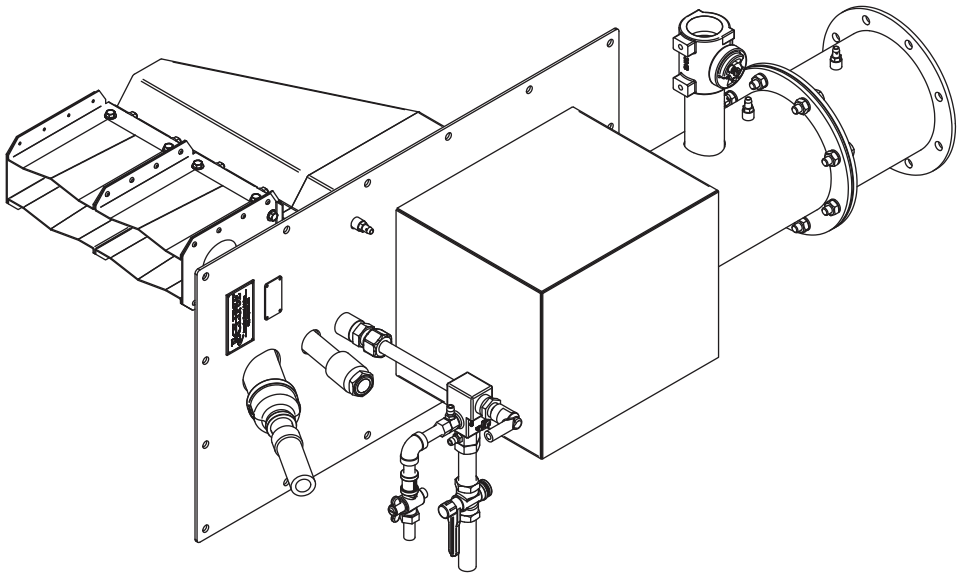
Installation Guide 159
4/12/2013

Eclipse Linnox

Burners

Model ULE

Version 1



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Innovative Thermal Solutions

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Document Conventions

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

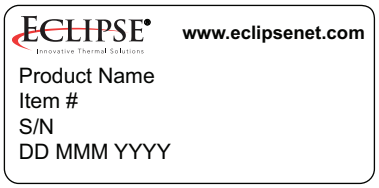
The explanation of these symbols follows below. Please read it thoroughly.

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 injurt 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.

Table of Contents

Introduction 1

Product Description

The Linnox is a line model burner designed for applications where a maximum linear heat distribution is required.

The Linnox burner is a pre-mix type burner, especially designed for direct-air heating applications where the lowest achievable NO_x 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_x and CO emissions at a high turndown rate while maintaining extremely stable combustion.

This burner can be easily configured for many different capacities by choosing from a wide range of burner modules each 300 mm in length.

The Linnox is designed to provide:

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

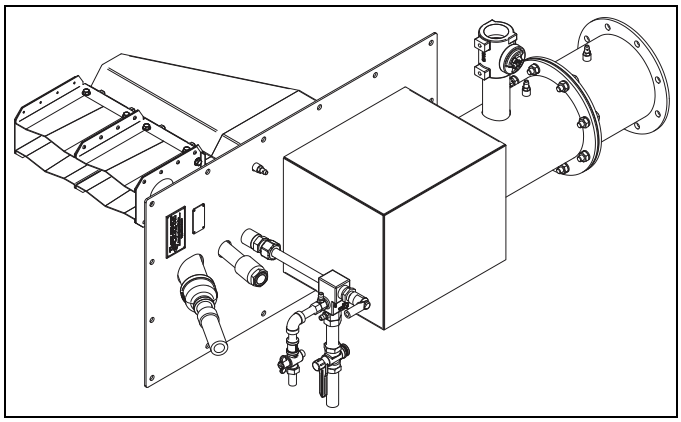


Figure 1.1. Standard Linnox Burner

Audience

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

These aspects include:

- Installation
- 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 a safe, effective and trouble-free installation.

Linnox Documents

Design Guide No. 159

- Used with Datasheet Series 159 to design the burner system

Datasheet No. 159

- Available for individual Linnox models
- Required to complete design and selection

Installation Guide No. 159

- This document

Worksheet No. 159

- Required to provide application information to Eclipse Engineering

Spare Parts List Series 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

2

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.

Installation 3

Introduction

This section provides guidance for correct installation of Eclipse Linnox burners.

