1 DESIGN CRITERIA

The design of a heating system with direct exchange gas unit heaters must take into account three essential points:
- Determining the heating demand for space heating and air renewal
- The determination of the type and number of gas unit heaters to be installed
- The positioning of gas unit heater

1.1 DETERMINATION OF HEATING DEMAND

The determination of the power demand for heating a building must necessarily take into account a variety of factors, such as the size and geometry of the room to be heated, the dispersion of the envelope, the need for air renewal, the age of the building itself, any free heat input (related to the production processes that may take place inside the heated building).
Three methods can be identified for the calculation of heating demand:
- Analytical calculation
- Approximate calculation
- Approximate sizing

1.1.1 Analytical calculation

The analytical calculation, entrusted exclusively to a design professional, makes it possible to determine the heating and ventilation demand of a building with the utmost precision and in full compliance with all legal requirements.
Typically this calculation is mandatory for the realization of the executive phase of the project, to which it is necessary to attach the calculation reports that analytically account for the installed thermal power.
In this scenario there are no approximations: the calculation is carried out with the utmost precision and with full adherence to the real situation.
Analytical calculation is therefore only possible with the help of specialised calculation software, which requires complete knowledge of the characteristics of the specific building.
It is absolutely always recommended when you want to build a heating system and is mandatory above a threshold of thermal power determined by the laws in force.

1.1.2 Approximate calculation

In order to be able to determine in a more approximate way the necessary power demand, before moving on to the executive phase of the analytical calculation, it is possible to use a free tool of much simpler and more immediate use, available on the Robur website.
It is a software that allows you to determine the heating demand in first approximation, according to some simple characteristics of the building, generally known or estimated without excessive approximations.
The software requires you to enter:
- Desired room temperature
- Outdoor design temperature
- Building dimensions (length, width, average height)
- Wall surface
- Glazed surface
- Surface dispersion characteristics (categorized by predefined types, to simplify the choice)
- Number of air changes per hour
- Possible oversizing required

However, this software does not replace the tools needed to determine, exactly, according to the law and by a qualified professional, the real heating demand for the building, which is required for the executive design.

1.1.3 Approximate sizing

In order to provide only an approximate indication of the presumed power demand, useful perhaps when evaluating the order of magnitude of an investment, but there is still no data available or even only estimable on the building, it is possible to use an extremely simple calculation formula that allows, albeit with great approximation, to have an idea of the thermal power that may be required for heating the building.
Obviously, this kind of calculation does not take into account the needs for ventilation, which will have to be properly calculated when it comes to making a more accurate sizing.
The formula to be used for approximate sizing is:
$W\ [W] = S\ [m^2] \times \Delta t\ [K] \times K\ [W/m^2\ K]$
where:
- W is the heating demand of the building in W
- S is the dissipating surface of the building (floor, walls, ceiling) in m^2
- Δt is the temperature difference between the outdoor design temperature and the desired temperature inside the building, expressed in K
- K is the average transmittance of the building envelope, expressed in $W/m^2\ K$

The average transmittance of the building envelope can be estimated as follows:
- 0,4 for newly constructed industrial or craft buildings with high insulation
- 0,9 for recent industrial or craft buildings with medium insulation
- 1,5 for general industrial or craft buildings with low insulation
- 2,5 for old industrial or craft buildings not isolated
- 4,0 for temporary rooms made of wood, sheet metal or plastic, not insulated (e.g. greenhouses, tensile structures, etc.)

The recommended average transmittance value in the absence of any information about the building, provided it is an existing building, is 1,5 $W/m^2\ K$.
Some refinements of the results of the above formula are possible, taking into account:
- The lower dispersion to the floor (usually a fixed temperature of 2 or 5 °C is considered, depending on the region).
- The lower dispersion towards the walls in the presence of adjacent heated rooms (the dispersion actually zeroes) or even unheated rooms (the temperature difference is in any case lower than that with the outside temperature).
- The higher dispersions due to glazed surfaces (which may have transmittance coefficients of 5 $W/m^2\ K$ or higher in the absence of double glazing).
- The internal heat inputs (e.g. from heat-producing processes).
- The ventilation losses (a minimum of 0,3 renewal/hour can be estimated even for the opening of doors and gates to the outside, but the value can increase considerably if there is a minimum required air renewal or mechanical air extraction systems inside the building).
- The heat stratification effects in the presence of tall buildings.
- The effects due to intermittence in the use of the room (start-up of the installation).

This calculation does not replace in any case the tools needed to determine, exactly, according to the law and by a qualified professional, the real heating demand for the building, which is required for the executive design.

