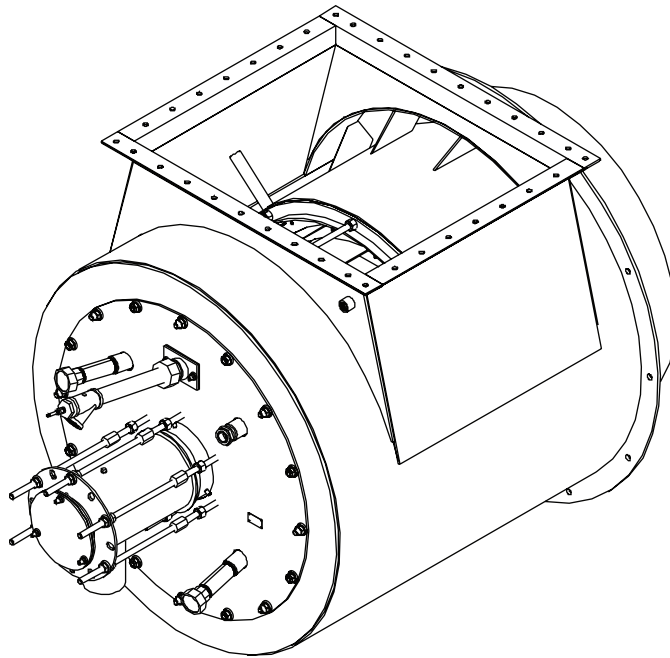


Eclipse Vortometric

Burners

Models HI and MI
Version 4



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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.

 ECLIPSE <small>Innovative Thermal Solutions</small>	www.eclipsenet.com
Product Name	
Item #	
S/N	
DD MMM YYYY	



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

Eclipse Vortometric Burners are built to fire a variety of fuels at very high inputs. They operate over a wide range of excess air levels on a variety of fuels including natural gas, propane, butane, fuel oil and alternative fuels. The Vortometric burners feature a high combustion air swirl that provides a stable flame with high turndown capabilities on low NO_x and CO emissions.

Vortometric burners are available in the MI (Medium Intensity) and HI (High Intensity) series. The MI series provides a smaller diameter, longer flame than the HI series and comes with either a refractory, air cooled alloy or single alloy tube (non-air-cooled combustor). The HI series burners have a larger diameter, shorter flame and are only available with the refractory lined combustor.

Both the HI and MI series Vortometric burners are available in 12 sizes which operate over a range of 6,000,000 to 210,000,000 BTU/hr (1,760 to 61,500 kW) making them ideal for large dryers, ovens, kilns, thermal fluid heaters, thermal oxidizers, oil heaters, vaporizers, boilers, liquid and waste incineration and other air heating applications.

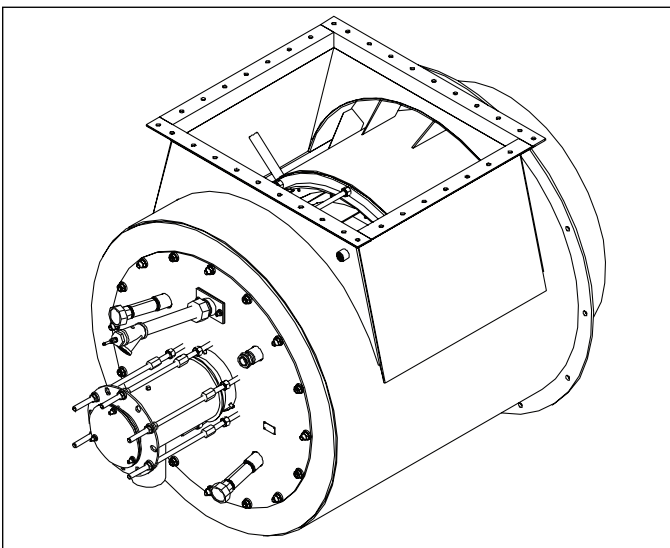


Figure 1.1. Vortometric Burner

Audience

This manual has been written for people who are already familiar with all aspects of a nozzle-mix burner and its add-on components, also referred to as “the burner system”.

These aspects are:

- Installation
- Use
- Maintenance

The audience is expected to have previous experience with this type of equipment.

Vortometric Documents

Installation Guide No. 128

- This document

Datasheet, Series No. 128-1 through 128-3

- Available for individual Vortometric models
- Required to complete design calculations in this guide

Design Guide No. 128

- Used with Datasheet to complete installation

Worksheet No. 128

- Required to provide application information to Eclipse Engineering

Related Documents

- EFE 825 (Combustion Engineering Guide)
- Eclipse Bulletins and Info Guides: 818, 820, 826, 832, 852, 854, 856

Purpose

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

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 the system. If any part of the information in this manual is not understood, contact Eclipse before continuing.

Safety Warnings



- 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.



- The burner and duct sections are likely to have HOT surfaces. Always wear the appropriate personal protective equipment when approaching the burner.



- 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.

Installation

3

In this section you will find the information and instructions that you need to install the burner.

Handling

- Make sure that the area is clean.
- Protect the components from the weather, damage, dirt and moisture.
- Protect the components from excessive temperatures and humidity.
- Take care not to drop or damage components.

Storage

- Make sure that the components are clean and free of damage.
- Store the components in a cool, clean, dry room.
- After you have made sure that everything is present and in good condition, keep the components in the original package as long as possible.

NOTICE

- **When the refractory combustion block is supplied with the burner, it is critical that the instructions for handling and storage are followed. The refractory should be considered fragile; improper handling and storage will cause premature failure.**

Position of Components

The position and amount of components are determined by the kind of control method chosen. All the control methods can be found in Design Guide 128. Follow one of the schematics in the System Design section to build your system.

Approval of Components

Limit Controls & Safety Equipment

All limit controls and safety equipment must comply with all applicable local codes and/or standards and must be listed for combustion safety by an independent testing agency. Typical application examples include:

- American: NFPA 86 with listing marks from UL, FM, CSA
- European: EN 746-2 with CE mark from TuV, Gastec, Advantica

Electrical Wiring

All the electrical wiring must comply with all applicable local codes and/or standards such as:

- NFPA Standard 70
- IEC60364
- CSA C22
- BS7671

Gas Piping

All the gas piping must comply with all applicable local codes and/or standards such as:

- NFPA Standard 54
- ANSI Z223
- EN 746-2

Where to Get the Standards:

The NFPA Standards are available from:

National Fire Protection Agency
Batterymarch Park
Quincy, MA 02269
www.nfpa.org

The ANSI Standards are available from:

American National Standard Institute
1430 Broadway
New York, NY 10018
www.ansi.org

The UL Standards are available from:

333 Pfingsten Road
Northbrook, IL 60062
www.ul.com

The FM Standards are available from:

1151 Boston-Providence Turnpike
PO Box 9102
Norwood, MA 02062
www.fmglobal.com/approvals

Information on the EN standards and where to get them is available from:

Comité Européen de Normalisation
Stassartstraat 36
B-1050 Brussels
Phone: +32-25196811
Fax: +32-25196819
www.cen.eu

Comité Européen de Normalisation Electronique
Stassartstraat 36
B-1050 Brussels
Phone: +32-25196871
Fax: +32-25196919
www.cenelec.org

Checklist Before Installation

Intake

To admit fresh combustion air from outdoors, provide an opening in the room of at least one square inch per 3,000 BTU/hr (5 cm² per 1 kW). If there are corrosive fumes or materials in the air, then supply the burner with clean air from an uncontaminated area, or provide a sufficient air filtering system.

Exhaust

Do not allow exhaust fumes to accumulate in the work area. Provide some positive means for exhausting from the furnace and the building.

Access

Make sure that you install the burner in such a way that you can gain easy access for inspection and maintenance.

Environment

Make sure the local environment matches the original operating specifications. Check the following items:

- Voltage, frequency and stability of the electrical power
- Type and supply pressure of the fuel
- Availability of enough fresh, clean combustion air
- Humidity, altitude and temperature of air
- Presence of damaging corrosive gases in the air
- Prevent direct exposure to water

Burner Mounting

Depending on your application, please keep the following in mind when mounting a burner:

- Ensure that the burner is level and that the furnace or heater casing has sufficient rigidity to support the burner. If necessary, provide stiffeners on the casing or supports under the burner.

- The opening in the furnace or heater which holds the combustor must allow clearance for the stainless steel liner around the refractory and 1" (25mm) of side clearance for the insulation, see Figure 3.8.
- Use gasket between the burner mounting flange and the furnace or heater casing and ensure that there is a gas-tight joint between these two surfaces. This tightness is especially critical for systems operating under positive pressures.

Prepare the Burner

There are several components that must be installed to a burner system before it can operate. Instructions to do that follow:

Gas, Gas/Oil or Oil Lance Positioning

Prior to starting the burner, the lance position in relation to the burner throat cone must be checked.

NOTICE

- **Burners are not necessarily shipped with lances in the correct position; it is also possible that the lance could shift during shipment. All of the following adjustments provide a relative position for safe operation for all applications; occasionally, adjustments in or out from the relative positions may be necessary depending on your application.**

For Gas Only Burners Adjustment (Figure 3.1)

1. To adjust the gas lance, loosen the gland.
2. Using the chart in Figure 3.1, determine the "X" dimension based on your burner size.
3. Once the "X" dimension is verified and the gas lance is centered in relation to the throat cone, tighten the gland.