NOTE: Information in Datasheet Series 159 may be necessary to complete some of the installation procedures.

⚠ WARNING

- **Only qualified, competent personnel with combustion system experience are allowed to install, adjust and maintain the burner.**
- **All installation work must be carried out in compliance with current legislated standards.**

Handling

- Inspect the burner package ensuring that all components are clean and free of damage.
- Use the appropriate support equipment when lifting the burner components.
- Protect the components from the weather, damage, dirt and moisture.
- Protect the components from excessive temperatures and humidity.

Storage

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

Position of Components

The position and amount of components are determined by three factors: burner design, system design and chosen control method. All three factors are considered in “System Design” chapter of the Linnox Design Guide 159. Use the information in that chapter 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 electrical wiring must comply with all applicable local codes and/or standards such as:

- NFPA Standard 70
- IEC60364
- CSA C22
- BS7671

Gas Piping

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

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

The gas piping must be accepted by local authorities.

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

Air Supply

To admit fresh combustion air from outdoors, provide an opening in the room of at least one square inch per 4,000 Btu/h (6 cm^2 per 1 kW). If there are corrosive fumes or materials in the air, supply the burner with clean air from an uncontaminated area, and always provide a sufficient air filtering system.

Exhaust

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

Access

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

Environment

Make sure the burner operating 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
- Adequate oxygen concentration for combustion on the process gases
- Humidity, altitude and temperature of the air
- Presence of damaging corrosive gases in the air
- Prevent direct exposure to water

General Installation Conditions

Mechanical

Connect the burner feedings with the corresponding manifold using steel piping, or copper in special cases. Weld in accordance with both the country's regulation where the equipment will be installed, and user specific standards as applicable.

Check the following before installing the burner:

- Remove all dirt (dust and other particles) and avoid further soiling during piping and accessory installation.
- Check that there are no obstructions in the burner duct or in the feed piping connections.

Electrical

Install the high-voltage transformer (as applicable) as close to the burner as possible.

Burner Mounting

Because Linnox burners are tailor made for your application, please refer to the attached assembly drawing for information of mounting plate dimensions and insulation thickness.

The burner mounting plate is provided with:

- Peep sight for flame observation
- Pressure tap for measuring process pressure
- Pipe nipple to mount UV scanner
- With or without insulation box (refer to assembly drawing)
- With or without gasket between mounting plate and installation (refer to assembly drawing)

⚠ CAUTION

- **The burner flame shields can reach a temperature of 1650˚F (900˚C) at 480˚F (250˚C) process temperature upstream from the burner. Measurements should be taken to prevent excessive thermal load on the process ducting.**

Gas Piping

The burner should not be used as a support for the incoming gas supply pipe work. Suitable brackets or hangers should be provided for this purpose. Care should be taken to ensure that the incoming gas pipe is adequately sized for the necessary gas flow and burner pressure (See appropriate datasheet for gas pressure requirements).

⚠ WARNING

- **Gas inlet pressures must stay within the specified range. Pressure above the specificed range can damage the ratio regulator.**
- **Pressure below the specified range can impair the ability of the ratio regulator to control the gas flow.**

Electrical Supply

The burner should be controlled via a sequence programmer, approved according the local standards. For connections please refer to the related wiring diagrams.

NOTICE

- **Wiring to the burner must be in accordance with current wiring standards. It is vital that the live and neutral wires are connected correctly as reversal could present a hazard. Also the grounding must be checked to ensure a good connection. (Wiring diagrams are provided with this guide.)**

- **GAS PIPEWORK MUST NOT BE USED FOR GROUNDING PURPOSES.**

- **If burner control signals are supplied via a flame safeguard control panel provided by others, Eclipse Combustion can not accept any responsibility for incorrect interfacing.**

Checklist After Installation

To verify proper system installation, do the following:

1. Make sure there are no leaks in the fuel lines or the air lines.

2. Make sure all the components of the control system are properly installed. This includes verifying that the wiring is properly connected.

3. Make sure all interlocks are working properly.

4. Make sure required air and gas pressures are available. Verify that the blower rotates in the correct direction. If incorrect, have a qualified electrician rewire the blower to reverse its rotation.

5. At systems with high negative or positive process pressures, take care that pressure switches and pressure regulators (purge air) are cross connected to the processs pressure.