1.2 DETERMINATION OF THE TYPE AND NUMBER OF GAS UNIT HEATERS TO BE INSTALLED

Once the heating demand for the building has been determined, using one of the methods described in the Paragraph 1.1 *p. 1*, it is necessary to identify the correct type and number of gas unit heaters to be installed.
Information on the choice of the type has already been given in Section A01, which are summarized in the following Table 1.1 *p. 2*:

Table 1.1 *Gas unit heater selection guide*

	G	K	R	M
Efficiency	up to 105,7 %	up to 96,2 %	up to 94,5 %	up to 88,8 %
Burner type	premix	premix	premix	atmospheric
Burner modulation	30÷100%	50÷100%	two power levels (60÷100 %)	on/off
Air flow	modulating or fixed	modulating	fixed	fixed
Air flow	assiale	assiale	assiale centrifugal vertical downflow	assiale centrifugal
Models	4 models	4 models	7 axial fan models 4 centrifugal fan models 5 vertical downflow models	7 axial fan models 3 centrifugal fan models
Control	supplied digital chronothermostat	supplied digital chronothermostat	optional	optional
Price range	€€€€	€€€	€€	€

For the choice of the number of gas unit heaters it is useful to consider the following:

- It is always recommended, when possible, to install more gas unit heaters of lower power rather than a single gas unit heater of larger size. This allows for better heat distribution, better management of the heat output, lower noise emission and less risk in case one of the appliances is unavailable.
- In the same room it is recommended to install gas unit heaters of the same size (or similar), so as not to create areas with greater air flow.
- Few more powerful gas unit heaters have a purchase and installation cost only slightly less than several gas unit heaters of lower power (around 15 to 20 %).

1.3 POSITIONING OF FREE THROW GAS UNIT HEATERS

The positioning of the gas unit heaters must take into account:

- Installation height
- Air throw
- Possible presence and influence of several gas unit heaters

In any case, it should not be forgotten that the generators must be powered (and therefore the gas pipe must be brought to each one) and the flue gas must be correctly evacuated (and the combustion air must be supplied, if the installation must be of type C).

For fuel gas supply, refer to Section C01.10.

For flue gas exhaust and combustion air supply, refer to Section C01.02.

For G series gas unit heaters, the correct evacuation of flue gas condensate must also be provided.

1.3.1 Installation height

The optimum recommended height from the ground to the base of the gas unit heater is 2,2 to 3,5 m, depending on the size of the gas unit heater itself, as shown in the following tables.

Table 1.2 *Gas unit heaters installation height*

		G30	G45	G60	G100	K32	K45	K60	K100
Installation data									
recommended height	m	3,0 ÷ 3,5							

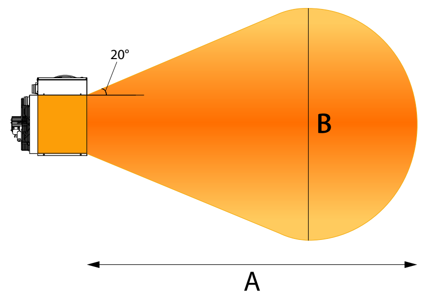
		R15	R20	R30	R40	R50	R60	R80	M20	M25	M30	M35	M40	M50	M60
Installation data															
recommended height	m	2,2	2,5	3,0 ÷ 3,5					2,5	2,5 ÷ 3,0	3,0 ÷ 3,5				

Lower heights than recommended result in air entering the occupied space at a still high speed, with potential discomfort for the people who are affected.
Heights higher than recommended could create stagnation of cold air (denser) in the area close to the floor, and therefore the flow of warm air would tend to "float" above the layer of cold air, preventing the warm air from reaching the occupied space.
The latter problem could be solved, at least in part, by tilting the louvres of the delivery grille more inclined, with a consequent reduction in the air throw of the gas unit heater.

1.3.2 Air throw

The air throw of a gas unit heater is the distance from its outlet at which the residual air speed is ≤ 0,5 m/s.
The following Figure 1.1 *p. 2* shows the shape of the air throw. Dimension B (air throw width) is about 70% of the air throw value for the specific gas unit heater model.

Figure 1.1 *Air throw shape*



A Air throw
B Air throw width

The throw does not indicate the area affected by the heating, but only the area directly affected by the movement of the air produced by the fans.

The heated zone is in fact much larger than the one identified by the air throw value alone and depends on the height of the building and the obstacles and air currents that the air flow coming out of the gas unit heater meets on its path.

