocity between 1000 and 3000 fpm (5 and 15 m/s) creates a good mixture of process air and burner flue gases.

There must also be a minimum distance of 7.9 inches (200 mm) between the burner and the duct wall to avoid excessive heat impact on the wall.

#### Peep sights

In the design of the mounting plate delivered by Eclipse, a peep sight is included to view the entire flame along the length of the burner.

It is advised that one peep sight be placed on the duct opposite the burner mounting plate in order to see the ignition or pilot properly and a second peep sight be placed further down the burner in order to see the entire flame bed from a remote point.

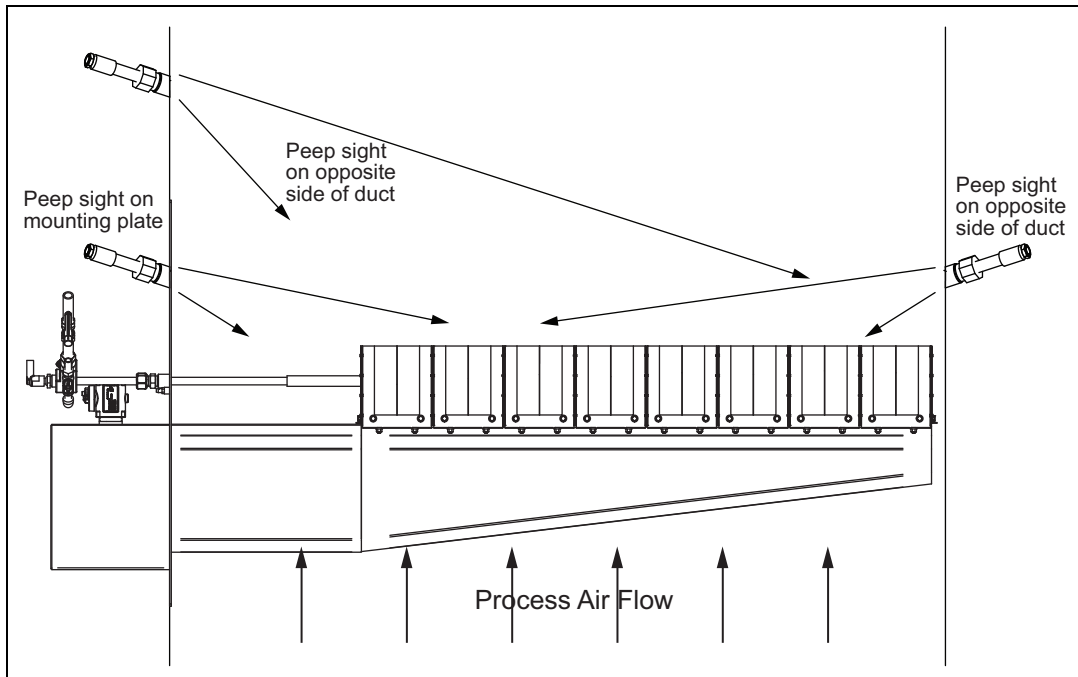


Figure 3.10.



# Appendix

## Conversion Factors

### Metric to English

From	To	Multiply By
actual cubic meter/h (am <sup>3</sup> /h)	actual cubic foot/h (acfh)	35.31
normal cubic meter/h (Nm <sup>3</sup> /h)	standard cubic foot /h (scfh)	38.04
degrees Celsius (°C)	degrees Fahrenheit (°F)	(°C x 9/5) + 32
kilogram (kg)	pound (lb)	2.205
kilowatt (kW)	Btu/h	3415
meter (m)	foot (ft)	3.281
millibar (mbar)	inches water column ("w.c.)	0.402
millibar (mbar)	pounds/sq in (psi)	14.5 x 10 <sup>-3</sup>
millimeter (mm)	inch (in)	3.94 x 10 <sup>-2</sup>
MJ/Nm <sup>3</sup>	Btu/ft <sup>3</sup> (standard)	26.86

### Metric to Metric


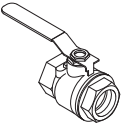
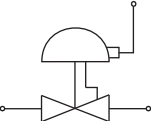
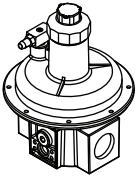
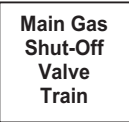

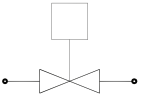
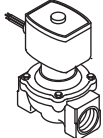



