FLAME CONTROL UNITS, SIGNALS AND FUNCTIONS

Progressive burners can be controlled by a 3-point signal (high/low flame) through the appropriate terminals. However, depending on the type of application and automation of the boiler, other types of signals can also be used, both at the burner input (analog modulation) and at the output (feedback signal proportional to load percentage, corresponding to actual power). A typical configuration in many boiler rooms may be, for example, using a 4÷20 mA input signal, with feedback through a potentiometer on the burner servo drive. Another very common case is the use of serial communication between several electronic control units in the boiler room. In this case different protocols (for example, Modbus), as well as different standards for signal connection and control (for example, RS-485) may be used.

BURNERS	CONTROL UNITS	FUELS		INPUT		
		SINGLE FUEL	DUAL FUEL	3-point modulation (high/low flame)	analog modulation [4÷20 mA]	analog modulation [0÷10 V]
mechanical models	LME 73.000 + PME 73.831	●	●	●	○	○
electronic models (EA)	LMV 20.100	●	–	●	–	–
	LMV 27.100	●	–	●	–	–
	LMV 37.400	●	–	●	●	○
el. mod. (EB)	LMV 37.400	●	–	●	●	○
el. mod. (EC)	LMV 26.300	–	●	●	●	○
el. mod. (ED)	LMV 26.300	–	●	●	●	○
el. mod. (ES)	LMV 51.100	●	●	●*	●	●
el. mod. (EI)	LMV 51.300	●	●	●*	●	●
el. mod. (EO)	LMV 52.400	●	●	●*	●	●
el. mod. (EK)	LMV 52.400	●	●	●*	●	●

NOTES:

INPUT analog modulation

OUTPUT feedback signal proportional to load

● function available on standard burner

○ function available upon request; extra price may be applied on custom products

* configurations subject to usage limitations; for technical details, please contact the nearest CIB Unigas branch office

Configuration samples

1) Let's assume the project requires a burner R515A with direct interface to boiler control unit.
Analog input signal to the burner: 4÷20 mA (input from external load controller)
Feedback signal to the boiler: potentiometer on servo drive, 0÷1000 Ω (output proportional to load percentage)
According to above table, first row, select a mechanical burner; in this case a simple progressive unit (PR) will suffice.
For example, R515A model M-.PR.S.IT.Y.1.65
Letter "Y" identifies burner customization.

2) Let's suppose a different case. Plant specs require a modulating gas burner, with signal 0÷10 V (output proportional to load percentage). The burner has to work in continuous service mode (without stopping every 24 h).
In this case the selected control unit is a LMV37.400 (see table, 4th row) and the burner model is electronic, EA.
Thus, burner type R515A model M-.MD.S.IT.Y.1.65.EA

Some functions are present on standard CIB Unigas burners, others may be requested during quotation phase and will require, as a result, modifications to standard products (such as adding a signal converter at the input or output terminals). The following is a table list of available configurations, depending on the burner model and the required functions. Customers are advised to specify in detail all the required functions when applying for a commercial offer, which will allow us, in turn, to configure the correct burner model, including OEM parameters of electronic control units, where necessary. If the desired signal combination is not included in this table, please contact our technical department in order to find a suitable solution.

OUTPUT			OTHER FUNCTIONS			
load signal [4÷20 mA]	load signal [0÷10 V]	load signal [0÷1000 Ω]	INVERTER	OPERATION 24h/24h non-stop (continuous operation)	MODBUS via RS-485	OXYGEN CONTROL
○	○	○	–	–	–	–
–	–	–	–	–	–	–
○	○	–	–	–	○	–
○	○	–	–	○*	○	–
–	–	–	●	○*	○	–
○	○	–	–	–	○	–
–	–	–	●	–	○	–
●	○	–	–	●	●	–
●	○	–	●	●	●	–
●	○	–	–	●	●	●
●	○	–	●	●	●	●

3) Like in the previous example, let's suppose the designer requires to add VSD (variable speed drive, or inverter) to the fan motor instead of 0÷10 V signal. The control unit is still a LMV37.400 but the burner model is now EB (see table, 4th row).

4) Last example, similar to previous ones but suppose now that both functions are required (feedback signal and motor VSD), plus continuous service as before. The burner control unit must support all these functions at the same time, hence select an electronic cam LMV51.300 and a burner model EI (see table, 9th row). The burner will then be an R515A model M-.MD.S.IT.A.1.65.EI

ADJUSTMENT OF THE BURNERS

When choosing the burner, the designer may select one among the following configurations.

TN (single-stage)
Burners with single-stage regulation operate in ON-OFF configuration: when an external switch (e.g. the boiler regulation thermostat) closes, the burner is switched on, and then operates at maximum power. When the generator set-point is reached, the contact opens, the flame is switched off and the burner is kept in stand-by.

AB (two-stage)
Burners with two-stage regulation operate in HIGH-LOW flame configuration: a signal from the boiler regulation thermostat takes the burner to high flame (maximum power); as soon as the high flame threshold is reached, the burner shifts quickly to low flame (minimum power). When the lower threshold is reached, the burner reverts to high flame. Boiler temperature will thus oscillate around the desired setpoint. If the thermostat limit threshold is exceeded, the flame is switched off and the burner shifts into stand-by. The two-stage regulation allows higher yields (efficiency).

