

Zoning

- Natural gas roof units must be used, apart from the following cases:
- low capacity roof units (4 tons or less) which do not serve an open area;
 - rooftop units serving heat areas that are too different (see notes on zoning); and
 - any units serving internal areas only (continuous cooling demand all year long), unless there is a significant need for fresh air requiring heating.

Additional tips and zoning information provided as an illustration of design principles

- Roof units must serve spaces that will have the same energy profile. Example:
- offices along the same facade of the building (peripheral areas);
 - a large interior open area (not including peripheral areas); and
 - spaces with large and sudden energy requirements (e.g. opening of large doors). Legend - Zoning for information

Zone	Surface* m ² (ft ²)	Air conditioning* Tons
Area 1: Internal	232 (2,486)	4
Area 2: Small offices	147 (1,582)	8.5
Area 3: Open space	315 (3,390)	9
Area 4: Small offices	236 (2,540)	13
Boutique	474 (5,102)	18.5
Garage	448 (4,822)	-
Warehouse A	633 (6,817)	-
Warehouse B	633 (6,817)	-

Natural gas installations

General note

All natural gas installations (piping, equipment, meter, etc.) must comply with Chapter I, Building and Chapter II, Gas CO₂ of the National Building Code of Canada (amended)-Quebec and CSA code B149.1 "Natural gas and propane installation code."

Pipe supports

1. Pipes must be installed, supported and fixed to allow for thermal expansion.
2. The supports must also enable resistance to vibrations and shocks, and allow for building's stabilization movements.
3. The maximum spacing between supports must be in accordance with the table provided in this document.
4. Installation of pipe supports must follow anti-seismic principles. The distance between each anti-seismic support is illustrated in the table provided here.

Examples of operating sequences

Roof units

The units are programmed according to the building's occupancy schedule:

- At all times, the natural gas heating stages must be turned off if the supply high temperature limit determined by the engineer.
- At all times, the natural gas heating stages must function for a minimum duration of 5 minutes* once they are activated, and not be reactivated for 5 minutes* afterwards, so as to minimize short-cycling.
- At all times, if the rooftop unit has a constant flow, the by-pass component is modulated to maintain a static pressure point in the ducts. This instruction is determined during balancing.
- At all times, if the unit has a variable speed fan, it is modulated to satisfy the maximum demand zone at which the VAV box opens between its minimum and maximum levels.

During occupied periods, the units function in one of the following modes:

1. Average demand: the heating stages begin according to the demand threshold of the average of all rooms.
2. Average of the three highest levels of air conditioning demand: only the three areas with the highest demand for air conditioning (therefore the lowest for heating) can initiate the gas heating stages.

The mode is chosen by the designer according to the energy needs profile of the rooms. For example, a unit serving glass-walled rooms facing south could use the mode based on the average of the three highest levels of air conditioning demand.

If the roof unit can modulate the gas heating power, the sequence changes as follows:

- During occupied periods, the unit maintains a set point for supply based on one of the following modes:
 - Average demand;
 - Average of three highest levels of air conditioning demand.
- The set point for supply varies between its minimum and maximum point as the need for heating increases. The maximum should not surpass 8°C* above the average temperature of rooms.

During occupied periods, the fresh air component is modulated to maintain the set point of CO₂. It is modulated from its minimum position to its maximum position in a linear manner when the reading is between the minimum and maximum CO₂ points. During unoccupied periods, the setpoint maintained in all the rooms is the night setback setpoint determined in the project. The fresh air component remains closed for this whole period.

During unoccupied periods, if a room's temperature decreases 1°C* below the night setback setpoint, the unit is turned on and the calculation of the rooms' demand from the unit is limited at a maximum heating demand, provided that the temperature of all the unoccupied rooms is below the set point (S.P) +1°C*. When the unit restarts, the temperature setpoint of the heated rooms is modified to ensure that the VAVs are open until the unit turns off.

Two hours before the occupied period begins, the units go into restart mode. The S.P. for rooms is equal to the S.P. for occupied periods, but the fresh air dampers remain closed during this period.

During this two-hour period, if electric baseboards are present in the rooms, they must be kept from functioning so that natural gas units take priority.

Areas

During occupied periods, the thermostat in each area modulates the VAV box (and its electric baseboard, if it has one) to maintain the room within its dead band.