6. Make sure all safety components are installed and working properly.

7. 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

Adjustment, Start & Stop 4

Introduction

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

⚠ DANGER

- **The burners covered by this guide are designed to burn a mixture of gas and air. All gas burning devices are capable of producing fires and explosions if improperly applied, installed, adjusted, controlled or maintained.**
- **Do not bypass any safety feature.**
- **Obey the safety precautions in the "Safety" chapter of this document, and read this chapter thoroughly before starting your system.**
- **Never try to light a burner if it shows signs of damage or malfunction.**

NOTE: Adjustment requires two guides: Installation Guide 159 and Datasheet 159. This chapter refers to the component information explained in Design Guide 159.

Putting into Operation

Preliminary Installation Checks

- Check that the main manual gas valve is closed and then open it.
- Check that the control board temperature parameters are correct.
- Check that the gas pressure is correctly regulated.
- Check that the main control panel switch is ON.
- Check that all air supply blowers are operating correctly.
- Confirm that burner and system interlocks are in working order.
- Reset the group control cabinet (general safeties) if necessary. General safety solenoid valve opening will take place.

NOTE: Eclipse authorized personnel should perform the initial start of all Eclipse burners.

Adjustment Procedure

Follow these steps to adjust the Linnox system for the first time:

1. Preparation
2. Dry run
3. Startup and low-fire adjustment
4. Operation Inspections

Step 1: Preparation

1. Ensure all installation work has been completed in compliance with current legislation standards.
2. Ensure all gas supply pipework has been purged of air in compliance with current legislation standards.
3. Ensure all required services are available.
4. Ensure all pre-checks have been completed in compliance with current legislation standards.
5. Ensure a digital or "U"-tube manometer for pressure measurement is available.
6. Check the setting of the maximum gas pressure switch and the minimum air pressure switch. The maximum gas pressure switch should be adjusted 20% higher than the maximum gas pressure required at the burner. The minimum air pressure switch should be adjusted to approximately 20% of the maximum air pressure.

The air pressure depends on the selected combustion air blower. Please refer to the related project documentation.

Step 2: Dry Run

1. Ensure that the process air blower is running.
2. Ensure that the manual isolating ball valve is closed.

3. Initiate the electrical supply to start the operating sequence. The combustion air blower will start running. If the sequence is operating correctly, the system will run through to the point of ignition, the safety shut-off valves will open and, in absence of a flame, the system will proceed to a lockout condition.

⚠ DANGER

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

Step 3: Combustion Air Check

NOTE: On multiple burner systems with a central combustion air blower, one should remember that the combustion air pressure will change depending on the total air demand. If one burner is adjusted, it is advised to set the combustion air of all other burners to at least 50% of the maximum capacity if the burners are not in operation. This will prevent flame failures or inability to reach the high-fire capacity when the installation is switched to normal operation.

NOTE: Start all process air blowers that affect chamber pressure.

Low-Fire Air Adjustment Procedure:

1. Start the combustion air blower.

2. Drive control motor to low-fire position (activate the manual switch or lock first).

3. Measure air differential pressure.

4. Adjust low-fire air if necessary.

NOTE: The slot at the end of the BV (air damper) shaft indicates the position of the BV. The BV is closed when the shaft slot is perpendicular to the direction of air flow through the BV. For adjustment of the BV, adjust the lever mechanism.

5. Verify ignition position

   a. Drive control motor to ignition position, 30% open.

   b. Adjust air pressure if necessary.

6. Verify high-fire air

   a. Drive control motor to high fire, fully open.

   b. If high-fire air is insufficient, refer to Section 7, "Troubleshooting" section of this document.

7. Return the control motor to low-fire position.

8. Close the pressure taps

Start Procedure

Step 4: StartUp Procedure

1. Check the pre-setting of the adjustment valves.

2. Switch the control motor to "automatic".

3. Open the manual isolating ball valve.

4. Initiate the burner management system to start the operating sequence. The control motor will be driven to the start position after which the ignition will take place.

The pilot flame should appear approximately 2-4 inches (5-10 cm) beyond the flame shields in a mixed blue and yellow color. If the flame is too weak or too big, adjust the support flame with the adjusting valve. Support flame appearance also depends on the start position of the combustion air valve.

After the trial for ignition period determined by local regulations, the second shut-off valve will open, and the main flame will ignite. A clear blue line flame will appear at the burner base. The appearance will vary for the different capacity ratings of the burner elements.