PR (progressive)
Conceptually, progressive burners operate like two-stage ones, i.e. with high-low flame type regulation. The difference is that transients between two stages follow a regulation control curve (combustion air-fuel ratio). AB burners are limited by the power difference between high flame and low flame stages; PR regulation, while retaining the same functional characteristics, does not pose such limits - the combustion is always well regulated, even at intermediate power output. Additionally, liquid fuel PR burners are equipped with a single variable-flow nozzle instead of two nozzles (one for each stage); in case of variable load operation, load transients do not require large power jumps.

Note: if the boiler control unit requires burner control via an analog input signal (e.g. 4 ÷ 20 mA or 0 ÷ 10 V), please select a PR model burner. When requesting a quotation, specify the signal type given by the control unit, and the required feedback signal (e.g. 0 ÷ 1000 Ω via potentiometer on the actuator).
Attention, the burner configuration may vary according to the specific requests. See the two previous pages for a detailed explanation of I/O signal options.

MD (modulating)
Modulating burners are equivalent to PR ones, but supply includes by default a power regulator based on PID control system. The regulator synchronizes burner power and required load, via a feedback signal coming from a sensor installed on the boiler (also called modulation probe). Thermocouples can be used (for hot water and superheated water boilers, diathermic oil heaters, hot air generators, ovens and furnaces) or pressure transducers (for steam boilers). The air-fuel ratio is adjusted along a curve over the entire working range.

PR or MD burners with electronic cam
Electronic cam burners employ the same operating principle as the corresponding mechanically regulated burners: the air-fuel ratio curve is stored in the electronic unit memory, rather than being physically set by a variable cam connected to servo motors. The electronic cam is extremely precise and offers several advantages, first of all overcoming limitations of mechanical linkages (e.g. wear, play between the moving parts, hysteresis). On the other hand, control units are more sensitive to electromagnetic interference, therefore quality of power supply is a fundamental factor in thermal plant design.

Note: to order a modulating burner, please select the desired probe separately.

Controlled variable	Temperature/pressure range
Temperature (*)	-15 ÷ 50 °C
Temperature	30 ÷ 130 °C
Temperature	0 ÷ 400 °C
Temperature	0 ÷ 1200 °C
Pressure	3 bar
Pressure	10 bar
Pressure	16 bar
Pressure	25 bar
Pressure	40 bar

(*) shot air probe

Other sensors and/or different scales available upon request.

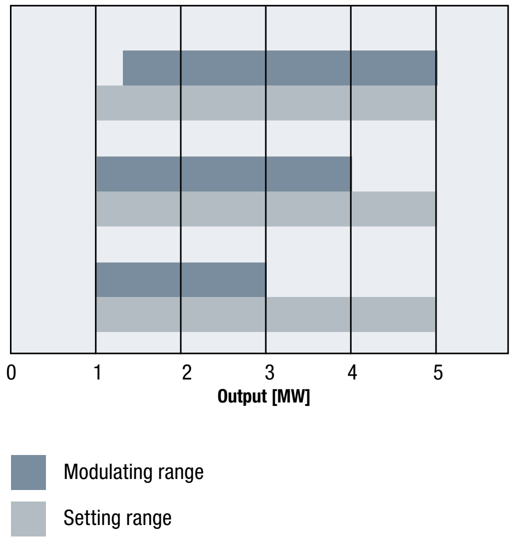
Control range and modulating ratio of a burner

Each burner, whether with an on-board or separate fan, is characterized by its performance curve defined by the minimum and maximum output within which it can operate. The modulating ratio is defined as the actual ratio between the minimum and maximum output of a specific thermal group burner-boiler (or burner-generator). The Performance curve is therefore quite different from the modulating range of the burner.

To better understand this concept let's make an example.
Let's consider a burner with a performance curve of 1.000 kW – 5.000 kW matched to a boiler that requires an output of 5 MW. If we assume a modulating ratio of 1:4, the minimum achievable output is 5.000 kW: 4 = 1.250 kW.

The same burner, matched to a boiler which requires a max output of 4 MW, with exactly the same modulating ratio of 1:4, delivers a minimum output of 1.000 kW.

Let's consider the very same burner matched to a boiler which requires 3 MW only. Since the burner cannot work below its mechanical limits, it will operate with a reduced modulating ratio 1.000 kW: 3.000 kW = 1:3.



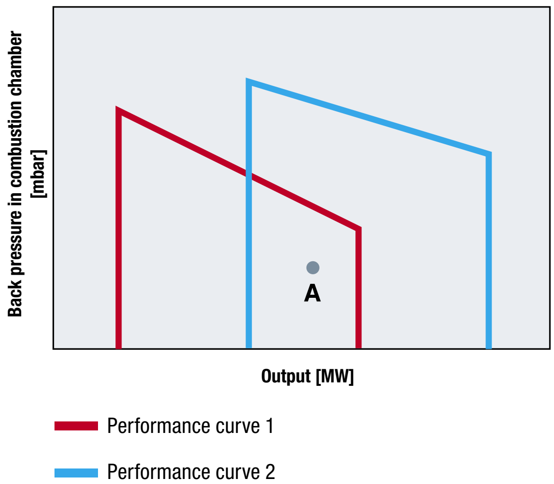
It's important to remember that the modulating ratio of any burner is strongly affected by the boiler on which it is installed. To obtain the best performance, it is recommended to choose the burner with the widest possible modulating ratio, and the maximum output as close as possible to that required by the boiler.