NOTE: Failure to center the lance in the burner throat will cause uneven air flow and flame instability. The lance should be centered within $\pm 1/8"$ (3mm).

For Combination Gas/Oil Burners - Initial Adjustment (Figure 3.2)

1. Adjust the oil lance position by loosening gland "A".
2. Align the conical faces of the oil and gas lances.
3. Once both lances are aligned, tighten gland "A" on the oil lance.

NOTE: After this initial adjustment, all subsequent adjustments for combination gas/oil burners require that both lances be moved as a single unit.

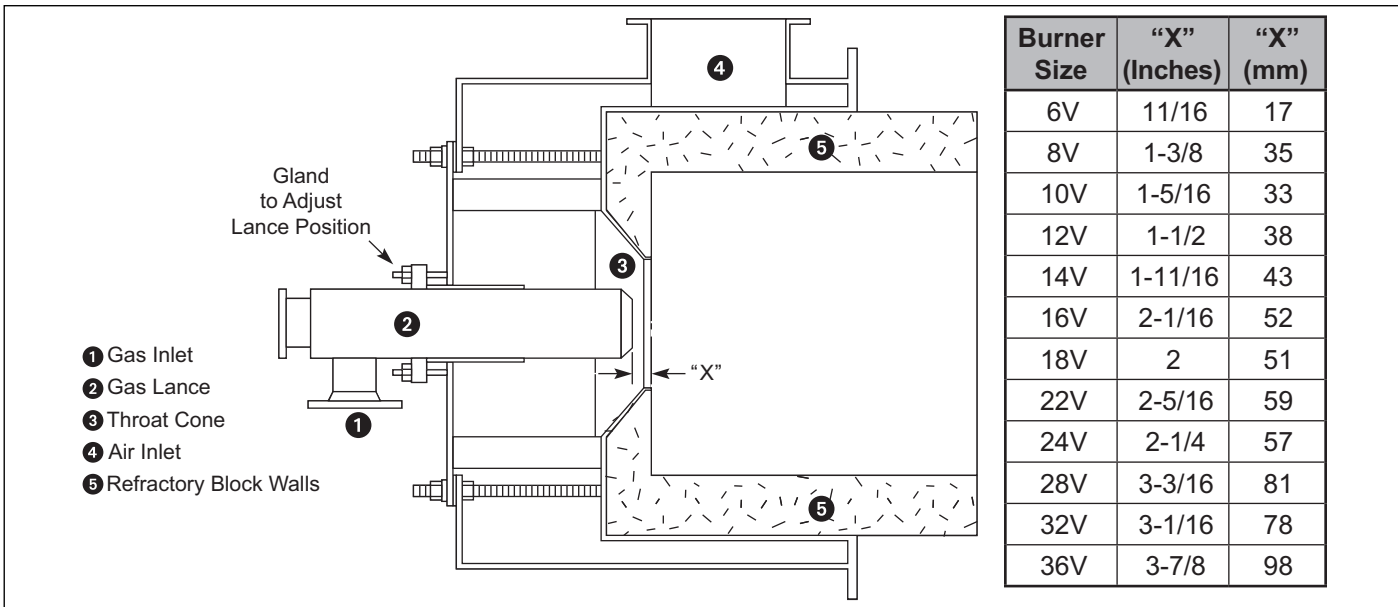


Figure 3.1. Vortometric Gas Lance Position

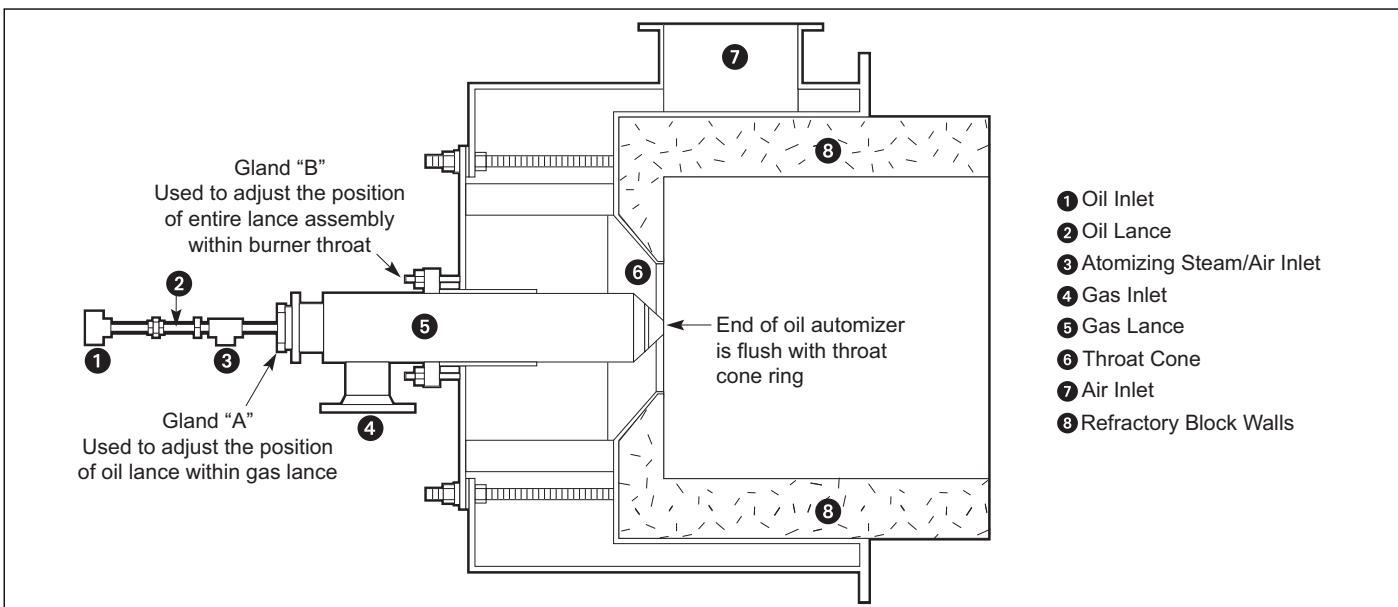


Figure 3.2. Vortometric Gas/Oil Lance Position

For Combination Gas/Oil Burners - Subsequent Adjustments (Figure 3.2)

1. Adjust the entire gas/oil lance assembly by loosening gland "B".
2. Move the entire lance assembly until the oil nose cone aligns with the small diameter of the throat cone.
3. Once both cones are aligned and the gas lance is centered in relation to the throat cone, tighten gland "B".

NOTE: Failure to center the lance in the burner throat will cause uneven air flow and flame instability. The lance should be centered $\pm 1/8"$ (3mm).

For Oil Only Burners Adjustment (Figure 3.3)

1. Adjust the oil lance position so that the end of the oil nose cone aligns with the small diameter of the throat cone.
2. Verify that the oil lance is centered in relation to the throat cone; once verified, tighten the large gland nuts.

NOTE: Failure to center the lance in the burner throat will cause uneven air flow and flame instability. The lance should be centered $\pm 1/8"$ (3mm).

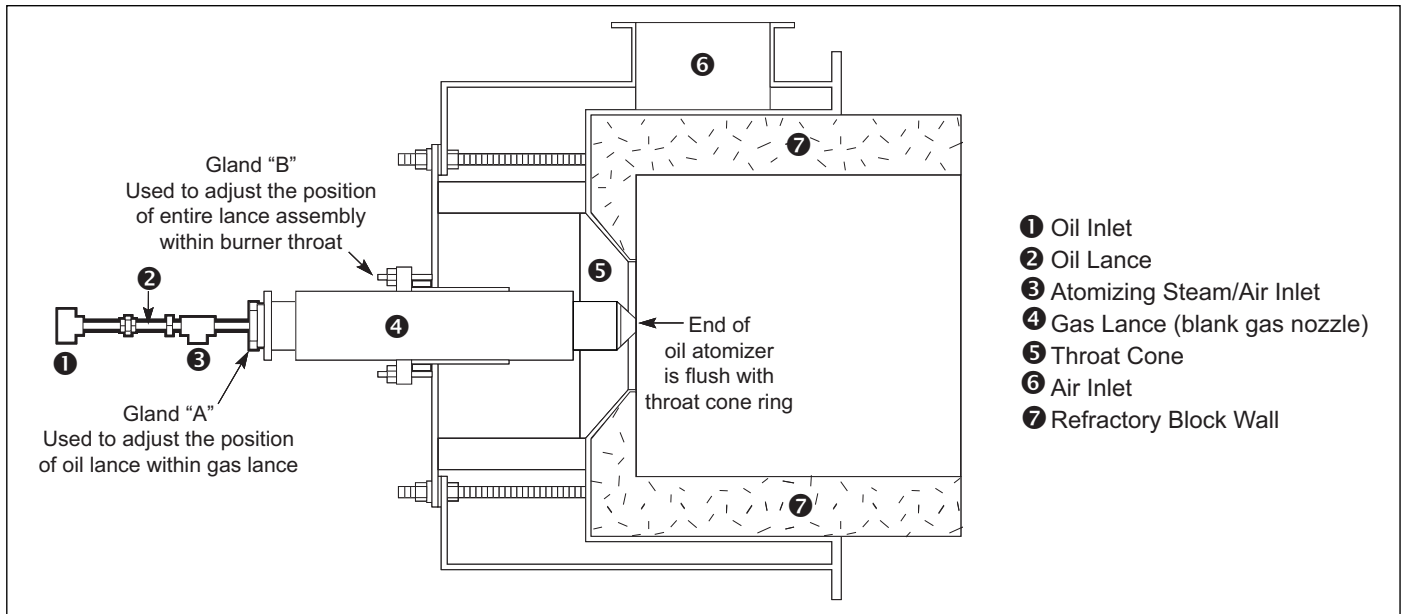


Figure 3.3. Vortometric Oil Lance Position

Install the Flame Sensor

An ultraviolet flame sensing device, or UV scanner, must be used with the 3/4" NPT swivel connector supplied with the burner. Two mounting ports are located near the lance assembly adjacent to the pilot which sight both pilot and main flames. Flame detection methods are affected by fuels and applications:

- For gas, light oil, or heavy oil with air atomization, locate a UV scanner in one of the two mounting ports near the pilot to prove pilot and main flames. The two remaining ports can house either a UV or sight glass depending on customer preference (see Figure 3.4).
- For heavy oil with steam atomization, two scanners must be used. Because atomizing steam absorbs ultraviolet light, a scanner mounted near the pilot will only prove the pilot flame. Therefore, a second scanner mounted on the combustor side in the firing chamber is needed to prove the main flame.