If the burner does not light the first time, it will be necessary to reset the sequence and follow this procedure again

5. If the burner did not ignite:

   a. Verify that air has been purged from the gas piping.

   b. If the support flame does not appear, open the adjusting valve one turn.

   c. If the flame appears at ignition, but the main burner does not light, turn the bias adjusting screw of the gas ratio regulator one turn clockwise to increase gas flow and try to ignite the burner again.

   d. Repeat steps b and c until burner ignites. If the burner does not ignite, follow guidelines in Section 7 "Troubleshooting" section of this document.

Low-Fire Settings

6. Set system control to stay at low fire during and after ignition sequence, or set control motor to manual.

7. Adjust ratio regulator bias adjustment for lowest gas flow that maintains a stable flame signal:
   - clockwise for more fuel
   - counterclockwise for less fuel

Ensure that the lowest flame signals are stable.

At low fire the gas diffential pressure across the mixer will be too low, approximately 0.08 ”w.c. (0.2 mbar), for a reliable reading.

Eventually, the static gas pressure at the mixer can be used as a pre-setting for the burner.

NOTE: A visual check of the flame is important to ensure the correct burner adjustment.

NOTE: If the recirculating process air is cold, < 212°F (100°C), the burner elements will not glow or will partially glow.

NOTE: If the recirculating process air is hot, > 390°F (200°C), the burner elements will glow.

NOTE: The visual appearance of the low-fire flame should be clear blue with some of the burner elements glowing.

Figure 4.1. Low Fire Flame Appearance

When operating at high fire, if the flame becomes too rich, carefully close the manual gas adjustment valve until the flame starts blowing off. Open the valve again to pull the flame back in. The flame should look like the center image in Figure 4.2. The flame shields may be slightly red and the flame may extend beyond these shields.

High-Fire Settings

8. Set the burner to high fire:

   a. Check the differential air pressure

   b. Adjust the corresponding gas pressure with the adjustment valve.

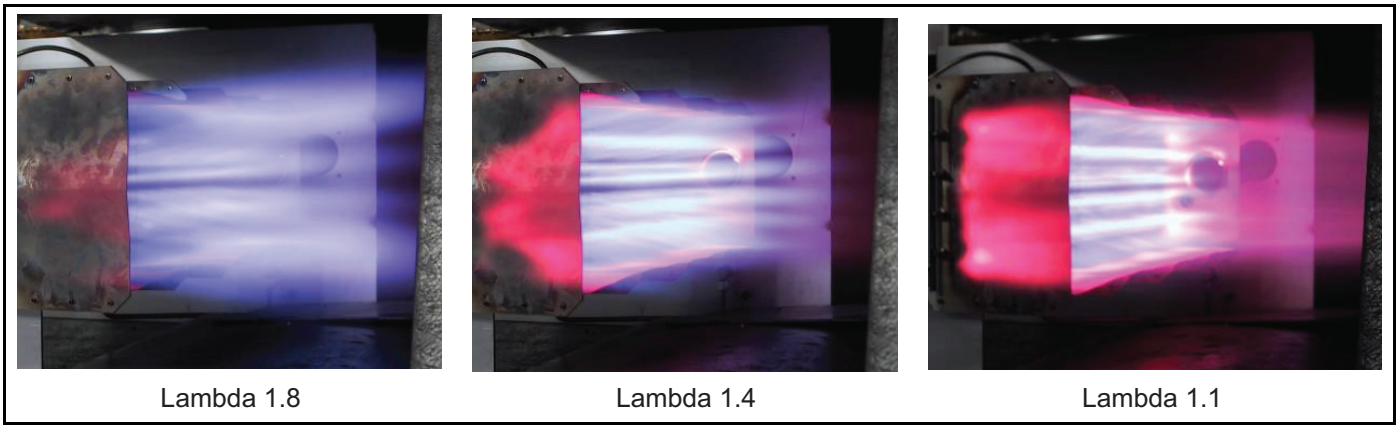
Fasten the lock screw at the adjustment valve after finishing adjustment.

NOTE: A visual check of the flame is important to ensure the correct burner adjustment. The flame will be sharp blue-white with a slightly orange glowing tip. The length of this tip depends on the burner capacity rating.

NOTE: If the flame tip is dominantly orange, the burner may be set too gas rich. Refer to the “Troubleshooting” section of this document.

