# ALGLASS FC-Natural gas version

## *SAFETY INSTRUCTIONS FOR INSTALLATION, USE AND MAINTENANCE*

**Thank you for the trust you have expressed by purchasing this equipment, which will give you full satisfaction if you follow its instructions for use and maintenance.**

**The manufacturer will not be held responsible where items not recommended by themselves are associated with this product.**

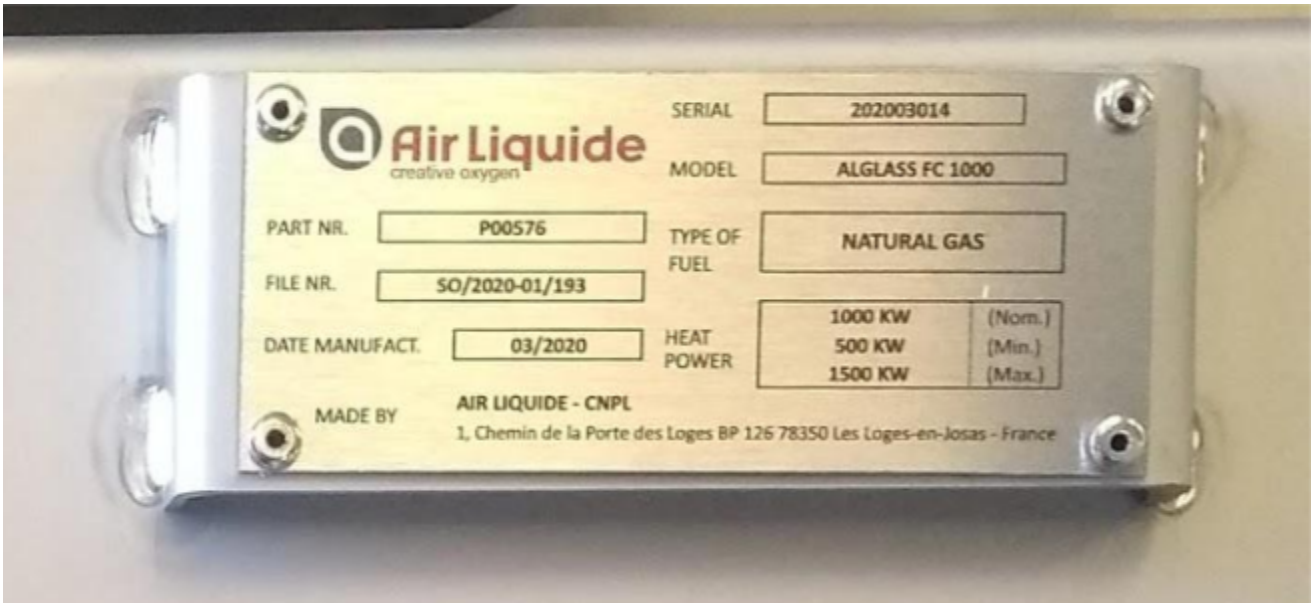
**For your safety, there follows a non-restrictive list of recommendations or requirements, many of which appear in the employment code.**

**Finally, we would ask you kindly to inform your supplier of any error which you may find in this instruction manual.**

# ***CONTENTS***

# ***A . IDENTIFICATION PLATE - EXAMPLE***

The plate below is fixed on the body of the ALGLASS FC NATURAL GAS BURNER unit, it is used to identify it. This is an example of the plate and informations mentioned on it :




Please, use these informations in all correspondences.

# ***B . SAFETY INSTRUCTIONS***

Every operator who manipulates the oxy-fuel ALGLASS FC burner should be trained on oxygen safety procedures. In particular, operators must be aware of the following minimum safety instructions for oxygen use:

- **Never use oil or grease for oxygen piping, nor assembling burner parts.**
- **Do not use organic materials for tightness components.**
- **Always clean all parts before installing them.**
- **Operators training for oxygen use.**

Failure to respect these instructions may cause ignition in the oxygen circuit, and further propagation along the oxygen piping.

# ***C . INTRODUCTION***

The ALGLASS FC is a burner specially developed for glass furnaces, which combines all the benefits of oxygen firing in a radically new design aimed at improving furnace efficiency. Fuel and oxygen are introduced in the furnace through a unique configuration of injectors, which produces a highly luminous flame up to three times wider than conventional oxy-fuel burners.
The standard ALGLASS FC burner is available in four sizes: 200, 500, 1000 and 2000 kW.
Demonstrated benefits of this new burner technology are:

- improvements in fuel efficiency with a flame energy directed to the glass rather than the furnace superstructure,
- improvements in heating uniformity and elimination of hot spots through enhanced bath coverage,
- high luminosity for efficient heat transfer to the glass,
- low pollutants emissions.