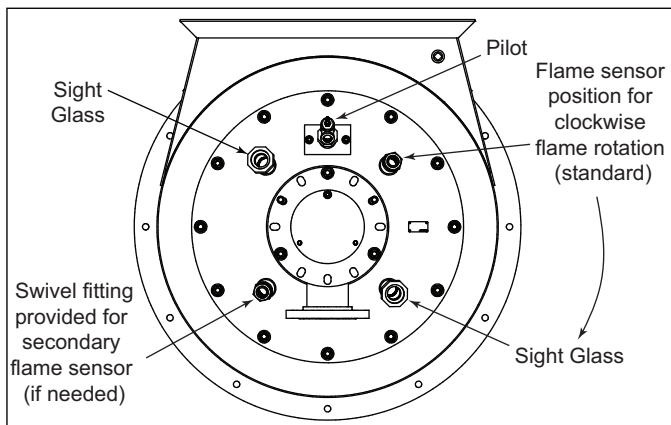


Figure 3.4. Flame Sensor Mounting & Sight Glass Locations

NOTE: Due to the low UV content of oil flames, some UV scanner/flame safety systems may have difficulty sighting oil flames at high inputs. In these cases, a more sensitive UV detector may be required or an infrared (IR) detector may be used. Contact Eclipse for support.

NOTICE

- Adjustments may vary from Eclipse published values if the flame controls other than those recommended in the Design Guide are used. Consult with the engineer who specified the alternate control for limitations.

Make sure that you connect the flame sensor of a burner to the electrical circuit of the burner.

! DANGER

- If you connect the flame sensor of a burner to the electrical circuit of the wrong burner, then you can cause fires and explosions.

For detailed information on how to install and connect a UV scanner, refer to scanner information guide.

NOTE: Four mounting positions are provided. The standard is to mount the flame sensor adjacent to the pilot, downstream of swirl flow. An additional swivel fitting is provided 180° apart, in case a secondary flame sensor is desired. The mountings for the swivel fitting and the sight glasses are the same, allowing them to be interchanged to meet a customer preference, or if swirl direction is counter clockwise.

Pilot Assembly

Pilot Ignition

The standard Vortometric spark-ignition pilot requires an ignition transformer with a minimum of 6,000 volt secondary. Mount the transformer in a location where it will not overheat while allowing as short an ignition lead as possible.

Pilot Assembly Positioning

The relation of the pilot assembly to the main burner lance affects air flow through the throat cone. Therefore, it is important that the pilot be as far away as possible from the throat cone while maintaining reliable ignition. For initial start-up, the pilot assembly should be positioned as in Table 3.1; if necessary, adjust the pilot assembly gland to achieve this distance (see Figure 3.5).

Spark Rod Replacement

To replace the pilot spark rod, remove the entire pilot lance assembly from the burner at the two mounting bolts. Remove threaded pilot end cup from pilot lance. Loosen spark rod adjusting coupling and insert spark rod into the tee fitting. Reinstall the end cup making sure the spark rod is installed through the center hole in the end cup.

Burner Size	MI	HI
6V	12.5 (317.5)	12.5 (317.5)
8V	12.6 (320)	13.6 (345)
10V	14 (355.6)	13.4 (340)
12V	14 (355.6)	14 (355.6)
14V	13.5 (342.9)	11.8 (299.7)
16V	11.9 (302)	10.1 (256.5)
18V	15.8 (401.3)	14 (355.6)
22V	18.3 (464.8)	15.75 (400)
24V	16.5 (419)	14.2 (360.7)
28V	16.3 (414)	12.6 (320)
32V	15.2 (386)	10.7 (271.8)
36V	19.5 (495.3)	14.8 (375.9)

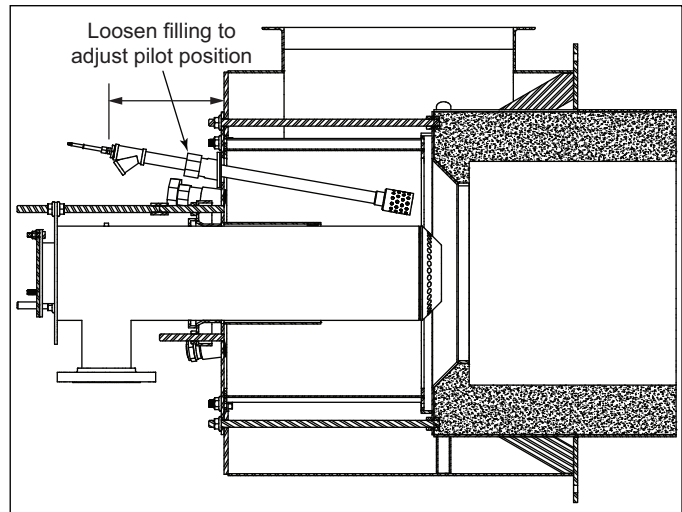


Figure 3.5. Pilot Position Adjustment

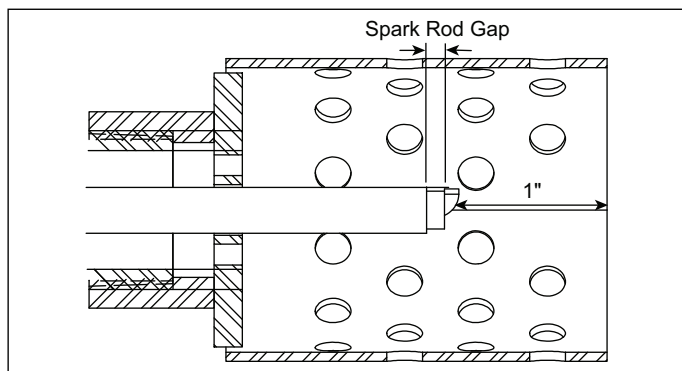


Figure 3.6. Spark Rod Gap & Position

Spark Rod Gap

The spark rod gap should be set at 1/8" (3mm). The pilot must be removed so the gap can be measured. See Figure 3.6.

Spark Rod Position

The end of the spark rod must be positioned 1" (25mm) from the outer edge of pilot cup. See Figure 3.6.

Support the Piping and Duct Work

Use brackets or hangers to support the piping and duct work to avoid placing undue loads on the burner. If you have questions, consult your local gas company.

Pipe Connections

The use of flexible pipe in gas, oil, and atomizing air lines to the burner is recommended. Adjustments of the main gas, pilot gas, and oil lance positions may be required during burner setup.

Avoid Large Pressure Drops

NOTE: The pressure drop of the gas in the piping is a critical parameter. Make sure that the size of all the piping is large enough to prevent excessive pressure losses.

Oil Fuel Considerations

- In heavy fuel oil (#5 or #6) applications, the oil temperature at the burner inlet should be 220 to 270°F (104 to 132°C) for good viscosity (maximum 150 SSU). Depending on burner location - steam or electric tracing and pipe insulation are usually needed to ensure the oil temperature at the oil lance inlet. Other oils (waste, bio-oil residue, etc.), may also require similar provisions to ensure good viscosity.
- Foreign material can easily clog the small injection holes in the oil nozzle tip. Ensure that all inside surfaces of assembled piping to the burner are free of dirt, grit, shavings, or foreign material. To avoid contamination, use thread sealant such as Teflon paste only on pipe threads that will not come in contact with the oil flow.
- A purge of the oil nozzle should be conducted after burner shutdown. Connect a line between the atomizing medium and the oil piping just upstream of the oil nozzle. Install check valves in this line and the oil piping.

Atomizing Steam Considerations

Atomizing stream must be dry and superheated to at least 20°F (11.1°C) above saturation temperature at the burner inlet. Therefore, this piping line must be insulated up to the burner inlet. Provisions must also be made for continuous condensate disposal via a steam trap and drain.

Compressed Air Considerations

- When compressed air is used for atomization, it is possible for water and oil vapor from the air compressor to contaminate the atomizer. Therefore, include preventative measures against this possibility when designing the atomizing air supply system.
- All components should be equipped with a suitable aftercooler, oil separator, and automatic traps or drain valve.
- When compressed air is used for atomization for heavy oils (#5 or #6), preheat the air to a temperature between 220 and 270°F (104 and 132°C) and insulate the air lines.