For example, if the working point of the boiler (point A in the picture) can suit many burners, it is recommended to pick up the model whose maximum output is closer to that required (curve 1). This is the best choice, both economically (smaller burner size), and technically, because it provides the widest modulating ratio.

A burner similar to curve 2 in the example, could only operate at an output which is already close to its min limit, and this would not allow any modulating ratio, meaning a completely negative situation.

Finally, let us remember two additional factors that can affect the modulating ratio:

- the boiler or heat generator manufacturer, as a rule, writes the maximum recommended modulating ratio to prevent the temperature of the flue gases at the minimum output to fall below the condensation limit.
- liquid fuel burners are bounded to the modulating ratio of the nozzles (typically 1:3 - 1:4, except special applications).



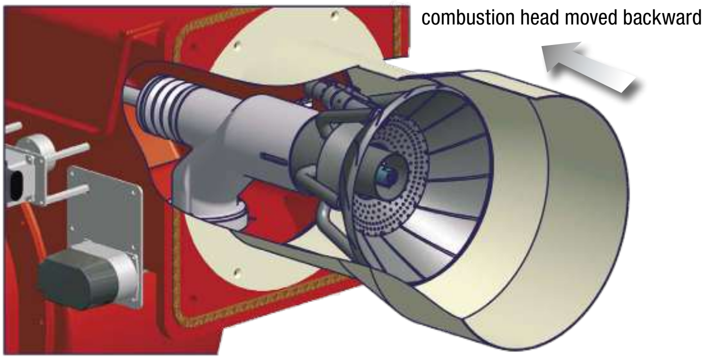
Burners with high modulation ratio

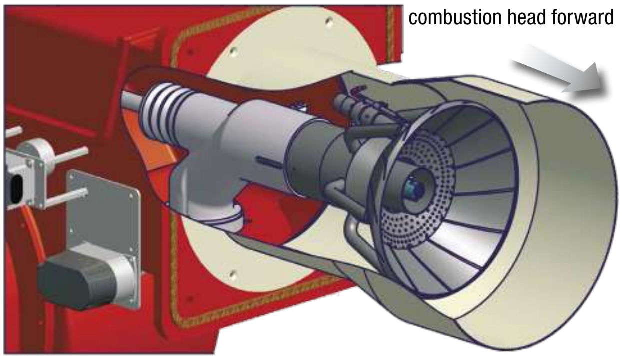
A special high modulation ratio customization is available on Class 2 gas and dual fuel burners with electronic control (variants with LMV51/52 units). This configuration can guarantee a ratio 1:6 between minimum and maximum power (1:10 with inverter).
This excellent performance is achieved by precisely dosing air flow at low power, while maintaining required flame stability.
High modulation ratio is recommended when project specifications call for an extremely low minimum load, and it is not possible to achieve this with other means (e.g. several smaller burners in cascade control).

Typical examples include burners for condensing boilers, applications such as processing plants or furnaces (e.g. food cooking ovens).

However, it is not recommended to use such configuration when there is risk of acidic condensate formation at the chimney (exhaust gases temperature too low), on ordinary steam boilers for example.

The use of burners with a high modulation ratio should always be agreed upon with the boiler or furnace manufacturer.





How to choose a monobloc burner at sea level and at altitude

To ensure a complete and safe combustion, the burner must be supplied with the correct flow of oxygen. The amount of oxygen available is proportional to the density of the combustion air, and the density depends on the environmental conditions.
For this reason, the performance curves of the burners are defined under standard environmental conditions at sea level with temperature 15 °C and pressure 101,3 kPa.

Of course, under real operating conditions, the temperature and pressure of the air change constantly. If the air density decreases (e.g. when summer temperatures are very high) also the oxygen available in one cubic meter of air is reduced and vice versa: this difference must therefore be taken into account.
Small daily variations are usually within the tolerances defined by the standard, so they are negligible.
On the other hand seasonal variations must be compensated, therefore it is suggested to schedule periodical checks of the combustion during the year. In this way, the formation of carbon monoxide (CO) is avoided, as the combustion is always in excess of air: typically the residual oxygen is fixed at 3%.

It should also be remembered that the atmospheric pressure and air density decrease as the altitude increases. Up to 300 meters this variation is negligible. However, in case the burner is intended to work in mountainous regions such as the Alps, it is necessary to recalculate the parameters of the system.

In order to avoid mistakes in calculations always remember to provide also the altitude of the thermal output plant at the moment of the enquiry!

The table on the right gives the correction factors to be applied to the calculations. Below is an example of how to choose a monobloc burner in altitude.

Suppose you have to select a burner intended for the city in altitude. This city is surrounded by mountains, and the thermal output plant will be built at approximately 1.000 meters above sea level.