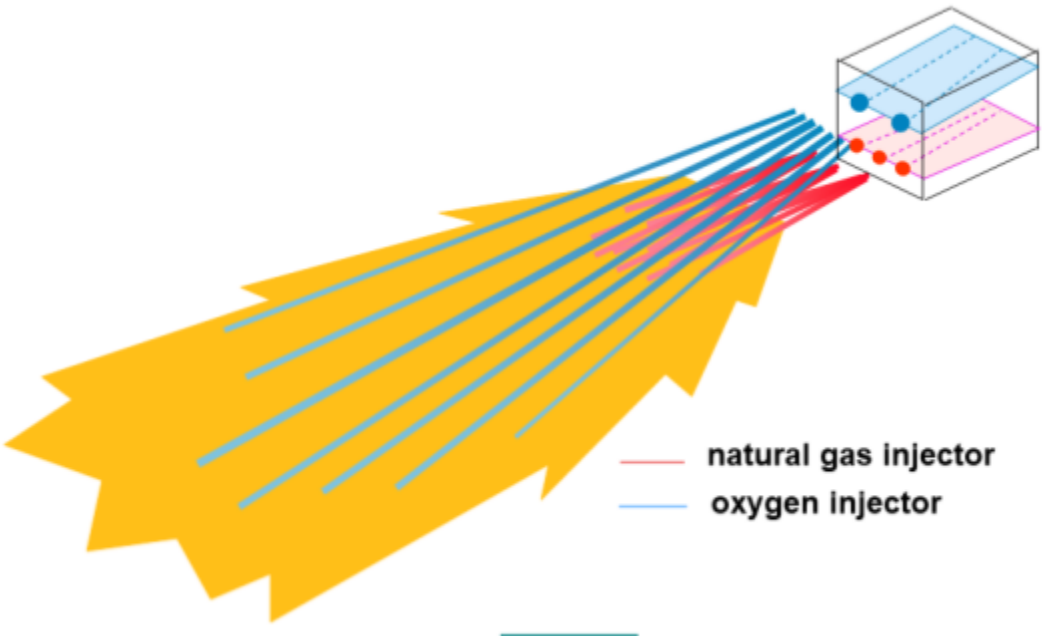
**Burner operation**

In conventional gas-cooled oxy-fuel burners, a stream of fuel gas surrounded by a parallel stream of oxygen is partially combusted in a burner block cavity (of cylindrical or rectangular shape), then ejected in the furnace in a jet of hot gases. Because fuel and oxygen are mixed inside the burner block and react immediately, the combustion is very intense, resulting in a high peak temperature flame.

The ALGLASS FC burner (patents pending) uses a totally different design where fuel and oxygen mix outside the burner block. The fuel is distributed at the bottom of a refractory burner block among three natural gas injectors arranged in a fan-shaped configuration, so that the streams of fuel form a wide sheet of gas in the furnace.

Oxygen is injected at lower velocity from two orifices located at the top of the block, which direct the oxygen flow towards the jets of fuel. The result is a wide and luminous flame, covering the glass melt.

Optional improved control of the flame shape and luminosity can be obtained by injecting a small part of the oxygen flow (for a total of 5-10% to 30-50% of the combustion oxygen depending on the burner setting) around each of the three natural gas injectors at the bottom of the block, in a pipe-in-pipe configuration. Increasing the secondary oxygen flow results in faster mixing between gas and oxygen and a shorter flame. With low secondary oxygen flow, mixing between oxygen and gas is delayed, which yields a longer flame. In both situations, the flame peak temperature is reduced because the oxygen and fuel jets are diluted with the furnace gases before they intersect. The energy released by the partial combustion of the natural gas with the secondary oxygen helps the thermal decomposition of the fuel, and formation of carbon particles that are highly radiant.




ALGLASS FC burner operation principle

# ***D . DESCRIPTION OF THE ALGLASS FC BURNER***

The ALGLASS FC burner is composed of (see Figure 1):

- The burner block (1) made of refractory material,
- The bracket adapter (2) for mounting the burner body on the block; the bracket adapter consists of two half sections secured by 2 bolts,
- A ceramic paper gasket (3) to be positioned between the burner block and the burner body,
- The burner body (4) with its flat Viton sheet gasket (5), mounted on the body,
- A plug (6) for the fuel oil orifice (for block with hole for fuel oil lance),
- The fuel gas lance (8) with high temperature alloy injectors (7).

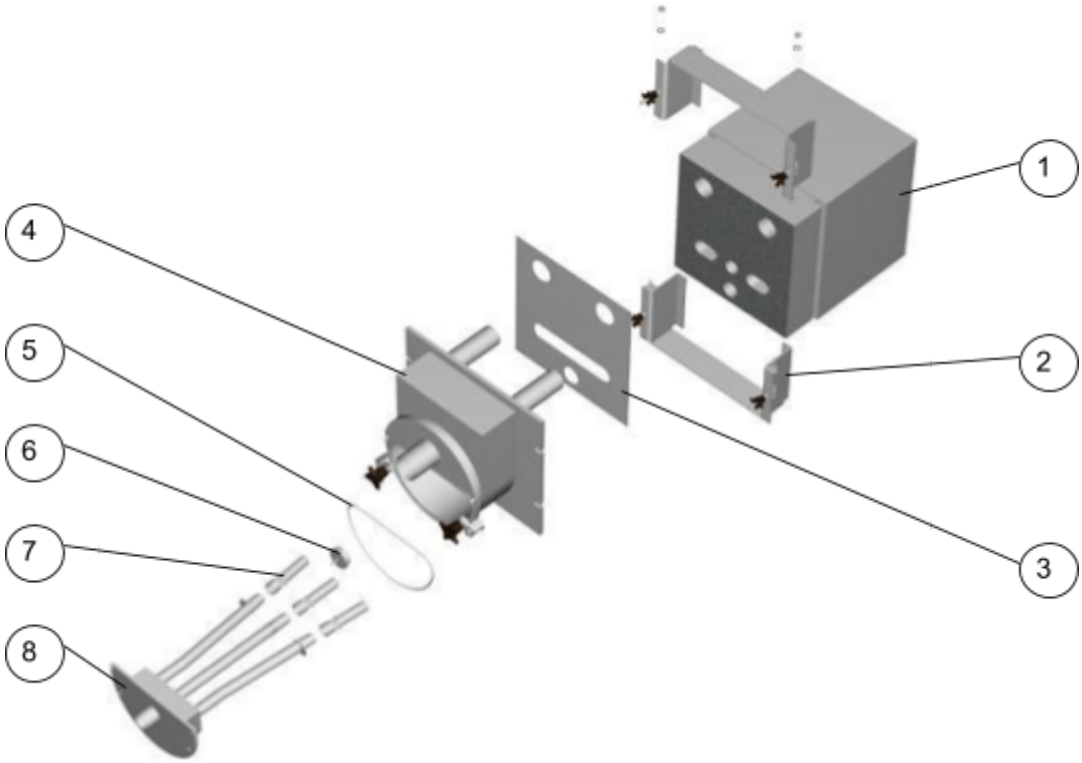



FIGURE 1

**All of the materials used for the burner fabrication are compatible with pure oxygen. All the burner metallic parts must be clean of dust and oil.**