For the correct choice of gas unit heaters, it is essential that the air throw does not directly hit the walls or any obstacles in front of the gas unit heater itself, as this would partially cancel out the contribution of the gas unit heater to the room heating and increase dispersion (in the case of a throw that hits a perimeter wall).

In addition, the air throw allows a complete mixing of the warm air coming out from the gas unit heater with the room air (inductive effect), which significantly reduces the stratification of the warm air.

The following Table 1.3 *p. 3* summarizes the air throws for all gas unit heater models.

Table 1.3 *Gas unit heaters air throw*

		G30	G45	G60	G100	K32	K45	K60	K100
Heating mode									
lenght of throw (residual speed < 0,5 m/s) (1)	m	18,0	25,0	31,0	40,0	18,0	25,0	31,0	40,0

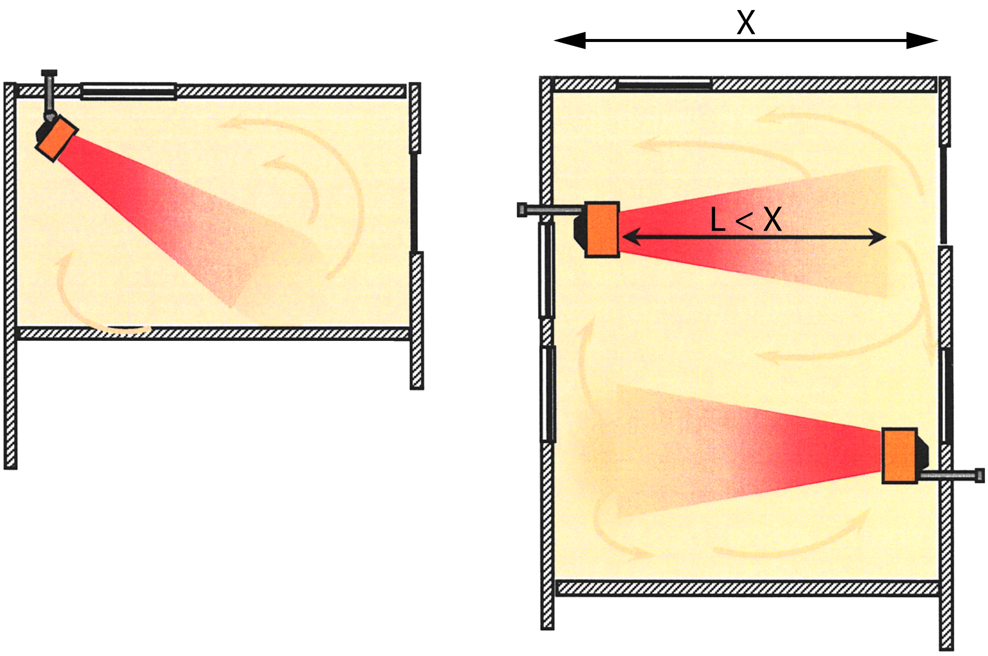
(1) Values measured in an open area; in a real installation, the thermal flow may reach greater distances than those given here (depending on the height of the ceiling and its thermal insulation).

		R15	R20	R30	R40	R50	R60	R80	M20	M25	M30	M35	M40	M50	M60
Heating mode															
lenght of throw (residual speed < 0,5 m/s) (1)	m	13,0	15,0	18,0	20,0	25,0	28,0	40,0	12,0	15,0	18,0	20,0	21,0	23,0	25,0

(1) Values measured in an open area; in a real installation, the thermal flow may reach greater distances than those given here (depending on the height of the ceiling and its thermal insulation).

When positioning the gas unit heater, its throw should be at about 75% of the distance between the gas unit heater and the opposite wall (Figure 1.2 *p. 3*).

Figure 1.2 *Gas unit heaters air throw*

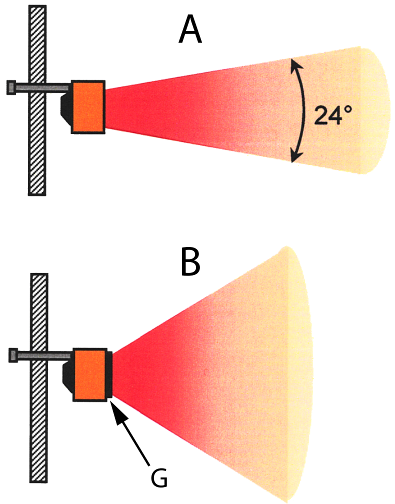


L Gas unit heater air throw
X Distance between the installation point of the gas unit heater and the opposite wall

In case the building has a smaller size than the air throw of the gas unit heater, it is advisable to use vertical diffusion louvres, available as an optional.