The data of the boiler to be matched are:
- nominal output Pn 4.000 kW
- efficiency η 91 %
- back pressure in combustion chamber Cp 12 mbar
- fuel natural gas

The first step is to calculate the output (Pb) required to the burner:

$$P_b = \frac{P_n}{\eta} = \frac{4.000}{0,91} = 4.400 \text{ kW}$$

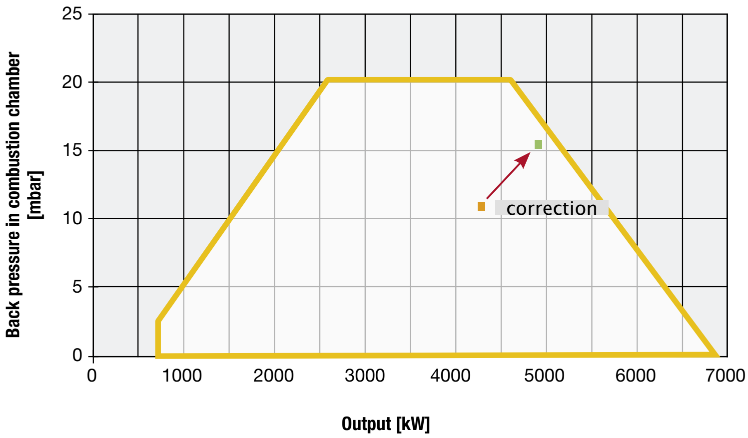
Installation height above sea level	Correction factors	
	K_1 (Power)	K_2 (Back-pressure in the combustion chamber)
300	1,036	1,074
400	1,049	1,100
500	1,061	1,127
600	1,074	1,154
700	1,087	1,182
800	1,100	1,211
900	1,114	1,241
1.000	1,128	1,272
1.200	1,155	1,334
1.400	1,184	1,402
1.600	1,213	1,472
1.800	1,243	1,546
2.000	1,276	1,628
2.400	1,342	1,801
2.800	1,410	1,988
3.200	1,483	2,199
3.600	1,561	2,437
4.000	1,644	2,703

Note the altitude of the plant above sea level (1.000 meters) and obtain the correction coefficients K1 and K2 from the table. In this case:
$K_1 = 1,128$
$K_2 = 1,272$

Correct the output and back pressure by applying K1 and K2 respectively:
P_b (corrected) = $P_b \times K_1$ = 4.400 x 1,128 = 4.960 kW
C_p (corrected) = $C_p \times K_2$ = 12 x 1,272 = 15,3 mbar

Finally, it is possible to pick up the right gas burner for the customer's plant, in this case it is R520A.

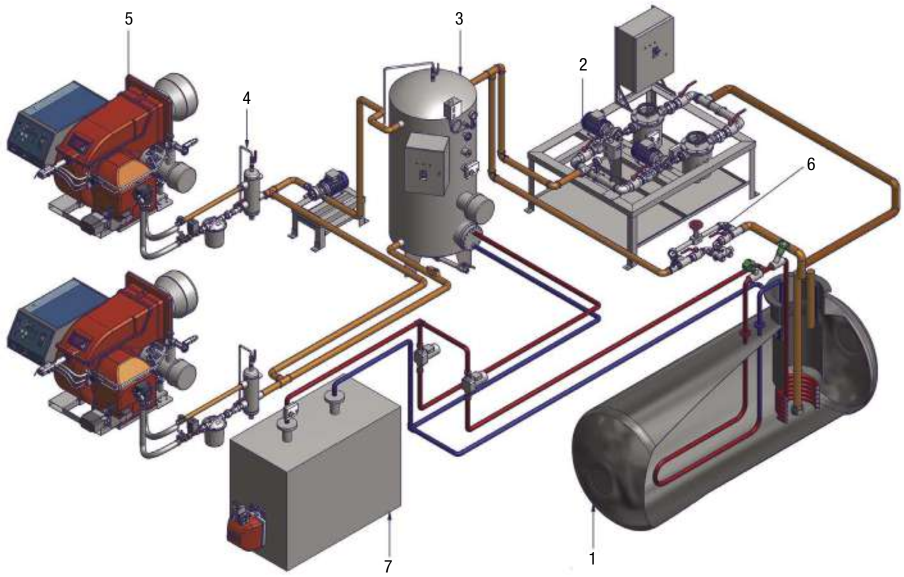
Performance curve of the R520A burner



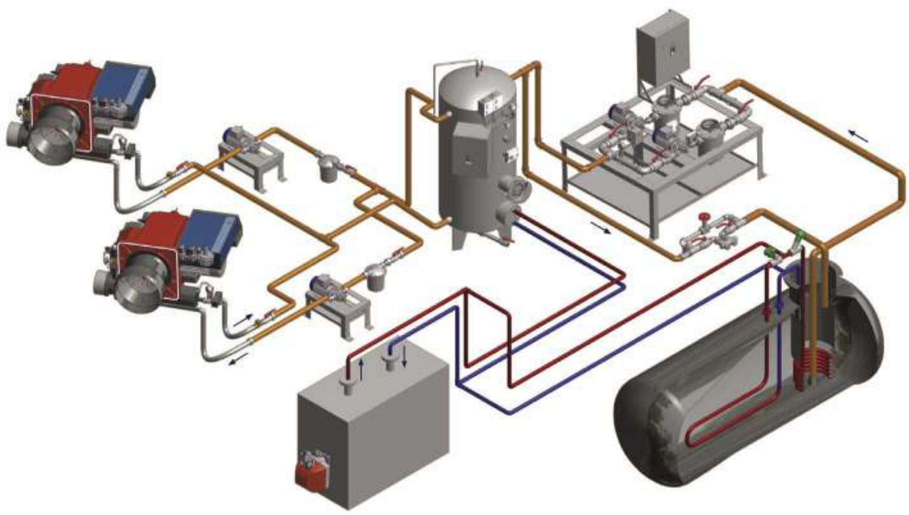
Attention! The correction applied does not change the actual output that the burner must develop. The boiler is always 4.000 kW, and the burner always develops 4.400 kW, then why was a 4.960 kW burner selected?
What has changed is the performance of the fan, which must deliver a sufficient oxygen flow to the fuel combustion.
The choice of burner is therefore made in the following way: the performance curve of the burner is maintained as if the system was located at sea level, but we pretend that the boiler requires a higher performance according to the K1 and K2 coefficients.
This operation is equivalent to maintain the real working point, and reducing the performance curve of the burner. The result is the same but the calculation is simpler and faster.