# ***E . INSTALLATION OF THE BURNER***

**Before installing the block inside the furnace wall, proceed to a blank assembling of all burner parts to verify the centering of NG nozzle inside the block hole.**

## *1. Installation of the bracket adapter*

**Warning: the bracket adapter (2 pieces) must be mounted on the burner block before the block is installed in the furnace wall** except if rear part of block is outside the furnace wall and there is enough room for brackets installation above and below the block.

The fixation system is in two parts: it is assembled with the supplied set of nuts and bolts (see Figure 2).

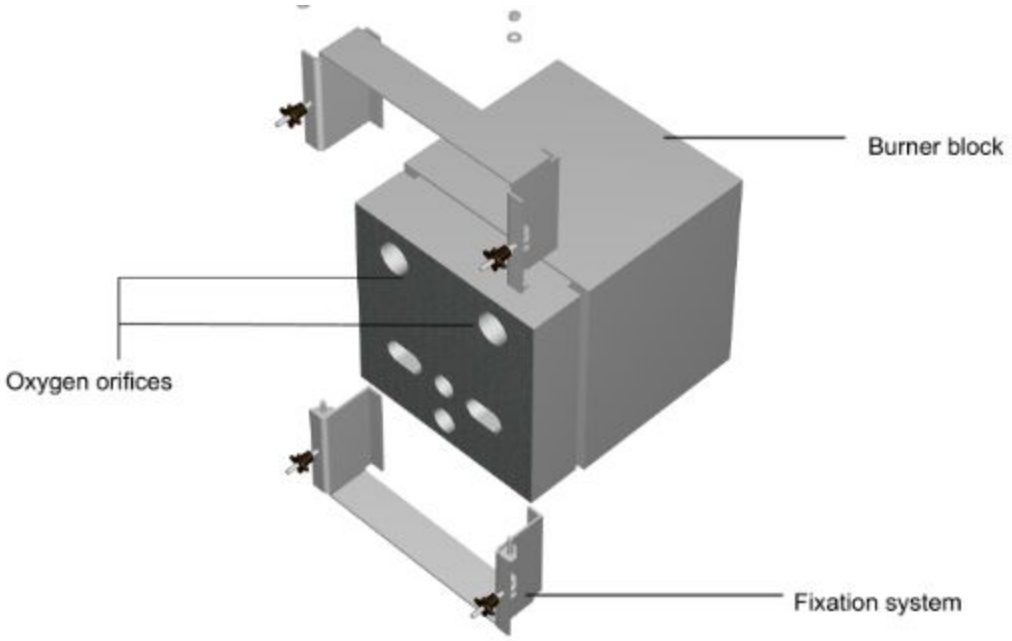



FIGURE 2

## 2. *Installation of the burner block*

The block has 2 oxygen orifices, 3 gas orifices and a fuel oil orifice (used to install a liquid fuel lance for operating the burner with fuel oil).

Before installing the burner block, check that the support of the block is horizontal or inclined no more than 2° to 5° toward the glass surface, to make sure that flames are not oriented towards the crown of the furnace.

In order to be sufficiently protected from the furnace radiation, the burner block outlet face must be placed in the same plane as the inner furnace wall or slightly in recess (1-2 cm).

Good tightness of the burner block mounting in the wall is essential to limit air inlets near the burner and reduce the formation of nitrogen oxides. It is recommended that the block is mounted with small refractory wedges and / or fibrous refractory sheets. Mortaring the block in place would be most desirable.

*New furnace (cold installation)*

- Place the burner block with its bracket adapter in the dedicated furnace opening. Make sure that the two oxygen orifices are above the natural gas orifices and horizontal before pushing the block into final position (block outlet face in the same plane as inner furnace wall).
- If the burner body is not installed before several hours, plug the holes (natural gas, oxygen and fuel oil) in the block with alumina wool.
- Tighten the mounting bracket.
- Ensure a proper tightness around the burner block with a heat resistant material.

*Existing furnace (hot installation)*

- Measure the reference position of old block and remove it. Plug the hole by a row of refractory brick (~80mm thickness).

- Preheat the block during 24h ~ 500-600°C to remove all moisture. Block must be covered by alumina wool to homogenize the preheating. Block can be installed in front of the opening plugged by brick (support is needed near the opening) or on forehearth.
- Mount the **brackets** (if not possible after block installation in furnace wall) with respect to their mark.
- Position the block (and its brackets) in front of the furnace opening. Plug the block holes with refractory wool.
- For AZS material (ERMOLD, ZEDMUL, Zircomullite): permit the block to heat up close to ambient furnace temperature during 30'- 60' while keeping front/back face ΔT<500°C with alumina wool covering it and then insert block in the furnace at a rate of 10 cm per 15' up to place block outlet face in the same plane as inner furnace wall thanks to reference position.
- For other type of block (high Alumina or Chrome): to avoid thermal shock, push the block (with its brackets if mounted) slowly into the opening, while keeping front/back face ΔT<500°C, at a rate of 5cm per hour for the first 15cm, and 10cm per hour afterwards (see figure 3) up to place block outlet face in the same plane as inner furnace wall thanks to reference position. During this step, keep alumina wool in front of brackets (if mounted) to avoid their overheating.
- Tighten the mounting bracket after removal of support and before complete installation of burner inside the furnace wall.