The louvres can be oriented with more or less accentuated inclinations with respect to the normal throw direction, obtaining a shorter and wider diffusion cone (Figure 1.3 *p. 4*).

Figure 1.3 *Outgoing air flow from the gas unit heater*



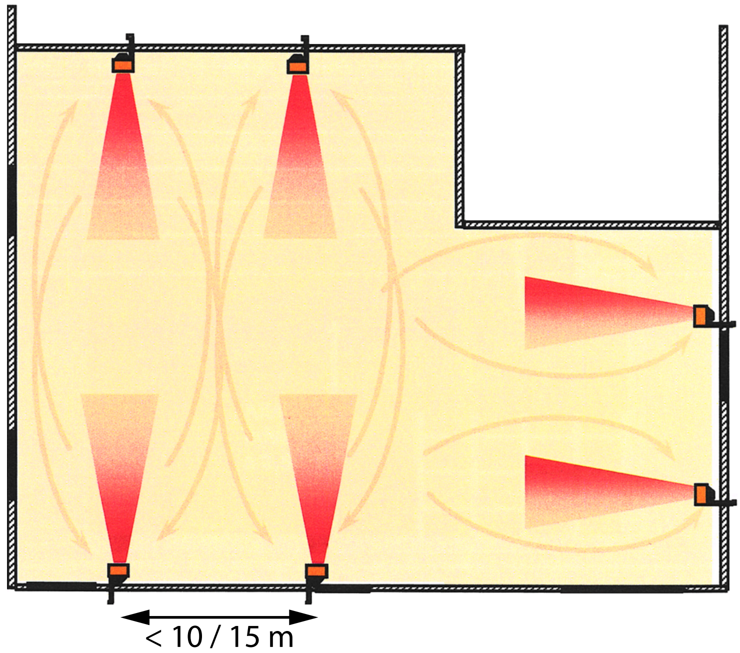
A Outgoing air flow from the gas unit heater without vertical louvres
B Outgoing air flow from the gas unit heater with vertical louvres
G Optional vertical louvres

More information on louvres can be found in Section C01.06.

1.3.3 Possible presence of several gas unit heaters

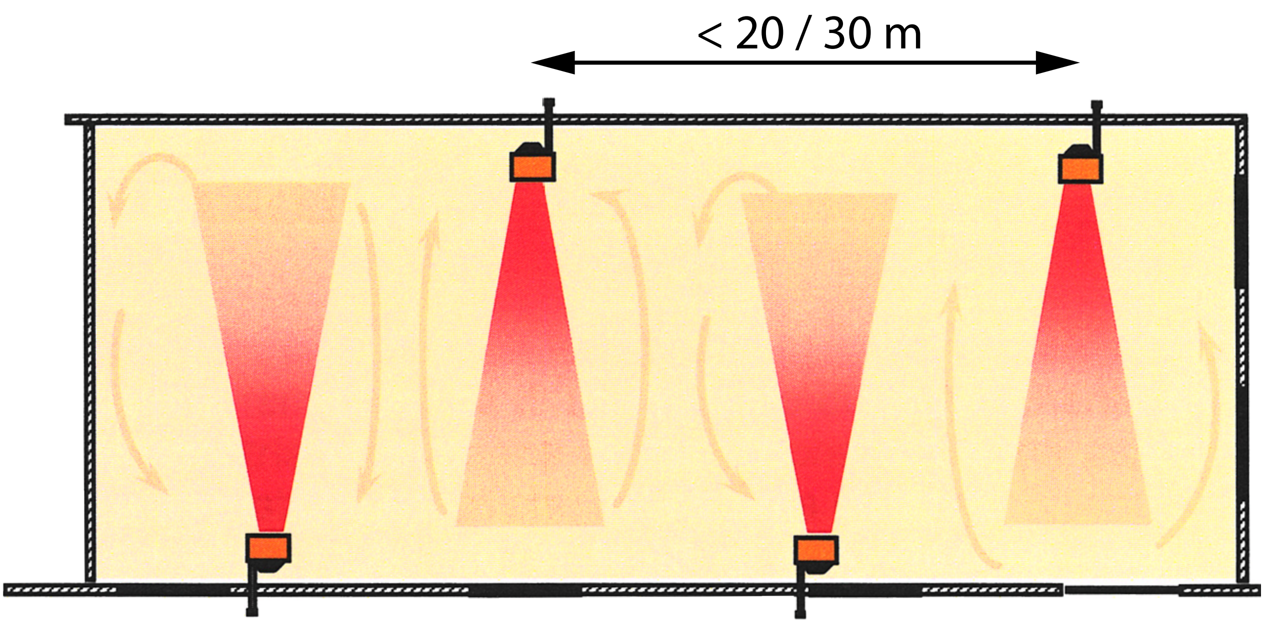
In the case of installation of several gas unit heaters serving the same room, it is important that they are positioned in such a way as to avoid on the one hand the mutual interference of warm air thwors, which would lead to an excessive heat concentration and potential annoying turbulence, and on the other hand an excessive distance between the gas unit heaters themselves, which would lead to an uneven distribution of heat, with consequent lower comfort zones.
The recommended choice is to position the gas unit heaters along the "cold" perimeter, with the air throw facing inwards.
An example of this configuration is shown in Figure 1.4 *p. 4* below.