Very often, for a correct light and heavy oil burners operation, it is necessary to prepare an additional fuel supply line.
In this case, rather than suck the fuel from the tank along separate lines suitable to each individual burner, a low-pressure supply circuit (normally 1 ÷ 2 bar) must be created.
Two of the most common fuel oil configurations are simplified in the following diagrams:

Ref. 01 - Example of a ring circuit for heavy fuel oil burners with mechanical atomization.



Ref. 02 - Example of a ring circuit for pneumatically atomized heavy fuel oil burners.



Below is a description, as an example, of some available solutions for oil preheating fuel supply to the burner.
The daily storage service tank (no. 1 in the figure) is heated by a service boiler (no. 7) with a steam or hot water boiler; its target is to keep the heavy fuel oil liquid enough to keep the necessary pressure inside the ring circuit.
The capacity of the service tank (no. 3) provides, if necessary, an additional temperature difference before supplying the oil to the burner (no. 5). The burners themselves are supplied through degassing tanks (no. 4), which allow to separate the gas which forms in the heated fuel oil.
On the back, below item no. 6, there’s a pressure regulator.
CIB UNGAS can supply, upon request, pumping units for diesel and heavy fuel oil, pressure regulators and degassing tanks.

VARIABLE SPEED DRIVE
FOR ELECTRONICALLY CONTROLLED BURNERS

The burner fan motors can be driven directly, or indirectly through a frequency converter (Variable Speed Drive, VSD).
In order to equip a burner with a frequency converter, first select an electronically controlled model (EB, ED, EI, EK, EG, ER, LG, LR); then select a VSD based on the power of the burner fan (see table below on this page).
For example: burner model N880X is equipped with an 18,5 kW fan motor, thus select an 18,5 kW VSD + braking chopper.

SUPPLY LIMITS AND CONDITIONS

Frequency converter loose supplied

- Inverter equipped with metal backplate suitable for wall mounting; IP54/IP55 protection class.
- Braking resistors (b. chopper) are loose supplied (IP54).
- Electromagnetic filter (EMC) class A2 or A1/B (suitable for shielded cable up to 20 m).

Frequency converter with electrical cabinet

- Frequency converter (IP20 protection class), built-in inside the burner electrical cabinet (IP55 protection class).
- Braking resistors (b. chopper): IP54 protection class.
- Electromagnetic filter (EMC) class A1/B (suitable for shielded cable up to 20 m).
- Select a burner equipped with cabinet-type control panel; see cabinets specifications, next page.

INVERTER CONVERTER TABLE					
Burner type	Fan motor power kW	Inverter power kW	Braking resistors (opzion)	VSD protection class	Braking resistors protection class
91	4,0	4,0	-	IP20 / IP54	-
92	5,5	5,5	-	IP20 / IP54	-
93/RX92R/RX92.1/HRX92R/HRX92.1	7,5	7,5	-	IP20 / IP54	-
512	9,2	11,0	-	IP20 / IP54	-
515	11,0	11,0	-	IP20 / IP54	-
520	15,0	15,0	-	IP20 / IP54	-
525	18,5	18,5	-	IP20 / IP54	-
G258A	4	4	-	IP20 / IP54	-
G335A/G225X/G270X	5,5	5,5	-	IP20 / IP54	-
G380A/G400A/G325X/H365X	7,5	7,5	-	IP20 / IP54	-
H440X/H500X/H630A/H685A	9,2	11,0	-	IP20 / IP54	-
K590X/K660X/K750X/K750A/K880A/K990A	15,0	15,0	-	IP20 / IP54	-
1025 / N880X	18,5	18,5	• (included)	IP20 / IP55	IP54
1030 / N925X / N1060A	22,0	22,0	• (included)	IP20 / IP55	IP54
1040 / N1060X / N1300A	30,0	30,0	• (included)	IP20 / IP55	IP54
2050R / 2050	37,0	37,0	• (included)	IP20 / IP55	IP54
2060	45,0	45,0	• (included)	IP20 / IP55	IP54
2080	55,0	55,0	• (included)	IP20 / IP55	IP54

Note: packaging included (wooden crate suitable for road transport).
Standard UE power supply: 400 V AC 3ph. 50 Hz; other options available, please make an inquiry if interested.
Shielded cable between burner motor and VSD: not included. If design specifications require a cable longer than 20 m, please make request for a higher-class EMC filter.
Inverters for smaller burners (not included in the table): available on request, please contact nearest CIB Unigas branch office.