**Note:** never use internal hole of the block to lever or displace the block.

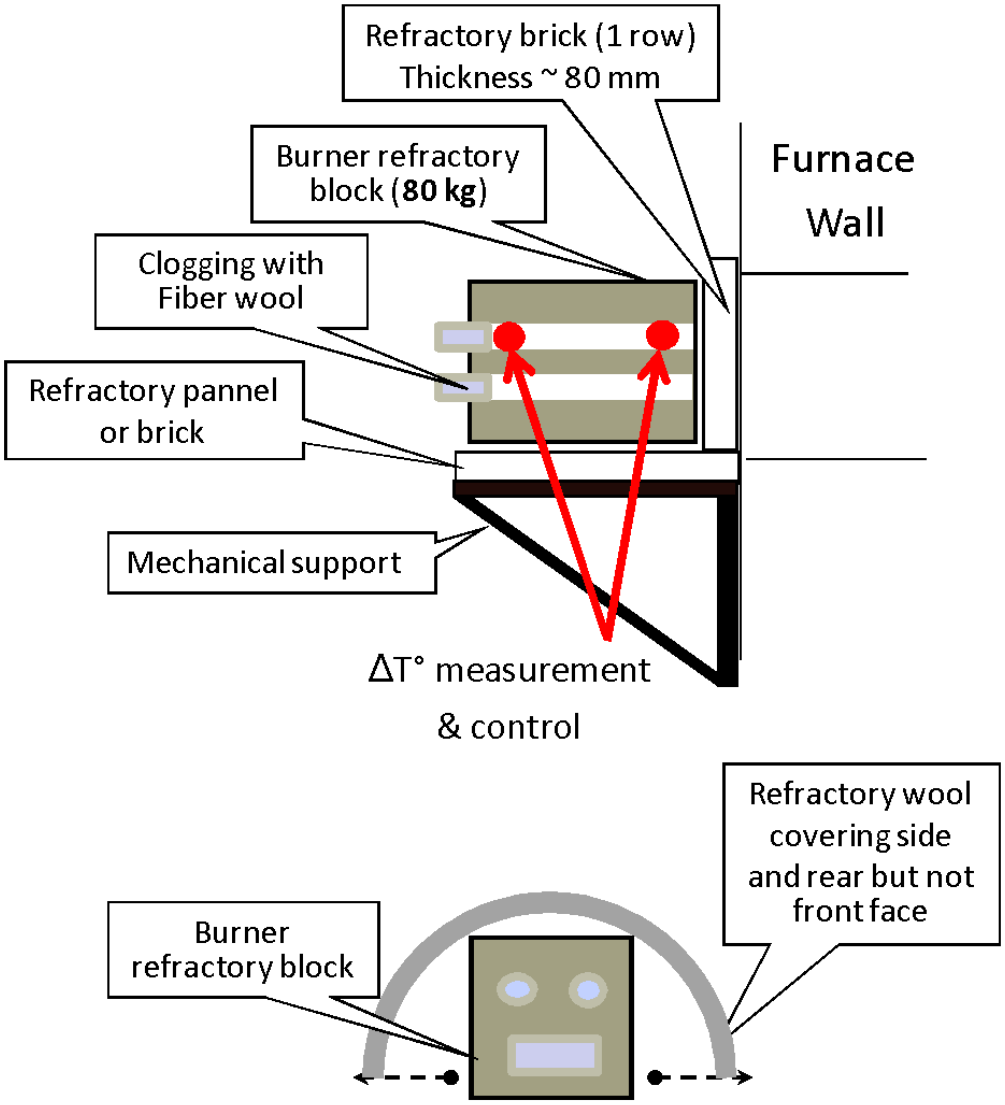



FIGURE 3

### *3. Preparation of the burner parts*

**The burner is delivered "Oxygen clean". Before assembling the burner, make sure that all parts have not been contaminated by grease, oil or particulates. If it has been contaminated, all metallic parts of the burner must be thoroughly cleaned one by one in order to eliminate all traces of oil or grease and of particulates. Use only oxygen compatible products for this operation. In case of a doubt on what product to use and procedure, contact an Air Liquide representative.**

### *4. Installation of the burner body on the block*

Install the burner body in the block just before firing it.

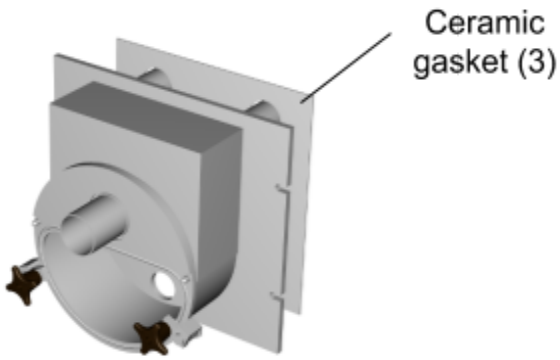



FIGURE 4

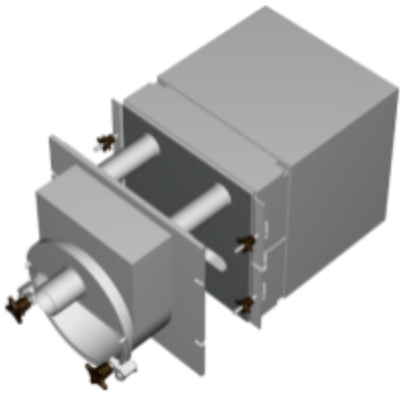


FIGURE 5

1. Place the square ceramic fiber gasket (3) on the burner body (see Figure 4).
2. Connect the oxygen hose to the burner and open the manual valve: from now on, cooling air must flow through the burner.
3. Remove the alumina wool plugs from the block, and check that the inside of the block is not obstructed by foreign materials (fibrous refractory or glass condensates).