NOTE: The burner flame shields are allowed to glow red hot depending on the burner capacity rating and the process temperatures.

9. If the setting of adjustment valve has been changed, repeat Steps 6 and 7 to check and readjust the low-fire setting.



Lambda 1.8 | Lambda 1.4 | Lambda 1.1

Figure 4.2. High Fire Flame Appearance

A flame that is too lean (Lambda > 1.4) will produce too much CO and have a fluctuating flame signal. A rich flame (Lambda < 1.4) will create too much NOx and burner parts will overheat

⚠ CAUTION

- **Adjusting the burner too gas rich will shorten the lifetime of the burner elements and flame shields. Therefore, have a qualified Eclipse engineer adjust and regularly check the burner settings.**

Step 5: Operation Inspections

1. Simulate a flame-out condition by closing the manual inlet ball valve. Run the ignition cycle again.

2. Check high gas pressure switch for correct operation by reducing the set point until it trips. The burner must be at high fire. Reset to the original setting and run the ignition cycle again.

3. Check the combustion air pressure switch for correct operation by increasing the set point until it trips. Reset to the original setting and run the ignition cycle again.

4. Measure and record the gas and air differential pressure and flame signal at low and high fire for future reference.

⚠ DANGER

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

⚠ CAUTION

- **Do not turn the combustion air blower off until the chamber temperature is below 250°F (120°C). This will prevent hot gases from flowing back through the burner, which would cause damage to the burner.**

Stop Procedure

1. Shut off main gas supply valves and pilot.

2. Drive combustion air valves to high-fire position.

3. Leave combustion air at high 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.

4. Shut down all manual valves as required.

Maintenance & Troubleshooting

5

Introduction

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

Maintenance

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, the intervals may be shorter. Check with the local authorities that have jurisdiction over recommended maintenance schedules.

⚠ CAUTION

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

One Month after Startup

1. Check and compare burner adjustments with the original recorded settings. Correct the settings if they are outside the specified tolerance range.
2. Check and clean or replace the gas filter if necessary.
3. Check all gas piping and connections for leakage. Leaks must be cured immediately.
4. Check tightness of all bolted/screwed joints.
5. Check burner and mixer unit for leakage, damage or deterioration. Those parts in contact with the process environment, must be inspected thoroughly.
6. Check the flame shields, burner elements and all joints for wear and damage.
7. Check if the burner element fixing nuts are tight.
8. Check the burner surroundings for signs of excessive corrosion or deformation due to thermal overload. Repair or replace insulation or thermal protection shields if necessary.

Every Three Months

1. Visually check all components for damage.
2. Check manual shut-off valve for correct operation.
3. Visually check all cables and connectors for damage and tightness.

Every Six Months

1. Check burner and mixer unit for leakage, damage or deterioration. Those parts in contact with the process environment must be inspected thoroughly.
2. Check the flame shields, burner elements and all joints for wear and damage.
3. Check if the burner element fixing nuts are tight.
4. Check and clean or replace the igniter.
5. Check the flame quality, verifying both visually and via the air-fuel ratio that the flame is neither too lean or too rich.

It is important that the flame at low fire is stable and doesn't blow off, which happens when the mixture is too lean (has too much excess air).

If the mixture is too rich (not enough excess air), the parts in the burner modules will begin to glow immediately and possibly overheat. Simultaneously, the NOx emissions will increase. An incorrectly tuned flame will also result in a low flame signal and could create a flame failure.

Yearly Checklist

1. Check and compare burner adjustments with the original recorded settings. Correct the settings if they are outside the specified tolerance range.
2. Check for correct operation.
3. Check and clean or replace the gas filter if necessary.
4. Leak test shut-off valves.

5. Check all gas piping and connections for leakage. Leaks must be cured immediately.

6. Check tightness of all bolted/screwed joints.

7. Check the interlocks by simulating fault conditions. Resolve all flame safety problems before restarting the burner.

8. Check the direct burner surroundings for signs of excessive corrosion or deformation due to thermal overload. Repair or replace insulation or thermal protection shields if necessary.