Figure 1.4 *Example of installation of gas unit heaters in large rooms*



Even if the air throw is not sufficient to overlap the warm air throws, this should not cause alarm, considering that the central part of the building, being the least exposed to dispersion from the walls, usually needs less warm air supply to be adequately heated.
It should be avoided to have all the gas unit heaters placed on one side of the building if you are not sure that the air throw will reach the opposite cold area, as this could lead to a stagnation of cold air near the opposite wall, which would not be adequately reached by the flowing air. In these cases the advice is to install the gas unit heaters on walls and in opposite throw directions (Figure 1.5 *p. 5*).

Figure 1.5 *Example of installation with opposing flows*



In both cases it is noted that the maximum distance between the air flows of the gas unit heaters should not exceed 10/15 m.

1.4 POSITIONING OF DUCTABLE GAS UNIT HEATERS

The ductable gas unit heaters allow to transfer the warm air produced in areas even far away from the gas unit heater, using appropriate air ducts.
The choice to use a ducted gas unit heater also has another purpose, that is to introduce in the heated rooms warm air at low/very low speed. This is the case, for example, of productions where the type of processing requires a minimum air movement (spinning, processing of dusty material, presence of dust that can be lifted by excessive air flow).
The positioning of the ducted gas unit heater can take place inside the same room or in another room, different from the heated one, by means of an air duct, but always inside the buildings.
The presence of a centrifugal fan serving the gas unit heater presupposes a higher noise level, which must be taken into account when choosing the gas unit heater position.

1.4.1 Positioning in a room other than the heated one

In case the gas unit heater is placed in a different room from the heated one, it is important to remember that:

- The gas unit heater sucks the air from the room where it is installed and sends it warm through the ducting. The heated room must therefore be connected to that of the gas unit heater.
- The rooms may be connected by means of openings or transit grids which must never be obstructed or closed.
- If there are louvres equipped with air filters, remember to keep them clean with periodic maintenance that will depend on the degree of impurities in the ambient air.
- The louvres that allow the return of ventilation air to the gas unit heater should have a passage section at least twice as large as the supply duct section, in order to reduce crossing speed, pressure drop and noise.
- If the air entering the gas unit heater fan cannot be taken from the heated room, it will be necessary to provide an opening in the installation room that allows the necessary air to enter. If this is taken from outside, this must be taken into account when calculating the building's heat demand. In addition, it will be necessary to assess the need to install appropriate pressure relief dampers inside the heated room.
- The installation of a gas unit heater in another room than the heated one for fire prevention issues does not exempt from the verification of all safety and fire prevention regulations (e.g. it may be necessary to install a fire damper or a partition with specific fire, heat and smoke resistance characteristics).

1.4.2 Air ducting design

The air ducting must be designed and sized taking into account:

- minimum air flow to be granted to the gas unit heater (air flow at maximum useful head)
- minimum pressure drop on heat flow delivery
- maximum useful head of the centrifugal fan

The latter data is useful for the correct sizing of the air duct which must not have pressure losses greater than the fan head.
For information, It's useful to remind that the largest pressure drops in an air duct do not due to straight duct sections, but to localised pressure drops such as narrowings, changes of direction and above all the heat emission vents in the room.
The application of a minimum pressure drop on the heat flow delivery, where necessary, serves to operate the centrifugal fan within its working curve.
For air ducts for medium/large size gas unit heaters, it is recommended to use the constant pressure drop method (tapering of the ducts along the lenght).

Further information on air ducting is available in Section C01.07.

Further information on fan characteristic curves and residual head available for the various models can be found in Section C01.08.