4. Place the burner body in the block (see Figure 5).
5. Place the bracket adapter bolts in the burner body plate slots, and tighten them to compress the ceramic fiber gasket by 50%.

**Notes:**

The manual oxygen valve must always be open, except when removing the burner body.

Never use the burner body as a lever to displace the block.

Cooling air must be clean, dry and oil-free.

### *5. Installation of the gas lance*

The gas lance is mounted in the burner body only when everything is ready to fire the burner.

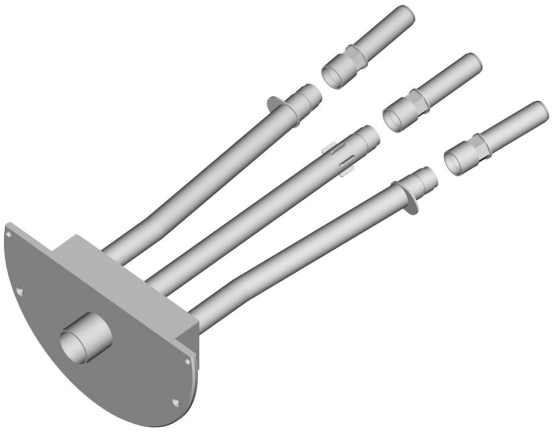


FIGURE 6

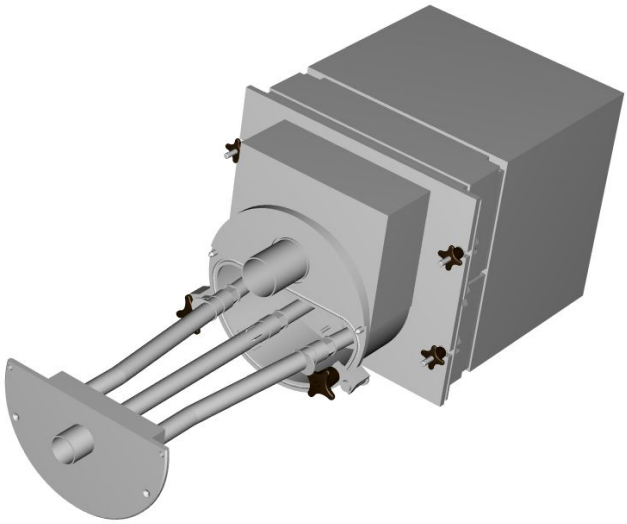


FIGURE 7

1. Install the flat Viton sheet gasket on the burner body flange,
2. Mount the gas injectors on the gas lance (see Figure 6),
3. Use a special grease compatible with oxygen,
4. Tightening of the gas injectors must be done by hand (no tools),
5. Check that the gas orifices are not obstructed by foreign material,
6. Connect the gas flexible hose,
7. Check cooling air is flowing through O2 burner body,
8. Insert the gas lance in the burner body (see Figure 7),
9. Tighten the nuts to compress the flat Viton sheet gasket,
10. Open the manual natural gas valve.

In order to avoid overheating of the metallic parts, fire the burner immediately.

**WHEN COOLING AIR IS NOT AVAILABLE, THE GAS LANCE MUST BE DISMOUNTED FROM THE BURNERS.**

**IF THE GAS LANCE IS LEFT IN THE BURNER WITHOUT COOLING, SYSTEMATICALLY INSPECT IT AS DAMAGE MAY HAVE OCCURRED TO THE METALLIC PARTS (see maintenance chapter).**

# ***F . BURNER MAINTENANCE***

It may be necessary to remove a burner for regular maintenance inspections or when the burner will not be used for a long period of time.

### *1. Inspection of the injectors*

1. Turn the burner off,
2. Close the manual natural gas valve,
3. Unfasten the gas lance nuts,
4. Remove the gas lance,
5. Check inside the block is not obstructed by any materials (refractory or glass deposit),
6. Check the gas injectors tips (deformation, burnt parts)
7. Replace the gas injector tips if necessary (**check that the new gas injectors are free of traces of oil and grease, and clean if necessary**),
8. Reinstall the gas lance as described in section E.5.

**During the first month of operation of the burner, inspection of the injectors must be carried out every week. During the second month, the period between inspections can be extended to two weeks. Air Liquide recommends that each gas injector is inspected every month, and every time a burner is left in the furnace without cooling air.**

### *2. Unmounting the burner*

When the burner is not going to be used for extended periods of time, the burner should be removed from the burner block.

1. Turn the burner off,
2. Close the manual natural gas valve,
3. Unfasten the gas lance nuts,
4. Remove the gas lance,
5. Unfasten the bracket bolts,
6. Remove the burner body from the burner block,
7. Plug the block orifices with Alumina wool,
8. Disconnect O2 flexhose from burner body and NG flexhose from gas lance
9. Store the burner body and the gas lance in a clean dry area.

A burner that was previously removed may be re-installed by following the same procedure as described in Chapter E.

**Use only new ceramic gasket for the burner body to block tightness.**

**All the burner metallic parts must be carefully cleaned for use with pure oxygen.**

The inside of the block has to be inspected and cleaned if necessary.