Pilot Gas Considerations

- All supplied gas pilot piping (natural gas, propane, etc.) **must** be fitted with pilot gas pressure regulator.
- All supplied gas pilot piping (natural gas, propane, etc.) **should** be fitted with an adjustable orifice valve for pilot gas flow adjustment.

Strainers

No matter what fuel is used, it is essential that the valve train components, the atomizer, and the fuel oil tip be protected from foreign material damage. Therefore, it is suggested that strainers be used as follows:

• Oil Valve Trains:

- It is recommended that an edge plate type filter with a 20 mesh (841 micron) rating be used upstream of all valve train components.
- It is recommended that a strainer with a 40 mesh (400 micron) rating be used adjacent to the oil lance inlet.

• Atomizing Valve Trains:

It is recommended that a strainer with a 20 mesh (841 micron) screen be used upstream of all valve train components for steam or compressed air applications.

• Fuel Gas Valve Train:

It is recommended that a strainer with 20 mesh (841 micron) screen be used upstream of all valve train components.

Atomizing Control Methods

There are two possible control methods for atomizing air and steam:

- **Fixed:** If the burner's turndown ratio requirement does not exceed 5:1, the atomizing pressure at the burner may be set to run constantly at 50/55 psig (3.5 / 3.8 bar), eliminating the need for a differential pressure regulator.
- **Modulating:** Use a differential pressure regulator which is "top loaded" with the oil pressure at the nozzle, which allows the atomizing pressure to increase proportionally with the oil pressure. To do so, set the atomizing pressure approximately 20 psig (1.4 bar) above the oil pressure, but not exceeding 50/55 psig (3.5 / 3.8 bar). To ensure this maximum pressure is not exceeded, adjust the pressure regulator for the incoming atomizing supply to not exceed 50/55 psig (3.5 / 3.82 bar).

Installing & Curing Refractory Block

On most sizes it is the customer's choice whether the combustion refractory block is factory or field installed. The following provisions deal with installing either choice. The standard, general purpose refractory for Vortometric combustion blocks is an alumina plastic ramming mix.

Factory Installed Refractory

The Eclipse factory installed refractory has been oven cured at relatively low temperatures to remove most of the water content. However, some residual water may still be present and must be removed at the initial start-up.

After the burner and refractory have been installed, the following steps will ensure proper curing and maximum strength to reduce chances of cracking or spalling.

1. Set the combustion air at its minimum input.
2. Light only the pilot and leave on for approximately three hours.

3. After three hours, light the main burner at minimum input.
4. Increase the furnace temperature by 150°F (65.5°C) per hour.
5. Water evaporation (steam) is usually heaviest and most prominent around 1000°F (538°C). If steam is prevalent after the hour at 1000°F (538°C), hold at that temperature for two to three hours or until the steam stops.

NOTICE

- **If at any time during the curing process, visible steam rises from the refractory, hold the temperature until it dissipates.**
6. Once the steam stops coming from the refractory, resume the 150°F (65.5°C) temperature rise per hour until the combustion chamber reaches 2000°F (1093°C) (or less, if the maximum allowable system temperature is under 2000°F (1093°C)).
 7. Hold at temperature in step 6 for three to four hours to ensure proper curing.

Field Installed Refractory

The customer is responsible for supplying all refractory materials for field installation as follows:

1. Cover the inside surfaces of the combustor shell with a 1/8" (3mm) layer of Plibrico Plisulate® fibrefax paper or equivalent.
2. Install alloy anchors in the combustor shell according to the refractory supplier's recommendations. The alloy anchors should be coated with bitumastic wherever they protrude through the layer of Plibrico Plisulate. For all vertically firing down applications, consult Eclipse for more information regarding suggested anchor mounting procedures.
3. Install the chosen refractory, realizing it is essential that:
 - The combustion block dimensions are held as given on the burner datasheets.
 - The inside diameter of the combustion block is concentric with the air cone in the burner. Refer to Figure 3.8 for wall interference, and typical refractory installation details and recommendations.
4. The refractory should be pounded into place with a pneumatic rammer, starting around the air cone. Use care in ensuring that the specified contours and dimensions on the aforementioned Eclipse drawing are

maintained. Provide vent holes so moisture can escape during dry-out. The surface of the refractory must be rough rather than smooth to aid in water evaporation during curing.

NOTE: The corner angle between the cone and the sidewall must be 90° or slightly less, but **not** more.

Customers should follow the curing cycle recommended by the refractory manufacturer. Contact Eclipse for more information.

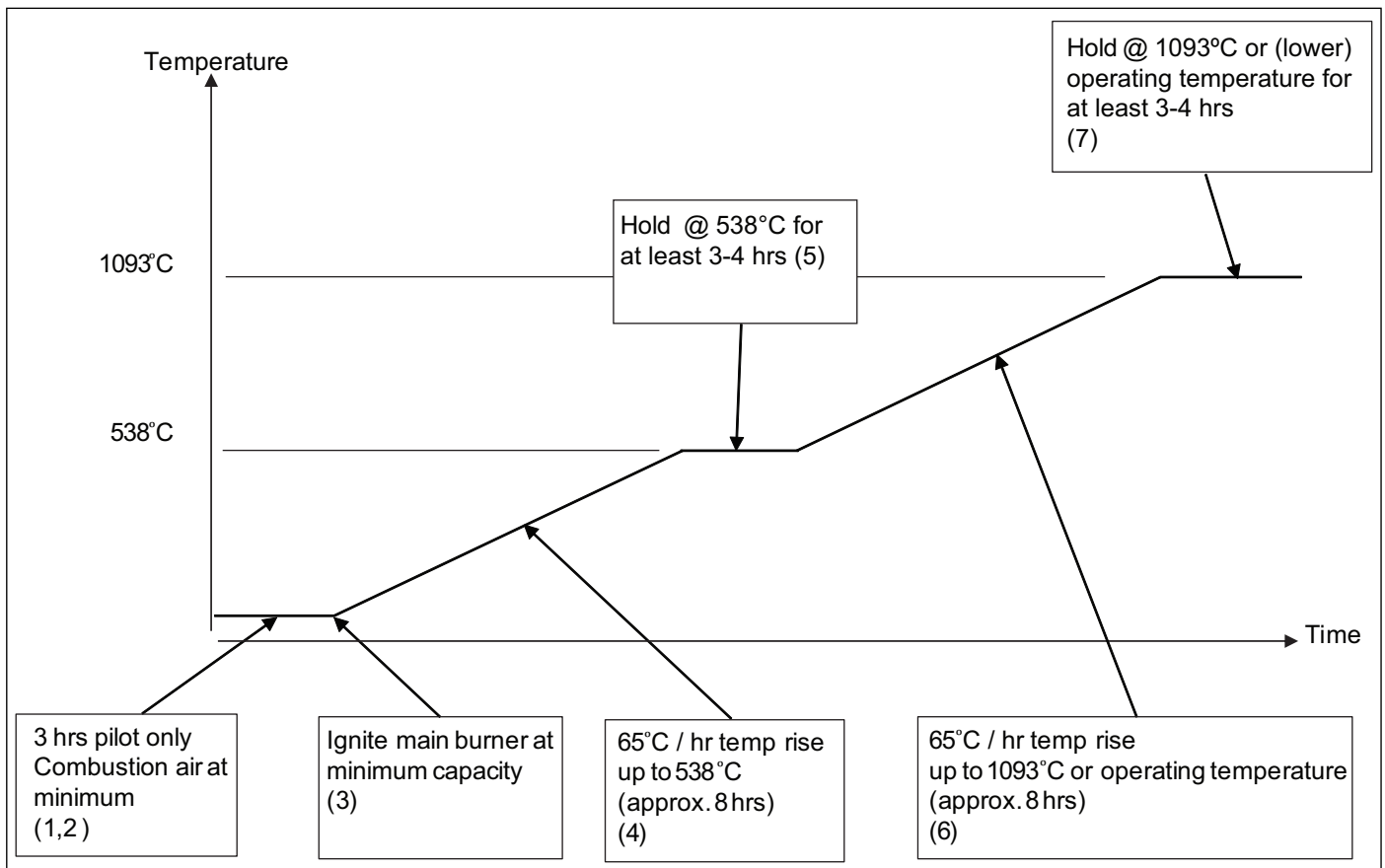


Figure 3.7. Vortometric Refractory Curing Schedule (Factory Installed Refractory)

Checklist After Installation

To make sure that the system is installed correctly, do the steps that follow:

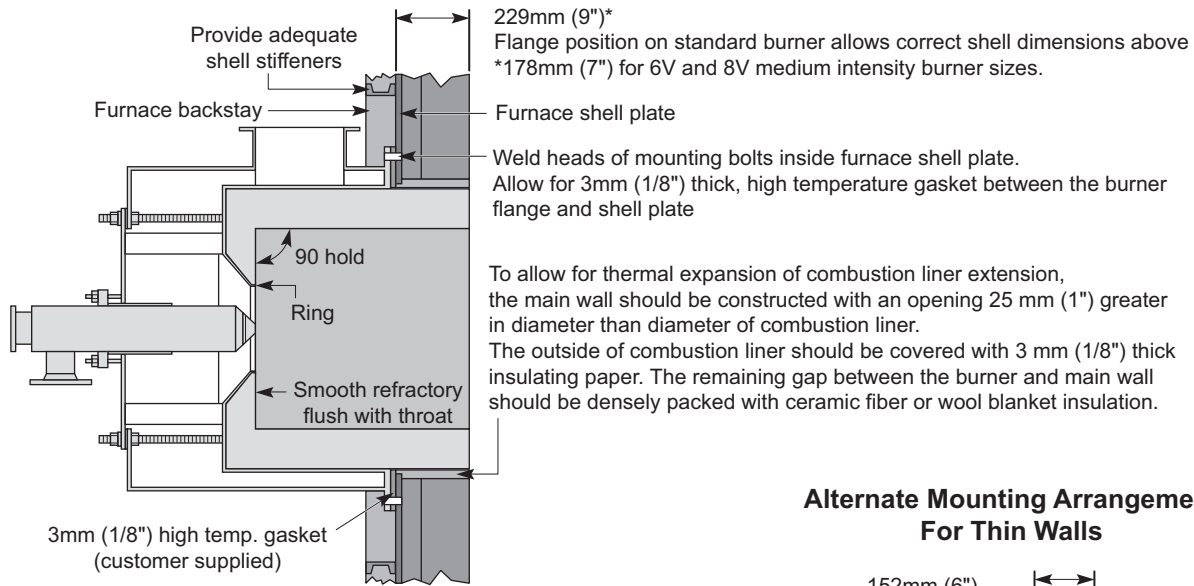
1. Make sure that there are no leaks in the fuel lines.
2. Make sure that the blower rotates in the correct direction. If incorrect, have a qualified electrician rewire the blower to reverse its rotation.
3. Set the air proving switch.
4. Set the low fuel pressure switch.
5. Set the high fuel pressure switch.
6. Close all burner fuel cocks.
7. Trip out pressure switches and other limit interlocks. Make sure that the main fuel shut-off valves close.



- **If simulated limits or simulated flame failure do not shut down the fuel system within the required failure response time, immediately correct the problem.**

Suggested Mounting Arrangement For Standard Burner

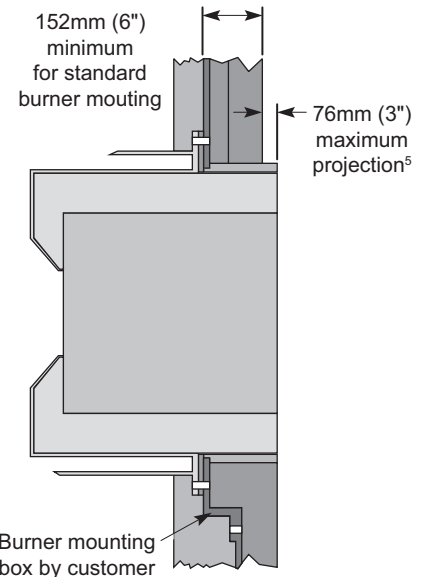
Mounting illustrations show typical refractory combustor. Mounting dimensions also apply to single alloy combustor and air cooled combustor.



General Notes:

1. Mounting illustrations show typical Vortometric combustor blocks of high alumina plastic refractory as used by Eclipse for normal duty.
2. The dimensions given must be held as specified, and the inner diameter of the combustor must be round and concentric with the throat cone.
3. Alloy rod-type anchors welded inside the combustor block are the customer's responsibility if the refractory is field installed rather than factory installed.
4. All mounting arrangements are meant for vertically or horizontally fired burners. Regardless of orientation, the refractory block MUST be protected from thermal expansion of the furnace wall.
5. Single Alloy Combustor and Air-Cooled Combustor not applicable for applications with combustion chamber temperature above 1600°F (870°C).

Alternate Mounting Arrangement For Thin Walls



Alternate Mounting Arrangement For Thick Walls

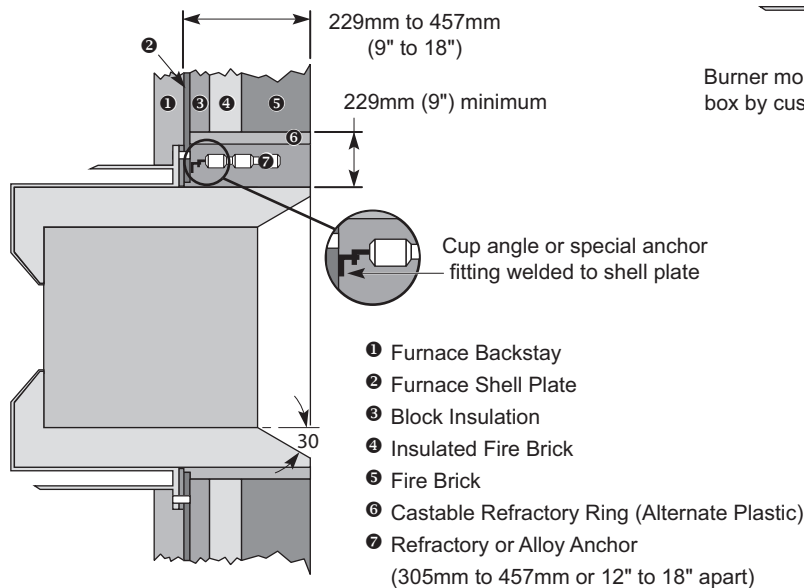


Figure 3.8. Vortometric Burner Mounting Arrangements

Adjustment Start & Stop 4

In this chapter you will find instructions on how to adjust a system, start a system, and stop a system.



- **Do not bypass any safety features. This can cause fires and explosions. Obey the safety precautions in the Safety chapter and read all of this chapter before starting your system.**

Adjustment Procedure

If you are adjusting the burner system for the first time, then you must follow these steps:

Step 1: Reset the System

Close the automatic fuel shut-off valves and the fuel cocks.

Step 2: Set High Fire Combustion Air Pressure Drop

1. Start the combustion air fan.
2. Set the air control damper to produce the desired high fire pressure drop across the burner. Air pressure drop should be read as a differential pressure between the windbox pressure test port and the chamber. See the datasheets for the combustion air pressure drop versus air flow curves.

Step 3: Verify Air Settings

Make sure that all the settings are still the same after you cycle the system several times between high fire and low fire. Check the air proving switch and adjust if necessary.

Step 4: Ignite the Pilot

NOTE: Test spark ignitor with a visual or audible check before attempting ignition.

1. Set the system to operate on pilot only. Consult the literature included with the flame monitoring relay.
2. Set pilot regulator to 6" w.c. (15 mbar) outlet pressure.

3. Open the pilot adjusting valve two turns (see figure 4.1).

4. Initiate start sequence and ignite the pilot.

NOTE: Initially it may be necessary to repeat step 4 two or three times to purge air out of the gas pipework.

5. Trim pilot with adjustable gas cock to obtain pressure drops of:

- 1.5" to 2.0" w.c. (3.7 to 4.9 mbar) for natural gas
- 0.6" to 0.9" w.c. (1.5 to 2.5 mbar) for propane and butane

Refer to the burner datasheets for pilot input capacities. Pressure drop is differential between pilot lance inlet and chamber.

NOTE: The pilot flame should be a bushy, blue flame with curls around the main gas/oil lance nozzle. This flame should provide a stable pilot with good flame signal readings sufficient to energize the main gas valve.

6. If necessary, adjust the position of the UV scanner to ensure good pilot flame detection.

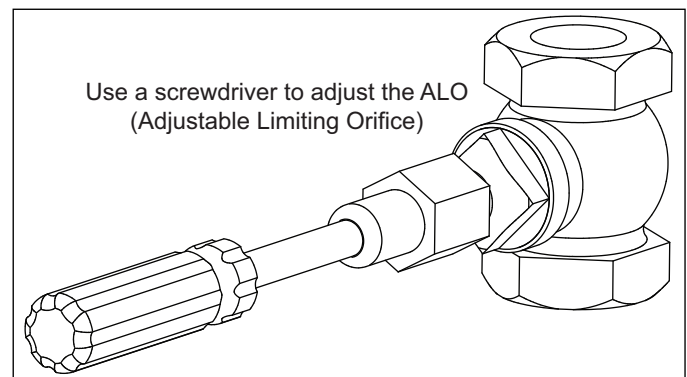


Figure 4.1. Typical ALO Valve Adjustment

Step 5: Ignite the Burner

NOTE: This procedure assumes that automatic flame safety is installed and is serviceable.

For Gas Burners

1. Make sure the combustion air fan is running.
2. Adjust the main gas regulator to supply the minimum pressure required; see the Vortometric datasheets for gas pressure drop information.
3. Verify that the main gas control valve is at its minimum open position.
4. Light the pilot.
5. Open all manual fuel shut-off valves.
6. Initiate the ignition sequence through the flame safety.
7. Check that the pilot and main burner flames have ignited.
8. Measure the gas pressure drop, taken between the burner pressure taps as indicated on the datasheets and a tap in the combustion chamber. The gas flame should be pale blue color set inside the refractory combustion block.

NOTE: Combination gas/oil burners may be operated on gas with the oil lance in place provided that the atomizing medium is left on at a minimum pressure of 5 to 10 psig (0.35 to 0.7 bar). When shutting down, leave the atomizing medium on until the block and combustion chamber are cool. Combination gas/oil burners may also be operated with the oil lance and oil lance gland removed; see Figure 3.2 for gland “A” identification and location. When doing so, a blanking plate must be substituted for gland “A” at the rear of the gas lance.