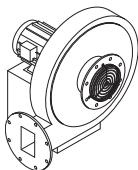
From	To	Multiply By
kiloPascals (kPa)	millibar (mbar)	10
meter (m)	millimeter (mm)	1000
millibar (mbar)	kiloPascals (kPa)	0.1
millimeter (mm)	meter (m)	0.001

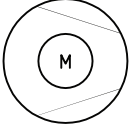
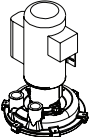
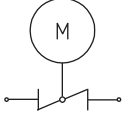
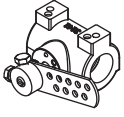
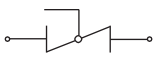
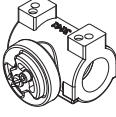
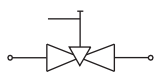

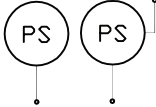

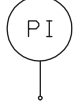

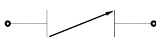


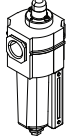


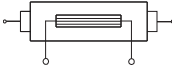
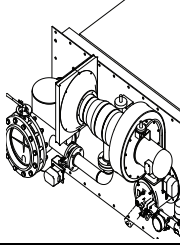

### English to Metric

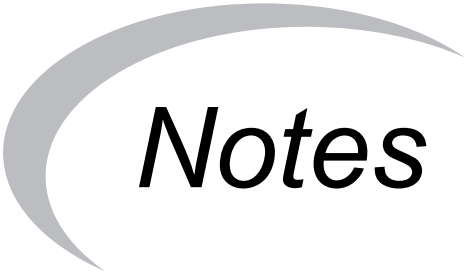
From	To	Multiply By
actual cubic foot/h (acfh)	actual cubic meter/h (am <sup>3</sup> /h)	2.832 x 10 <sup>-2</sup>
standard cubic foot /h (scfh)	normal cubic meter/h (Nm <sup>3</sup> /h)	2.629 x 10 <sup>-2</sup>
degrees Fahrenheit (°F)	degrees Celsius (°C)	(°F - 32) x 5/9
pound (lb)	kilogram (kg)	0.454
Btu/h	kilowatt (kW)	0.293 x 10 <sup>-3</sup>
foot (ft)	meter (m)	0.3048
inches water column ("w.c.)	millibar (mbar)	2.489
pounds/sq in (psi)	millibar (mbar)	68.95
inch (in)	millimeter (mm)	25.4
Btu/ft <sup>3</sup> (standard)	MJ/Nm <sup>3</sup>	37.2 x 10 <sup>-3</sup>



# System Schematics

Symbol	Appearance	Name	Remarks	Bulletin/ Info Guide
		Gas Cock	Gas cocks are used to manually shut off the gas supply.	710
		Ratio Regulator	A ratio regulator is used to control the air/gas ratio. The ratio regulator is a sealed unit that adjusts the gas pressure in ratio with the air pressure. To do this, it measures the air pressure with a pressure sensing line, the impulse line. This impulse line is connected between the top of the ratio regulator and the burner body.	742
		Main Gas Shut-Off Valve Train	Eclipse strongly endorses NFPA as a minimum.	790/791
		Pilot Gas Valve Train	Eclipse strongly endorses NFPA as a minimum.	790/791
		Automatic Shut-Off Valve	Shut-off valves are used to automatically shut off the gas supply on a gas system or a burner.	760
		Orifice Meter	Orifice meters are used to measure flow.	930
		Combustion Air Blower	The combustion air blower provides the combustion air to the burner(s).	610

Symbol	Appearance	Name	Remarks	Bulletin/ Info Guide
		Hermetic Booster	Booster is used to increase gas pressure.	620
		Automatic Butterfly Valve	Automatic butterfly valves are typically used to set the output of the system.	720
		Manual Butterfly Valve	Manual butterfly valve are used to balance the air or gas flow at each burner.	720
		Adjustable Limiting Orifice	Adjustable limiting orifices are used for fine adjustment of gas flow.	728/730
		Pressure Switch	A switch activated by rise or fall in pressure. A manual reset version requires pushing a button to transfer the contacts when the pressure set point is satisfied.	840
		Pressure Gauge	A device to indicate pressure.	940
		Check Valve	A check valve permits flow only in one direction and is used to prevent back flow of gas.	780
		Strainer	A strainer traps sediment to prevent blockage of sensitive components downstream.	
		Flexible Connector	Flexible connectors isolate components from vibration, mechanical, and thermal stresses.	
		Heat Exchanger	Heat exchangers transfer heat from one medium to another.	500
		Pressure Taps	Pressure taps measure static pressure.	



# *Notes*