Before attempting burner mounting on a hot furnace, the operator should perform a dry run of the burner assembly in a less hostile environment.

### *3. Cleaning and gasket change*

Every time a burner is dismounted, a cleaning of all metallic parts (without flat VITON sheet gasket) that are in contact with pure oxygen by a specific cleaner product for oil and grease is mandatory.

The flat VITON sheet gasket on the flange, and the gaskets of the quick connecting components, must be inspected every 3 months.

Every year, all these sealing components must be replaced by new ones.

### *4. Spare parts*

Contact CNPL:

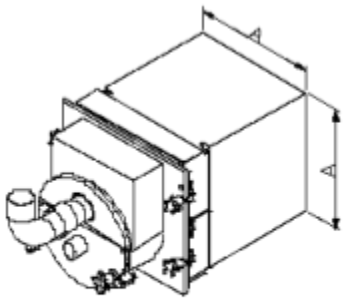
Air Liquide
CombustioN Product Line
1, chemin de la Porte des Loges
78350 Les-Loges-En-Josas - France

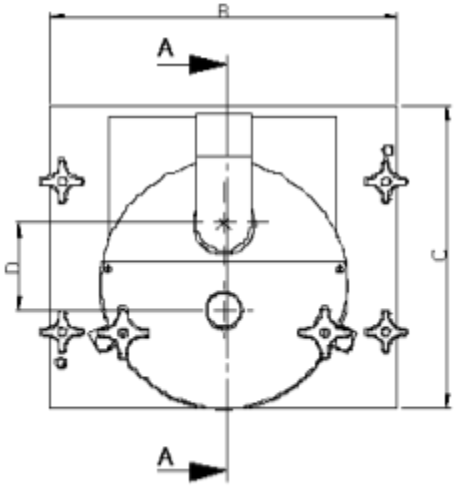
E-mail : ww-al-cnpl@airliquide.com

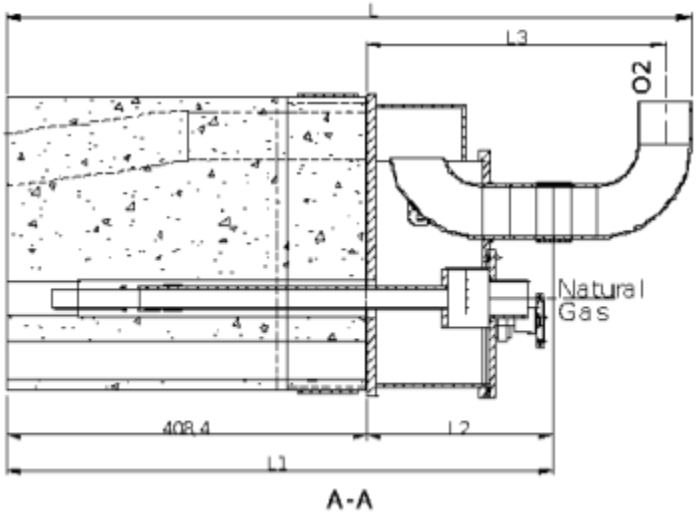
# G . APPENDIX

## 1. Burner dimensions

| ALGLASS FC **burner gas version** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Model (kW)** | **L** | **L1** | **L2** | **L3** | **A** | **B** | **C** | **D** | **$O_2$ (Oxygen)** | **NG (Natural Gas)** |
| **200** | | 587 | 179 | | 220 | 278 | 230 | 51 | M-G 1" BSPT | M-G 1/2" BSPT |
| **500** | 723,6 | 592,5 | 184,1 | 291,1 | 220 | 282 | 230 | 63,7 | M-G 1"1/2 BSPT | M-G 3/4" BSPT |
| **1000** | 749 | 617,9 | 209,5 | 316,5 | 275 | 337 | 285 | 67,5 | M-G 1"1/2 BSPT | M-G 1" BSPT |
| **2000** | 774,5 | 618,4 | 210 | 336 | 330 | 392 | 340 | 98 | M-G 2" BSPT | M-G 1"1/4 BSPT |



## *2. Capacity ranges and pressure drop*

- Capacity ranges of the ALGLASS FC burner:

| Model | Maximum capacity | Nominal capacity | Minimum capacity |
|---|---|---|---|
| ALGLASS FC 200 Gas version | 300 kW | 200 kW | 50 kW |
| ALGLASS FC 500 Gas version | 750 kW | 500 kW | 250 kW |
| ALGLASS FC 1000 Gas version | 1500 kW | 1000 kW | 500 kW |
| ALGLASS FC 2000 Gas version | 3000 kW | 2000 kW | 1000 kW |

- Pressure drop of the ALGLASS FC burner:

The ALGLASS FC burner requires low oxygen and fuel inlet pressures. The table below gives some values of the pressure drop through the burner depending on the flow rates.

| **ALGLASS FC 200 Gas version (all orifices)** | **Flow rate ($Nm^3/h$)** | **Pressure drop (mbar)** |
|---|---|---|
| **Oxygen** | 22 | 3 |
| | 32 | 11 |
| | 43 | 22 |
| | 65 | 49 |
| **Natural gas** | 10 | 9 |
| | 15 | 19 |
| | 20 | 30 |
| | 30 | 59 |

| **ALGLASS FC 1000 Gas version (2 orifices of 8 mm)** | **Flow rate ($Nm^3/h$)** | **Pressure drop (mbar)** |
|---|---|---|
| **Oxygen** | 156 | 33 |
| | 210 | 46 |
| **Natural gas** | 71 | 26 |
| | 95 | 57 |