For Oil Burners

1. Make sure the combustion air fan is running.
2. Adjust the main oil regulator to supply the minimum pressure required; see datasheets for oil nozzle pressure drop information.
3. Turn on the atomizing medium and adjust atomizing pressure to approximately 20 to 30 psig (1.4 to 2.1 bar).

NOTE: If using heavy oil as the fuel with either steam or preheated air for atomization, warm up the oil feed pipe and fuel oil nozzle by running the atomizing medium through the burner bypass valve. Leave this bypass valve open for 5 to 10 minutes.

4. If steam is being used for atomization, allow sufficient time to drain the system of accumulated condensate and ensure steam traps are working.

5. Verify that the main oil control valve is at its minimum open position.
6. Light the pilot.
7. Open all manual fuel shut-off valves.
8. Initiate the ignition sequence through the flame safety.
9. Check that the pilot and main burner flames have ignited.
10. The oil flame should be a bright yellow color set inside the refractory combustion block.

Step 6: Adjust Low Fire

If necessary, adjust the main control valve’s minimum open position to obtain the desired low fire setting.

NOTE: The first time that the burner is started, allow the refractory combustion block to warm up slowly to reduce thermal shock. Refer to “Installing and Curing Refractory Block” on page 11 for details.

Step 7: Adjust High Fire

For Gas Burners

1. Drive the main gas control valve to high fire.
2. Measure the gas and air pressure drops at high fire and compare to the appropriate chart on the datasheets. If the maximum input is not achieved or is too high, an adjustment can be made to the main gas control valve or the main gas pressure regulator can be adjusted higher or lower.
3. The main gas flame should be slightly blue periphery and a somewhat yellowish center at high fire, refer to datasheets for flame length estimates.

For Oil Burners

1. Drive the main oil control valve to high fire.

NOTE: Oil control valves can be coarse during operation and it is very easy to over fire the system. Take care when initially setting the high fire position.

2. Measure the oil pressure drop at high fire and compare to the appropriate chart in the datasheets. If the maximum input is not achieved or is too high while the main oil control valve is fully open, an adjustment can be made to the main gas control valve or the main gas pressure regulator can be adjusted higher or lower.

- Note the atomizing air pressure. If modulating control is used, the atomizing pressure should be approximately 20 psig (1.4 bar) above the oil pressure without exceeding 50/55 psig (3.5 / 3.8 bar); refer to "Modulating Control" for further details.
- The high fire oil flame should be bright yellow; refer to datasheets for flame length estimates.

Step 8: Verify Settings

- Once the high and low fire conditions have been set, cycle the burner from high to low fire several times to check repeatability of settings.
- Shut down the burner and relight to ensure automated pilot and main flame ignition operates correctly.
- Check all safety interlocks and limits to ensure proper operation.

NOTE: Flame lengths are measured from the open end of the combustor. Flame lengths are estimates based on general operating conditions and are useful for design purposes. Actual flame lengths will depend on chamber size and presence of secondary air.

Start Procedure

- Start the air supply fan.
- Open all gas or oil cocks.
- Start the automatic ignition sequence.



- If a burner does not light, and the system does not shut down automatically, then you must close the main gas cock on the gas burner systems. An uncontrolled flow of gas can cause fires and explosions.**



- Do not touch the ignition plug or the ignition wire when the ignition is on. You will get a shock.**

- Make sure that you can see the flame in the burner. **If the burner does not light and the system does not shut down automatically**, close the main gas or oil cock manually. Do **not** operate the system. Go to "Checklist After Installation" section in the Installation section of this guide and verify the steps. Repeat the start sequence. **If the burner system does not light and the system shuts down automatically**, see the troubleshooting tables in the next chapter.

Stop Procedure

For Gas Burners

- Drive combustion air and gas valves to low fire position.
- Shut off main gas supply valves and pilot.
- Leave combustion air at low fire until combustion chamber and block are cooled to under 250°F (120°C); once cooled, shut off combustion air fan. Higher shutdown temperatures may be allowable depending on system design. Consult Eclipse for more information.
- Shut off all manual valves as required.

For Oil Burners

- Drive combustion air and fuel valves to low fire position; shut down the oil supply.
- Turn on the pilot.
- Purge the oil nozzle with the atomizing medium through the bypass connection valves.
- When the oil nozzle is clear of oil, turn off the pilot.
- Leave combustion air and atomizing medium on until the combustion chamber and block are cooled to under 250°F (120°C); once cooled, shut off the combustion air and atomizing medium supplies. Higher shutdown temperatures may be allowable depending on system design. Consult Eclipse for more information.
- Shut off all manual valves as required.

Maintenance & Troubleshooting

5

This section is divided into two parts. The first part describes the maintenance procedures, and the second part helps you to identify problems that may occur and gives advice on how to solve these problems.

Preventative maintenance is the key to a reliable, safe and efficient system. The following are suggested guidelines for periodic maintenance. Burners in severe environments or operational conditions should be checked more frequently.

NOTE: The monthly and yearly lists are an average interval. If your environment is dirty, then the intervals may be shorter. Check with local authorities having jurisdiction on their recommended maintenance schedules.



CAUTION

- Turn off power to burner and controls before proceeding with burner inspection.

Monthly Checklist

1. Inspect flame-sensing devices for good condition and cleanliness.
2. Test all alarms for proper signals.
3. Check ignition spark electrode operating and check proper gap: $3\text{mm} \pm 0.25\text{mm}$ ($0.13" \pm 0.01"$).
4. Check all valve motors and control valves for free, smooth action and adjustment.
5. Test interlock sequence of all safety equipment and manually make each interlock fail, noting that related equipment closes or stops as specified by the manufacturer. Test flame safeguard by manually shutting off gas to burner.
6. Test all manual fuel valves for operation.
7. Check filters on main air fan for cleanliness.
8. Check gas filter or strainers.

Yearly Checklist

1. Test (leak test) safety shut-off valves for tightness of closure.
2. Test pressure switch settings by checking switch movements against pressure settings.
3. Visually check ignition cable and connectors.
4. Check the refractory combustion block to ensure that it is not badly cracked or spalled. Minor hairline cracks are of no consequence and should be considered normal. Hairline cracks that radiate through the thickness of the refractory from the inner surface to the outer surface should be monitored closely and patched if the crack continues to deteriorate the refractory. Examine the refractory around the throat cone, since this area is where breakage can easily occur. If repairs are needed to this area, ensure that any new refractory is installed to the original contours and surface texture.
5. Remove the pilot assembly and examine the ceramic insulators on the spark rods. Clean the spark rod end with a fine emery cloth. Adjust the spark gap to $3\text{mm} \pm 0.25\text{mm}$ ($0.13" \pm 0.01"$).
6. Remove the gas lance assembly and clean the gas orifices. Use compressed air to blow all scale or dust out of the ports.
7. Remove the oil lance assembly, and clean the oil injection orifices and atomizing air nozzles according to the instructions that follow in this chapter.

Maintenance Procedures

Fuel Oil Tip Cleaning

Vortometric burner sizes 6V through 12V use a one piece oil nozzle which requires the disassembly of the entire atomizer to clean.

Vortometric burner sizes 14V and larger use an oil nozzle which is made in two pieces, which allows the outer end of the tip to be removed from the nozzle body. Therefore, the tip head containing the oil orifices can be removed for cleaning without dismantling the entire atomizer.

NOTE: On a burner with CLOCKWISE air rotation, the tip head has LEFT HAND threading. On a burner with COUNTERCLOCKWISE air rotation, the tip head has RIGHT HAND threading.

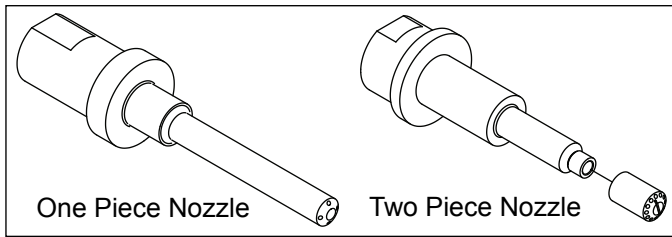


Figure 5.1. Oil Nozzles

When inspecting and cleaning the fuel oil tips, please observe the following:

- Votrometric oil nozzles are manufactured of stainless steel, with all surfaces manufactured to close tolerances and highly polished. Therefore, avoid marring the nozzle's machined surfaces in any way when the atomizer is dismantled.
- Never use abrasive cleanser or emery cloth on the internal surfaces of the nose cone. However, a wire brush may be used on the outside surfaces of the nose cone where carbon has accumulated.

If the oil tip holes become blocked, you cannot clear the blockage by forcing the atomizing medium through them. Instead, the tip must be removed and cleaned out. Care should be taken when dismantling and cleaning the oil tip to avoid burring or other damage. After removing the tip, the recommended cleaning procedure is as follows:

1. Soak the tip in a solvent such as Varsol™, especially if the atomizer has been used with heavy oil.
2. Blow out the tip with compressed air in the reverse direction to the oil flow.
3. Wash the tip again in solvent.
4. Select the correct drill size needed from Table 5.1. Use a new bit to avoid potential marring. Insert the drill bit by hand into each hole in the oil tip to clear any hard carbon or other residue.

NOTICE

- **Forcing an oversized drill bit into the oil tip holes will permanently damage the tip.**
5. Blow out the tip with compressed air in the reverse direction to the oil flow.
 6. Wash the tip again in solvent.

7. Before reassembling the oil tip in the atomizer assembly, clean out the oil feed pipe with either compressed air or solvent as necessary.