As per Supplier's Instructions

1. Replace the UV sensor within the time frame as specified by the supplier.

Depending on the Circumstances

1. Check and clean or replace the combustion air filter if necessary.

2. Clean the burner. Flame shields must not be covered with dust or dirt.

Troubleshooting

Troubleshooting of electrical circuits should be done by qualified plant electricians, technicians or engineers experienced in all facets of this type of combustion equipment

Problem	Possible Cause	Solution
Cannot initiate startup sequence	Air pressure switch has not made contact	Check air pressure switch adjustment. Check air filter. Check blower rotation from blower
	External interlock failure	Check all external interlocks
	High gas pressure switch has activated	Check pressure switch settings
	Malfunction of the burner programmer	Have a qualified electrician troubleshoot and correct the problem
	No power supply to the burner programmer	
Burner sequence starts but locks out before ignition	Combustion air fault:	
	Blower failure	Check blower and remedy the fault
	Blocked blower inlet or filter	Clean inlet. Clean or replace filter.
	Pressure switch failure	Check pressure switch and replace if necessary
	3-way solenoid valve failure	Check solenoid valve. Replace coil if necessary
Startup sequence runs but burner does not light	No ignition: No power to the ignition transformer	Restore power to the ignition transformer
	No ignition: Open circuit between the ignition transformer and the ignition electrode	Repair or replace wiring to the ignition electrode
	No ignition: Ignition electrode needs cleaning	Clean the ignition electrode
	No ignition: The ignition electrode is not properly grounded to the burner	Clean the threads on the ignition electrode and burner.
	No ignition: Ignition electrode insulator is broken	Inspect the ignition electrode and replace if broken
Startup sequence runs but burner does not light (Continued)	Not enough gas: The support gas valve is not opening	Check wiring to the support gas valve. Check the output from the burner programmer
	Not enough gas: The support gas flow is adjusted too low	Open adjusting valve one turn.

Problem	Possible Cause	Solution
Support flame appears, but main burner does not ignite	Not enough gas: Second shut-off valve not opening	Check wiring to the second shut-off valve. Check output from the burner programmer. Open manual ball valve. Replace coil if necessary.
	Not enough gas: MultiBloc low-fire setting too low or too high	Adjust ratio controller bias
	Not enough gas: High-fire adjusting valve closed	Open adjusting valve to correct pre-setting
Burner lights and then goes to lock-out	No flame signal: Broken flame rod	Measure flame signal
	No flame signal: Dirty UV scanner lens	Inspect and clean sensor
	No flame signal: Ignition electrode and flame rod connections reversed	Exchange ignition electrode/flame rod wiring
The high-fire flame is orange or yellow. Burner parts are excessively hot	Gas/air ratio out of adjustment: Gas mixer nozzle blocked	Clean nozzle
	Gas/air ratio out of adjustment: Blocked loading line	Check/clean loading line
	Gas/air ratio out of adjustment: Air mixing plate blocked	Clean gas/air mixer
	Gas pressure too high: High-fire adjusting valve too far open	Check burner data for correct pressures
	Gas pressure too high: Gas ratio regulator failure	Replace gas ratio regulator
The low-fire flame is orange or yellow. Burner elements are glowing	Too much gas	Adjust ratio regulator
The low-fire flame is weak and unstable. Flame signals are low	Insufficient gas flow to the burner	Adjust the low-fire setting on the ratio regulator
	Not enough air	Adjust combustion air valve. Clean or replace filter. Check blower rotation
High-fire flame is weak and blue, flame signals are low	Insufficient gas flow to the burner	Check burner gas adjustment and readjust. Gas nozzle blocked
Burner does not reach its specified capacity	Not enough air: Air butterfly valve does not open	Check air control motor limit settings
	Not enough air: Blower is running in reverse	Check and correct blower wiring
	Not enough air: Inlet or filter blocked	Clean inlet or filter. Replace filter if necessary
	Not enough air: Burner elements blocked	Clean burner elements
	Not enough gas (air is ok): Gas pressure into the ratio regulator is too low	Check for sufficient gas pressure
Flame has irregular pattern showing holes	Burner elements blocked	Clean burner elements

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)	14.5×10^{-3}
millimeter (mm)	inch (in)	3.94×10^{-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)	2.832×10^{-2}
standard cubic foot /h (scfh)	normal cubic meter/h (Nm^3/h)	2.629×10^{-2}
degrees Fahrenheit (°F)	degrees Celsius (°C)	(°F - 32) x 5/9
pound (lb)	kilogram (kg)	0.454
Btu/h	kilowatt (kW)	0.293×10^{-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	37.2×10^{-3}

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