Attention: burners in EB, ED, EI, EK, EG, EP, ER, LG or LR configuration can work exclusively through a VSD coupled to the fan motor.
It is also possible to provide a modified burner, configured for inverter, but additionally equipped with a delta-star starter. The customer may then decide whether or not to use the inverter according to project requirements.
This option must be requested during quotation phase, before order.

Separate electrical panels for burners

Standard burners are provided with integrated electrical panels which include all electronic automation and all necessary components for a correct and reliable operation.

Alternative solutions to the integrated control panel are available upon request:
- Wall mounted control panel according to customers' specifications.
- Floor standing electrical panel; it has its base, and it is provided with a tilting panel.
- Large electrical panel with base plate (Closet type); this type of panel allows to mount an inverter or other necessary electronical equipment.


Floor standing

All electrical panels are provided with a door lock.

	Maximum dimensions		
Electrical panel type	width [mm]	depth [mm]	height [mm]
Floor standing	600 - 1000	500	1000
Closet type	600	400	2000
Wall mounted	400 - 600	200 - 300	600 - 700

Protection degree of self-supporting switchboards: IP55 (or higher upon request)


Closet type

The dimensions indicated are valid for the configurations widely used in boiler rooms.
Based on the specifications of the heating system, it is possible to realize electrical panels of different sizes, or prepare one common electrical panel to several burners.

Note: If you select the option "control cabinet type", you need to specify the cable entry position (cable entry from the bottom or top of the electrical panel housing).
Note: Some combinations have restrictions on the passage of signals from and to the outside to electronical equipment. To order a special electrical cabinet, the length of the electrical connections between the panel and the burner must be worked out in advance.

For burners with a special configuration, please ask our Technical Department.


Wall mounted

EMISSIONS

The subject of emissions is very wide and complex. The scientific literature in this field is under continuous update and there's no way to describe it briefly.

The boiler room is a source of pollution caused by the combustion of hydrocarbons. Combustion products consist mainly of nitrogen, carbon dioxide and steam delivered into the atmosphere through the chimney. The products of secondary combustion include a long list of chemicals, such as (CO), nitrogen oxides (NO_x), fine particulate matter (PM) and others. The normatives in force provide their max limits.

The level of emissions depends on many factors, including:
- fuel composition;
- shape of the combustion chamber and characteristics of the boiler;
- type of burner head.

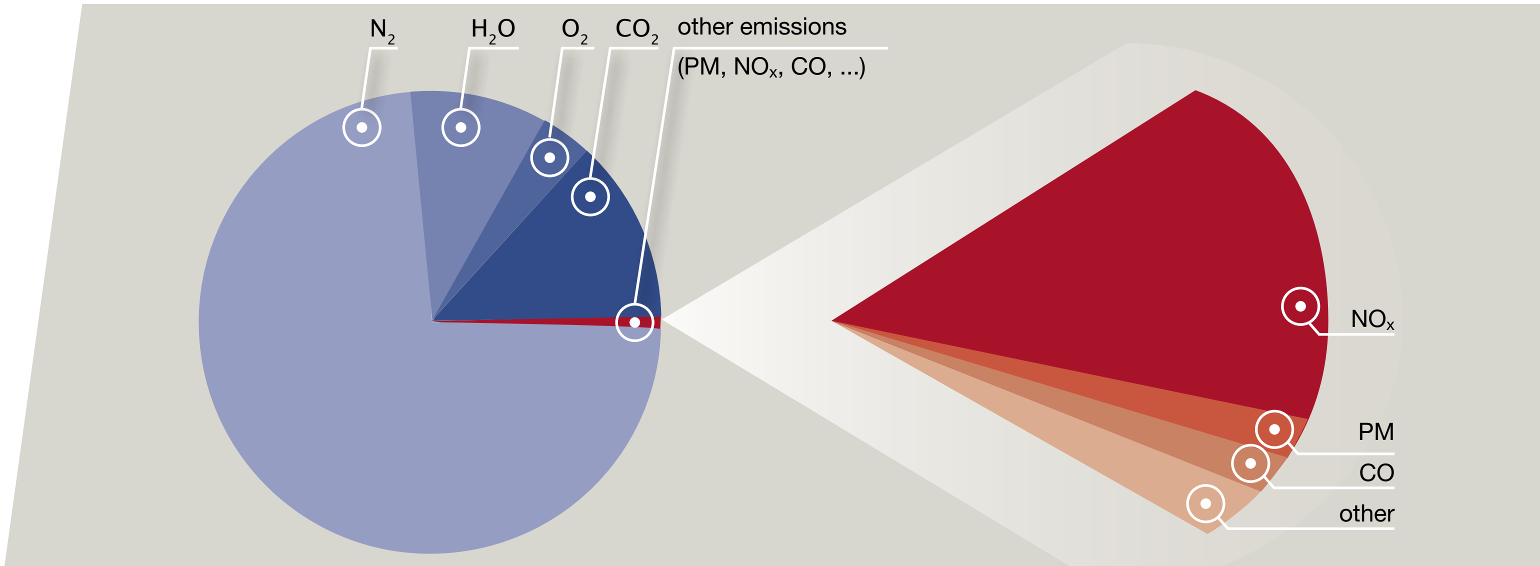
For example, liquid fuels usually contain sulphur and other impurities.