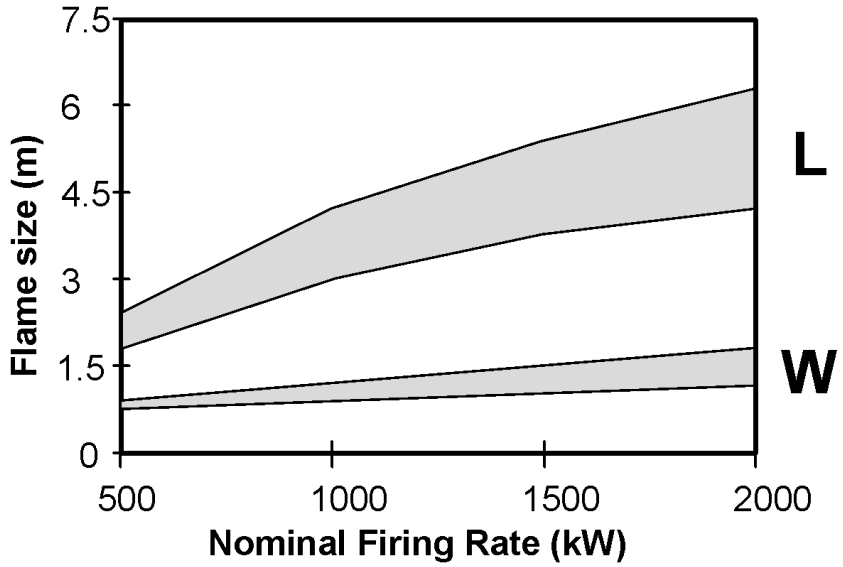
| **ALGLASS FC 2000 Gas version (2 orifices of 10 mm)** | **Flow rate ($Nm^3/h$)** | **Pressure drop (mbar)** |
|---|---|---|
| **Oxygen** | 213 | 6 |
| | 313 | 22 |
| | 417 | 36 |
| **Natural gas** | 94 | 7 |
| | 140 | 24 |
| | 187 | 40 |

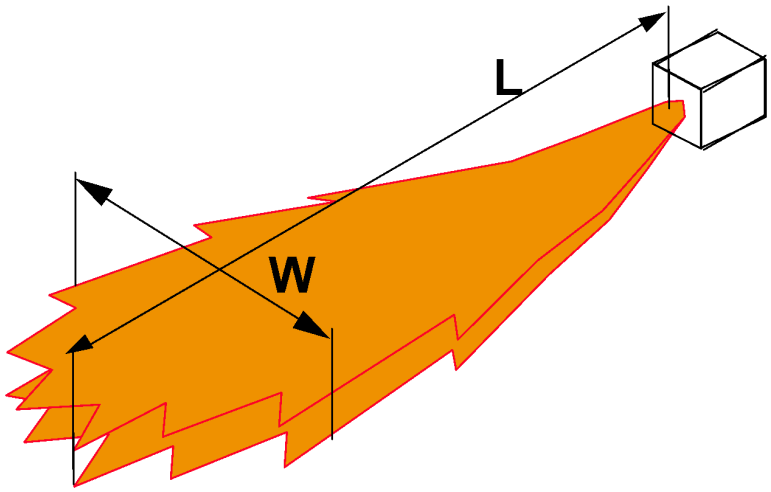
**Note:** pressure drop values for the ALGLASS FC 500 burner are very similar to those of the ALGLASS FC 1000 burner.

### *3. Flame length and heat transfer*

- Flame length of the ALGLASS FC burner:

The ALGLASS FC burner produces a highly luminous flame up to three times wider than conventional oxy-fuel burners (pipe-in-pipe configuration) and allows an effective energy transfer.
The flame dimensions for the ALGLASS FC burner in a pilot furnace are presented in the figures below



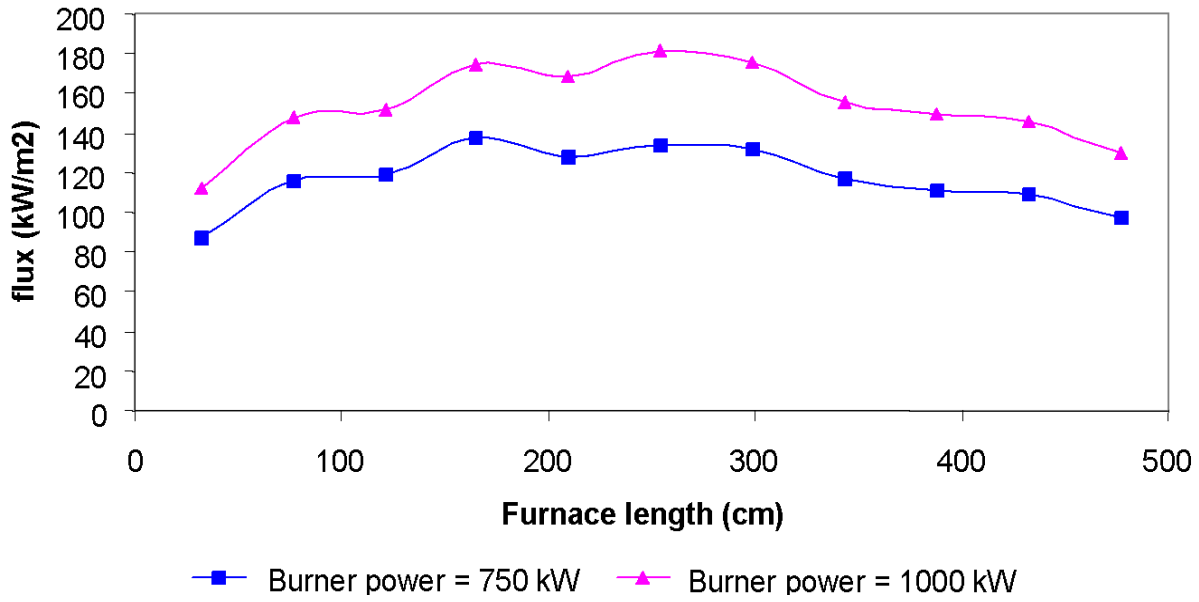



**Note:** the flame shape of the ALGLASS FC burner may be modified by changing the geometry (diameter) of the natural gas injectors and by adjusting (via the calibrated orifices located in the burner body) the flow rate of the oxygen injected around the three natural gas injectors.