Table 5.1. Fuel Oil Tip Data

Burner Size	Number of Holes	Hole Dia. Inch (mm)	Drill Size (Diameter in mm)
6V	4	0.0400 (1.02)	60 (1.02)
8V	6	0.0400 (1.02)	60 (1.02)
10V	6	0.0469 (1.19)	3/64 (1.19)
12V	9	0.0430 (1.09)	57 (1.09)
14V	10	0.0469 (1.19)	3/64 (1.19)
16V	10	0.0550 (1.35)	54 (1.40)
18V	12	0.0595 (1.51)	53 (1.51)
22V	12	0.0670 (1.70)	51 (1.70)
24V	12	0.0730 (1.85)	49 (1.85)
28V	12	0.0860 (2.18)	44 (2.18)
32V	12	0.0980 (2.49)	40 (2.49)
36V	16	0.0980 (2.49)	40 (2.49)

Dismantling of Atomizer

NOTE: Refer to Figure 5.2 for oil nozzle component identification and location.

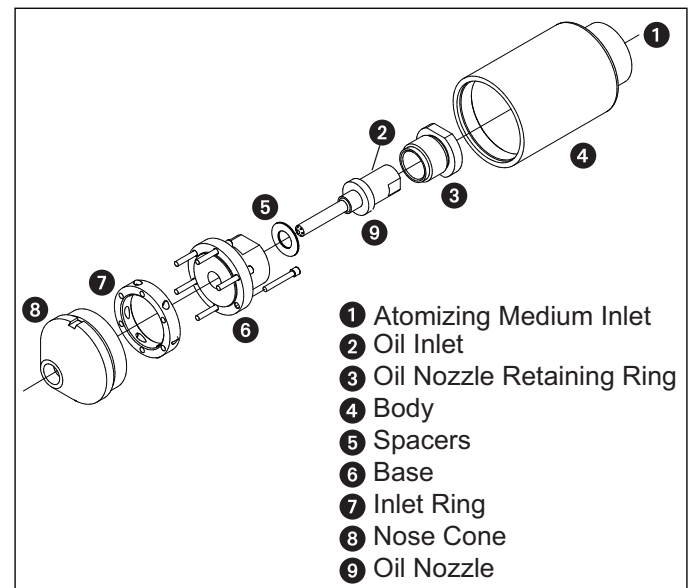


Figure 5.2. Atomizer Assembly Components

1. Remove the complete oil lance from the burner by removing the bolts on the rear flange of the lance assembly.
2. Place the oil lance in a pipe vise.
3. Loosen the bolts on the packing gland at the rear (outer) end of the oil lance.

4. Using a spanner wrench, loosen the nose cone assembly, which has a standard right hand thread.
5. After freeing the nose cone assembly from the threaded portion of the body, pull the nose cone forward enough to expose the base and tip retaining ring.
6. Using two adjustable wrenches, loosen the retaining ring from the base, then slide the retaining ring back on the fuel pipe to expose the wrench flats on the end of the oil tip.
7. Using an adjustable wrench on the flats of the oil tip, grasp the nose cone assembly and rotate it while pulling it forward. This action separates the nose cone inlet ring and base assembly from the tip. Be careful not to lose or damage the spacer washers.
8. Remove the oil tip by using a pipe wrench on the fuel oil feed pipe and an adjustable wrench on the oil tip flats.
9. Refer to the previous section, "Fuel Oil Tip Cleaning", for the proper oil tip cleaning procedure.
10. If it is necessary, dismantle the atomizer further, then remove the cap screws and carefully separate the nose cone, inlet ring and base.
11. Wash all parts with a solvent such as Varsol™. Wipe all parts clean of any foreign material.

NOTE: Due to the tight fit between the oil tip and base, no foreign material can be left on the tip's outside surface OR the base's inside surfaces. Foreign material such as grit can cause scoring of these surfaces and possible binding of the two surfaces. If necessary, a very fine emery cloth may be used to restore them.

12. Referring to Table 5.2, select the correct drill size to check the hole diameters of the venturi inlets in the tangential inlet ring. If the holes are worn beyond the corresponding maximum throat diameter number shown in Table 5.2, then replacing the venturi insert should be considered.
13. Examine the flat faces of the base and nose cone. Although slight "dimpling" of the surfaces adjacent to the inlet holes is normal, pitting and scoring is not. Clean these surfaces with solvent if they appear oily or sooty.
14. Clean any accumulated carbon from the internal bore of the nose cone, but do not scratch or mar these surfaces.

Assembly of Atomizer

1. With all of the parts clean of foreign material, apply anti-seize compound such as Bostik™ Never Seez-Pure Nickle Special or similiar lubricant on all mating surfaces and on all threads.
2. Slide the retainer ring onto the fuel pipe.
3. Screw the fuel pipe into the oil tip and tighten securely.
4. Assemble the base and inlet ring onto the nose cone using the provided cap screws. Tighten all cap screws securely and evenly. The tangential inlet ring can provide either clockwise or counterclockwise rotation to the steam. However, the steam's rotation direction (as viewed through the rear of the atomizer) **must** match the rotation direction of the air flow through the burner assembly's vanes.

Table 5.2. Atomizing Inlet Ring Data

Burner Size	Number of Inserts	Original Insert Thread Diameter Inches (mm)	Original Drill Size (Diameter in mm)	Maximum Worn Throat Diameter Inches (mm)	Maximum Worn Drill Size (Diameter in mm)
6V	6	0.0760 (1.93)	48 (1.93)	0.0820 (2.08)	45 (2.08)
8V	6	0.0995 (2.53)	39 (2.53)	0.1093 (2.78)	7/64 (2.78)
10V	6	0.1250 (3.18)	1/8 (3.18)	0.1360 (3.45)	29 (3.45)
12V	6	0.1440 (3.66)	27 (3.66)	0.1570 (3.99)	22 (3.99)
14V	6	0.1695 (4.31)	18 (4.31)	0.1875 (4.76)	3/16 (4.76)
16V	6	0.1935 (4.92)	10 (4.92)	0.2130 (5.41)	3 (5.41)
18V	6	0.2130 (5.41)	3 (5.41)	0.2340 (5.94)	A (5.94)
22V	10	0.1960 (4.99)	9 (4.98)	0.2130 (5.41)	3 (5.41)
24V	10	0.2090 (5.31)	4 (5.31)	0.2280 (5.79)	1 (5.79)
28V	10	0.2420 (6.15)	C (6.15)	0.2656 (6.75)	17/64 (6.75)
32V	10	0.2720 (6.91)	I (6.91)	0.2968 (7.54)	19/64 (7.54)
36V	10	0.3020 (7.67)	N (7.67)	0.3320 (8.43)	Q (8.43)

5. Install a new oil tip spacer, standard size of 0.030" (0.75mm) on the oil tip and insert the tip into the atomizer base. Step 7 details what size of spacers should be used to properly locate the oil tip.
6. Tighten the retainer ring securely, using the wrench flats on the ring and on the base.
7. Check the relationship of the oil holes to the nose cone by inserting the specified drill from Table 5.1 into the oil holes as shown in Figure 5.3. The drill's sides should just touch the nose cone's lip. If you have trouble inserting the drill into the oil holes, there are two probable causes:
 - If the drill cannot be inserted easily, then the oil tip is too far back in the nose cone, a thinner spacer is needed so the oil tip can come further forward, or
 - If there is an obvious space between the drill and the nose cone lip, then the oil tip is too far forward; more spacers are needed to move the tip further back.
8. Once the oil tip is correctly located, loosen the packing gland at the outer end of the atomizing steam pipe. Insert the entire atomizer assembly, including the fuel pipe, into the body and atomizing steam pipe.
9. Screw the nose cone assembly into the body threads, being careful not to get it cross-threaded. Tighten the assembly securely with a spanner wrench.
10. Tighten the packing gland at the outer end of the atomizing steam pipe. A final check on the location of the oil holes in relation to the nose cone lip can be done. Connect the oil feed line to a water supply line and spray water out of the nozzle at 5 psig (0.35 bar). If properly located, then the water streams emerging out of the oil holes should be separate, distinct and uniform; the water streams should also clear the inside lip of the nose cone or just barely touch the lip's edge.
11. Reinstall the oil lance into the burner and connect all hoses securely.

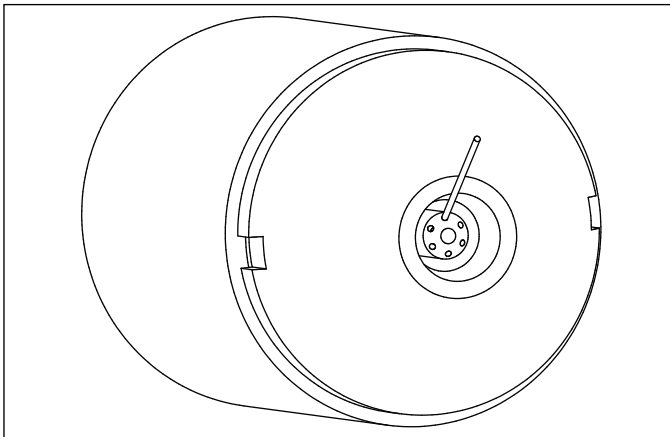


Figure 5.3. Oil Tip Position Adjustment

Each atomizer assembly is provided with three spacers of nominal thickness from 0.010" to 0.030" (0.25mm to 0.75mm); the 0.030" (0.75mm) spacer is the one generally used on the assembly. Depending on your situation, any one or combination of these spacers may be necessary to correctly locate the oil jets.