These substances do not burn, therefore, if there is a need to reduce emissions, it is necessary to use a high-performance burner or to use complex systems for the treatment of fumes.

The emissions of nitrogen oxide also depend on the characteristics of the combustion chamber and the combustion head.

Due to the fact that the limit values required by the technical standards for the environmental protection are more and more restricted it is necessary to pay particular attention to propose a correct choice of burner and boiler.

CIB UNIGAS Technical Management keeps always an eye on new technologies to reduce emissions. For these reasons CIB UNIGAS has been investing in the development of low environmental impact burners.



Typical composition of fumes

Less polluting emissions

All CIB UNIGAS burners are certified for both gaseous and liquid fuels in accordance with European standards and meet the requirements for polluting emissions.

Measurements of CO and NO_x emissions are carried out on standard size boilers, on all test conditions.

TABLE: LIMIT VALUES FOR EMISSIONS OF NITROGEN OXIDES AND CARBON MONOXIDE ACCORDING TO THE EUROPEAN STANDARD

Type of fuel	Burner class	Unit of measurement	CO	NO_x	Standards
natural gas	Class 1	mg/kWh	100	170	UNI EN 676
natural gas	Class 2	mg/kWh	100	>80 <120	UNI EN 676
natural gas	Class 3	mg/kWh	100	>60 <80	UNI EN 676
natural gas	Class 4	mg/kWh	100	<60	UNI EN 676
LPG gas	Class 1	mg/kWh	100	230	UNI EN 676
LPG gas	Class 2	mg/kWh	100	180	UNI EN 676
LPG gas	Class 3	mg/kWh	100	140	UNI EN 676
LPG gas	Class 4	mg/kWh	100	110	UNI EN 676
light oil	Class 1	mg/kWh	110	250	UNI EN 267
light oil	Class 2	mg/kWh	110	185	UNI EN 267
light oil	Class 3	mg/kWh	60	120	UNI EN 267

CIB UNIGAS burners, NOx emissions:
- Low NO_x gas burners correspond to Class 2, Ultra Low NOx burners without FGR correspond to Class 3.
- LPG burners correspond to Class 1, Low NOx LPG burners correspond to Class 3;
- Oil burners have a maximum NOx emission of 250 mg/kWh (Class 1);
- Heavy fuel oil burners (non-standard fuel oil) can, in the worst case, reach a maximum NOx emission of 700 mg/kWh.

CIB Unigas also offers Low NO_x solutions for complex systems and revamping of existing plants.
As far as carbon monoxide (CO) is concerned, a properly set CIB UNIGAS burner delivers a very small CO level.

If necessary, CIB UNIGAS offers FGR (Flue Gas Recirculation) solutions – these are burners with flue gas recirculation system which deliver emissions of less than 50 or 30 mg/kWh. Burners with FGR are designed for installations with Low NO_x emissions requirements, such as greenhouses or boilers in large residential areas where low levels of contaminants are a priority. Our FGR solutions meet environmental impact requirements.

The burners belonging to the different classes of NO_x emissions are identified by the following logos:

CIB UNIGAS >80 <120 mg/kWh CLASS 2 Low NOx
CIB UNIGAS >60 <80 mg/kWh CLASS 3 Low NOx
CIB UNIGAS < 60 mg/kWh CLASS 4 Low NOx
CIB UNIGAS <50 mg/kWh Low NOx
CIB UNIGAS <30 mg/kWh Low NOx

Often non-EU countries follow different normatives and measurement conditions. To ensure that the levels of pollutant emissions are always correct, it is necessary to know exactly the conditions in which tests were carried out, i.e. measurement of the gas, the error, type of fuel, boiler size, atmospheric conditions, etc.
In addition, standards can use different units of measurement*. Therefore for the comparison, it is necessary to translate the limit values expressed as follows in mg/kWh (milligrams per kilowatt hour), using the correct formula, depending on the selected fuel and residual oxygen in the exhaust gases.
* For example: ppm (parts per million), mg/Nm³ (milligrams per normal cubic meter), etc.

SULFUR OXIDES EMISSIONS

The polluting emissions of sulfur oxides (SO_x) mainly include sulfur dioxide (SO_2) and trioxide (SO_3). These chemicals are particularly aggressive and dangerous, both for the environment and human health.
However, sulfur oxides represent a separate case from CO and NO_x since their production during hydrocarbons combustion does not depend on the burner, nor on the boiler, but only on the quantity of sulfur already present in the fuel upstream of the process.
On the one hand, higher quality, gaseous fuels (methane, LPG) include insignificant amounts of sulfur, and the use of these fuels minimizes hazardous emissions. On the other, the problem is evident in liquid fuels (especially crude oil and heavy fuel oil), whose composition always includes a certain amount of sulfur - it will inevitably be oxidized in the combustion chamber and emitted as SO_x pollutant.