With low oxygen flow around the three natural gas injectors, mixing between the oxygen and the gas is delayed, which produces a long flame.
With higher oxygen flow around the three natural gas injectors, mixing between the oxygen and the gas is faster and the result is a shorter flame.

- Heat transfer of the ALGLASS FC burner

The wide and luminous flame produced by the ALGLASS FC burner allows effective energy transfer.
The profile for the transfer of heat to the charge for the ALGLASS FC 1000 model (natural gas version) in a pilot furnace is given in the figure below.

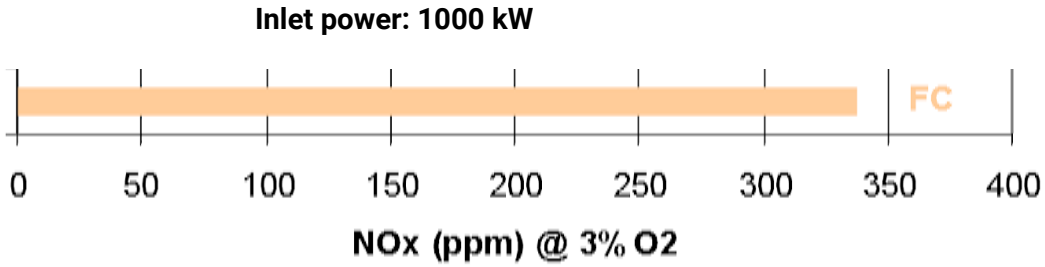


## *4. Nox emissions*

- Nox emissions of the ALGLASS FC burner

The ALGLASS FC burner generates low NOx emissions (a factor of 4 – 5 reduction by comparison with conventional pipe-in-pipe burners) due to separated injectors and lower (- 300 °C) peak temperature.

See the following graphic where NOx emissions are presented for ALGLASS FC burner, considering 3% of O2 in exhaust gases, when this burner is operated at 1000 kW in a pilot furnace.




## *5. General instructions for proper working conditions*

- General instructions for proper working conditions of the ALGLASS FC burner

1. The ALGLASS FC burner requires control over the fuel and oxygen, so we recommend the installation of a calibrated flow meter on the fuel and oxygen lines for determining accurate volumetric or mass flow rates.
2. During combustion, the burner body, the fuel lance and the burner block are cooled by the oxygen flow. However when combustion is not taking place, all parts of the burner are heated and can be destroyed by high furnace temperatures. In this case, a cooling air flow should be established using the oxygen line.
   When cooling air flow is not available, the fuel lance must be dismounted from the burner.
   However, the fuel lance can remain in a hot furnace for 15 minutes without any cooling.

3. The cooling air flow must not come from a compressor as oils may be present in the compressed air and contaminate components which need to be clean when oxygen is present.
   And it is recommended to supply a cooling air flow rate that is approximately 30 vol. % of nominal oxygen flow rate (see section “Gas specifications for the burner operation”).
4. Quick-coupling systems for the oxygen and fuel will facilitate disassembly and installation.
5. Quick-coupling systems also make possible to limit the time for which the burner parts, notably the fuel gas lance, are subjected to furnace temperatures without cooling flow.
6. Piping needs to be supported in order to avoid stresses on the burner body which could lead to cracking of the burner block.
7. Flexible hoses are advised for the burner supply. Flexible hoses can prevent the burner from damage due to stresses / expansion of the piping.
8. The burner block made of AZS rebounded material ($Al_2O_3$ + $ZrO_2$ + $SiO_2$) is generally suitable for most applications. However, it is necessary to ensure that this material is compatible with the customer process.
9. Viewing the flame through observation windows, such as peeping holes, makes burner start-up and adjustments easier.
10. Oxygen and fuel supply piping must be rated for the pressure and flow rate requirements of the burner operating at maximum capacity. Avoid long distances and turns in the piping as they increase the pressure drop.

## *6. Gas specifications for the burner operation*

- Gas specifications for the ALGLASS FC burner operation

| **MODEL** | ALGLASS FC 200 | ALGLASS FC 500 | ALGLASS FC 1000 | ALGLASS FC 2000 |
|---|---|---|---|---|
| **Min. oxygen temperature at burner inlet** | 10 °C | | | |
| **Max. oxygen temperature at burner inlet** | 40 °C | | | |
| **Min. Natural gas temperature at burner inlet** | 10 °C | | | |
| **Max. Natural gas temperature at burner inlet** | 40 °C | | | |
| **Oxygen supply pressure at burner inlet** | 50 mbar g. (Max. oxygen pressure drop through the burner at the maximum recommended firing rate) | | | |
| **Natural gas supply pressure at burner inlet** | 100 mbar g. (Max. Natural gas pressure drop through the burner at the maximum recommended firing rate) | | | |
| **Cooling air flow rate** | 20 Nm3/h | 30 Nm3/h | 60 Nm3/h | 120 Nm3/h |