Recommended Spare Parts

To make sure that the downtime of the system is as short as possible in case of a failure, you should keep a stock of spare parts.

Please refer to the Eclipse Product Information Center (EPIC) for a full listing of spare parts:
<http://www.eclipsenet.com/products>

Troubleshooting

Problem	Possible Cause	Solution
Cannot initiate startup sequence	Air pressure switch has not made contact; air flow is too low	Check air flow and investigate any changes
	Air pressure switch has not made contact; air pressure switch incorrectly set	Check air pressure switch adjustment
	Air pressure switch has not made contact; air pressure drop measured incorrectly	Move pressure taps on chamber to a better location (see Design Guide)
	High gas pressure switch has tripped; gas pressure too high	Check incoming gas pressure against initial settings; adjust as required
	High gas pressure switch has tripped; gas pressure switch set too low	Adjust setting to be approximately 4" w.c. (9.8 mbar) above gas pressure
	Low gas pressure switch has tripped; gas pressure too low	Check incoming gas pressure against initial settings; adjust as required
	Low gas pressure switch has tripped; gas pressure switch set too high	Adjust setting to be approximately 4" w.c. (9.8 mbar) below gas pressure.
	Purge cycle not completed	Check flame safeguard system or purge timer
	Main power is off	Make sure power is on to control system
	No power to control unit	Call qualified electrician to investigate
	Malfunction of flame safeguard system; flame sensor shorted out	Check UV sensor and wiring
	Malfunction of flame safeguard system; Electrical noise in sensor line	Shield or separate sensor lines from high voltage
	Malfunction of flame safeguard system; unit is broken	Call qualified electrician to investigate
Startup sequence runs but pilot does not light	Spark rod is not igniting gas stream	Check spark rod position, should be 1.0" (25.4mm) from end of cup
	No spark; no power to ignition transformer	Have electrician investigate
	No spark; open circuit between the ignition transformer and the spark rod	Repair or replace wiring to spark rod
	No spark; spark rod has carbon build-up	Clean or replace spark rod
	No spark; spark rod not correctly grounded	Clean spark rod threads. Do not apply grease or pipe compound to pipe threads
	No spark; spark rod gap is incorrect	Set gap to 3mm ± 0.25mm (0.13" ± 0.01")
	No spark; spark is shorting inside pilot pipe	Remove spark rod and clean inside of pipe
	No spark; spark rod ceramic has fractured and the spark is shorting inside itself	Replace spark rod
	Not enough pilot gas; pilot gas regulator set too low	Check incoming gas pressure against initial settings; increase as necessary
	Not enough pilot gas; gas pressure into pilot regulator too low	Check outgoing gas pressure of main regulator; increase as necessary
	Not enough pilot gas; pilot gas cock closed	Open pilot gas cock
	Not enough pilot gas; pilot solenoid valve does not open	Have a qualified electrician check power supply to solenoid
	Not enough pilot gas; pilot adjusting valve set too low	Adjust gas flows to give pressures/flows indicated in the datasheets
	Not enough pilot gas; air in the gas line	Repeat start-up several times to purge air out of gas lines
	Too much gas	Trim pilot gas adjusting valve to give pressures/flows indicated in the datasheets

Problem	Possible Cause	Solution
Start-up sequence runs, pilot lights but main burner does not light	No UV signal	Check wiring and control logic
	Not enough main fuel; main fuel regulator set too low	Check outgoing fuel pressure of main regulator; increase as necessary
	Not enough main fuel; fuel pressure into main regulator too low	Check incoming fuel pressure against initial settings; increase as necessary
	Not enough main fuel; main fuel cock closed	Open all fuel cocks
	Not enough main fuel; main safety shut-off valve does not open	Have qualified electrician check power supply and safety circuitry
	Not enough main fuel; main fuel control valve set too low	Adjust fuel flows to give pressures indicated in datasheet
	Not enough main fuel; air in the gas line	Repeat start-up several times to purge air out of gas lines
	Not enough main fuel; no fuel oil to nozzle	Repeat start-up several times to fill oil lines and nozzle, reduce piping length if necessary
	Not enough main fuel; too much gas	Trim control valve to give pressure indicated in the datasheets
Pilot ignites but flame safeguard shuts down burner	No UV signal	Check wiring and control logic; adjust position of UV sensor with swivel mount
Burner kicks out shortly after startup	Low main fuel pressure switch is set too high	Check and reset low pressure switch setting
The low fire flame is weak and unstable	Not enough fuel	Check start-up settings and adjust to increase fuel flow
	Too much air	Check combustion air pressure drops/flow across the burner and adjust
Burner does not go to high fire	Not enough fuel pressure into main fuel regulator	Adjust pressure regulator so pressure is provided at burner as specified in this manual.
	Fuel pressure drops as input is increased	Check for clogging of valves and regulators in fuel line
	Main fuel control valve is not functioning	Check actuator and linkage
Main flame is uneven and not centered in the refractory block	Incorrectly positioned gas/oil lance	Ensure gas/oil lance is centered within the throat cone
Main flame pulsates or is unstable	Unstable air flow	Check blower/air system for pressure pulsations
	Unstable fuel flow	Check pressure regulator and control valve for pulsations
	Pilot lance inserted too far	Pull back pilot lance
Main flame is too large at high fire	Fuel pressure too high at burner inlet	Check fuel pressure against design. Adjust main fuel pressure regulator, or adjust control valve
	Combustion air pressure drop/flow is too low	Open air damper on main air blower
Main flame does not achieve capacity	Combustion air pressure drop/flow is too high	Check pressure drop or flow, check air damper on main air blower
	Burner is firing below rated input	Check fuel pressure differential/flow, adjust main fuel pressure regulator as necessary
	Burner gas holes/oil ports are plugged	Inspect holes/ports for blockage, clean as needed

Problem	Possible Cause	Solution
Main flame is yellow or long (in gas applications) or a dull orange color (in oil applications)	Air pressure drop/flow is lower than required	Check pressure drop or flow, open air damper on main air blower
	Windbox air flow is restricted	Inspect windbox and blower to ensure that no foreign material is restricting the air flow
Main oil flame is white and hard	Too much air	Check combustion air pressure drop/flow, close control damper as necessary
Uneven oil flame with stingers shooting out to one side of the block	Orifices in the oil tip are plugged	Remove oil nozzle and clean as necessary
Orange or red "sparks" in the oil flame	The oil is too cold	Check oil heating system; increase temperature as necessary
	The atomizing medium pressure is too low	Check existing atomizing pressure versus required (see table in appendix)
Flame temporarily becomes black and smoky then clears up again or flame sputters and goes out momentarily	Moisture (condensate) in the atomizing medium	Ensure that the condensate trap is operating properly for atomizing steam
		Install dryers in the atomizing air line
Fiery ring of burning oil on the inside diameter of the combustor surface or carbon deposits on the inside of the refractory block	Poor atomization	Check atomizing pressure and adjust as necessary
		Check oil nozzle ports for clogging
Carbon accumulation on the oil nozzle cone	Oil nozzle is too far forward into the throat	Move lance back 1/4" (6.4mm) at a time until carbon no longer accumulates



Appendix

Conversion Factors

Metric to English

From	To	Multiply By
actual cubic meter/h (am ³ /h)	actual cubic foot/h (acfh)	35.31
normal cubic meter/h (Nm ³ /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 ⁻³
millimeter (mm)	inch (in)	3.94 x 10 ⁻²
MJ/Nm ³	Btu/ft ³ (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

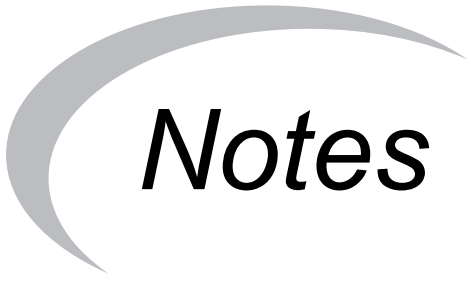
English to Metric

From	To	Multiply By
actual cubic foot/h (acfh)	actual cubic meter/h (am ³ /h)	2.832 x 10 ⁻²
standard cubic foot /h (scfh)	normal cubic meter/h (Nm ³ /h)	2.629 x 10 ⁻²
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 ⁻³
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 ³ (standard)	MJ/Nm ³	37.2 x 10 ⁻³

System Summary

Write down the settings for the burner system in the table that follows.

General System Parameters	Burner Settings	
	High Fire	Low Fire
Customer:	Main gas pressure:	Main gas pressure:
Customer PO:	Air pressure from the blower:	Air pressure from the blower:
Customer Signature:	Air pressure drop across the burner:	Air pressure drop across the burner:
Date:	Gas pressure drop across the burner:	Gas pressure drop across the burner:
Furnace Type:	Main oil pressure:	Main oil pressure:
Furnace Temperature:	Oil pressure across the burner:	Oil pressure across the burner:
Number of Burners:	Atomizing pressure:	Atomizing pressure:
High Fire Input Per Burner:	Atomizing pressure drop across the burner:	Atomizing pressure drop across the burner:
Orifice Sizes:	Flame signal strength:	Flame signal strength:
Operating Voltage & Frequency:	Flame length:	Flame length:
Altitude:		



Notes