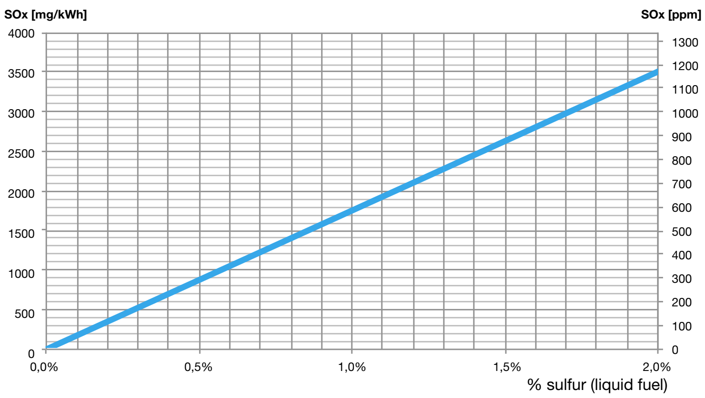
It is possible to estimate the quantity of SO_x produced with the diagram on this page, or with the following procedure.
Given the quantity of sulfur present in the fuel (expressed as a percentage by mass), just multiply this value by a numerical factor, 1.750.
The resulting number represents the emissions of SO_x at the chimney, expressed in mg/kWh.

Example
Given a fuel that contains 0,5 % sulfur, SO_x emissions will be equal to
0,5 x 1.750 = 875 mg/kWh.

Conversely, once the SO_x emission limit is known for a given thermal plant, it is possible to calculate the maximum admissible sulfur concentration in the fuel, dividing by the same coefficient above.

Example
Let's assume that emission limit required by project specifications is 300 mg/kWh SO_x.
The maximum percentage of sulfur in the fuel can be 300 : 1.750 = 0,17
The numerical result represents directly the percentage in mass: 0,17 %.

If the fuel oil contains a higher fraction of sulfur, the required limit will be exceeded, regardless of burner or boiler selection!



Reference conditions
Heavy fuel oil with net heating value Hi = 9.800 kcal/kg
Residual oxygen at the chimney O_2 = 3 % (λ = 1,15)

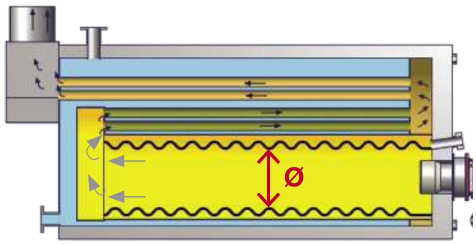
WHY DIFFERENT THERMAL GROUPS RELEASE DIFFERENT LEVELS OF NITROGEN OXIDES AT THE SAME OUTPUT?

The CO, NO_x and other pollutants are strongly influenced by a number of factors, not always burner related. There are factors independent from the thermal plant, such as environmental conditions (altitude, humidity, fuel composition, etc…) and factors related in particular to the design of the generator. The most important factors are summarized below.
It becomes evident that burner and boiler must be evaluated as a single thermal group, in order to comply to the rule on emission levels, or to the specific requirements of designers. The correct match between burner and boiler is discussed in greater detail on the following pages.

BOILER TYPE

↓

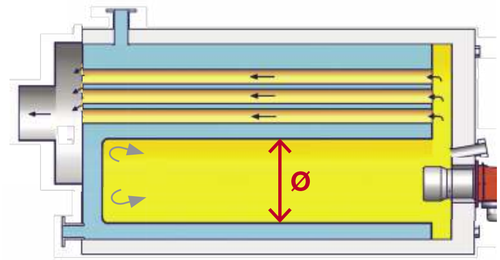
- type of generator (reverse flame, or 3 smoke-pass)
- dwell time of the flame within the combustion chamber
- heat exchange surface
- temperature and type of heat transfer fluid



DIMENSIONS OF THE COMBUSTION CHAMBER

↓

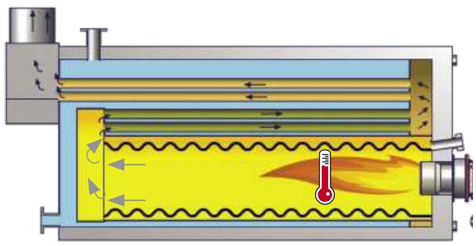
- combustion chamber internal gas circulation
- dwell time of the flame within the combustion chamber
- thermal load of the chamber



THERMAL LOAD OF THE COMBUSTION CHAMBER

↓

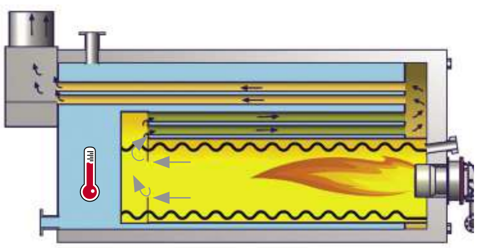
- flame temperature
- speed at which the NO_x is formed



BOILER TEMPERATURE

↓

- flame temperature
- speed at which the NO_x is formed



THICKNESS OF THE REFRACTORY OR BOILER DOOR

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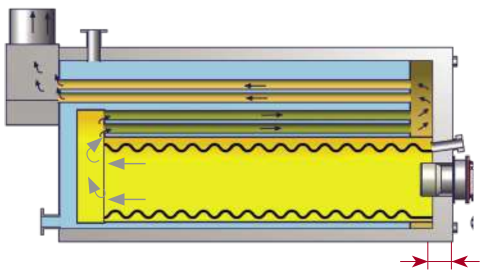
- length of the combustion head
- internal combustion gas circulation



Reverse flame boilers: contact our Technical Department.