If electric heating coils are used, they may operate only when the supplied air temperature is cooler than room's S.P. and when the room is in heating mode.

The electric baseboard is modulated from zero to 100% based on the heating demand between the minimum and maximum points of demand.

During heating, the VAV box opens when the unit's supply temperature is higher than the room's S.P. When the demand for heating reaches a sufficient threshold (to be determined by the designer), the box must open for full flow (100%) to facilitate the movement of air and heating, provided that the demand has not decreased to 0%.

During unoccupied periods, the electric baseboards cannot be used unless the room's temperature decreases more than 2°C* below the night setback setpoint.

Ventilation

1. For unvented infrared heaters, the fan must be installed above the level of the heating panel installation. Interlock the heating unit's operations with the fan. Plan the air supply system using a compliant method (e.g. ventilation or combustion air opening or direct-fired make-up air unit not shown in the diagram). See Art. 7.23 of CSA code B149.1.
2. In certain cases, the capacity of an electric or hydronic baseboard heater can be lowered if the unit is far enough from a window to avoid drafts, and if the roof unit has a sufficient level of modulation to avoid cycling (continuous heating). The purpose of baseboards is to provide additional heat and cut the cold air flow on people's feet. Selecting diffusers and placing them in the right location may eliminate the need for baseboards if the roof unit is well located and it is likely that all areas will be in constant need of heating.
3. To determine whether electric or hydronic baseboards are needed, ask the client if workstations will be installed at least 3 feet from the windows.
4. See the Notes section.
5. The sum of maximum flows in areas not served by the unit must be over 100% of the unit's nominal flow (for example 120%). The areas must adapt to demand so that the demand is 100% of the unit's nominal flow at all times.
6. Plans for an area must include control over each room by means of local thermostats that control baseboards and terminal vents. For constant flow systems (without a VAV box), it is important to have one or several thermostats in representative areas.
7. Select the type of diffuser according to the ceiling heights, in order to avoid stratification.
8. Not included in the illustration: CO detection system and air compensation to be planned as necessary - please consult the respective information sheets on commercial installation.
9. For taller stores, take care when selecting diffusers if the ceilings are higher than 16 feet (avoid using conventional diffusers).

Avoid using air duct networks that are too restrictive or oversized as they prevent the unit from reaching its nominal flow. Some generally useful tips:

- Slightly oversize ducts - properly size the ducting while leaving room for manoeuvre between design and fan capacity. That margin allows for changes that arise due to site conditions and filter contamination. It is best to use a recognized method of testing air-side pressure drops, such as those used in ASHRAE standards.
- Use a larger fan motor if the ventilation ducts are more restrictive than expected, or if the building's configuration makes it difficult to optimize the ducts layout.
- Use optimized duct transitions (long-radius elbows, turning vanes) and transitions that minimize losses in the ventilation ducts.

Selection of equipment: tips to consider

Maximize the potential of natural gas rooftop units.

- Carefully size the units for air conditioning (avoid oversizing).
- Unless there is a large supply of outside air or other exceptional circumstances, choose the smallest natural gas heating capacity available from the manufacturer (a lower capacity enables longer heating by the natural gas burner, even if cold peaks require the electric baseboards installed to complement as last heating stage).
- Choose equipment with at least two heating stages.
- Give preference to airtight units:
 - access panel with a handle that closes securely;
 - economizers that comply with ASHRAE 90.1 for the leak rate.

(Equipment with useful options to reduce the infiltration of cold air in the winter, that require less heating power and reduce the probability of fluctuations in the supply temperature.)

- Use CO₂ sensors - the heating of outside air is a major heating requirement. Adjusting the quantity introduced into the building according to the number of occupants can substantially reduce such heating needs. Be mindful of the location of the CO₂ sensor. Comply with ASHRAE Standard 62.1 in effect.

- Advanced options: choose high-efficiency units to maximize energy performance and comfort.
 - a. variable-speed fan;
 - b. burner with multiple stages and modulation; and
 - c. highly water-tight cabinet and economizers.

These options reduce more constant heating with the air system, which enables the effect of hot air gusts.

With these options, it is also easier to comply with ASHRAE standards, which stipulate that a maximum gap in temperature must be maintained between the system's supply temperature and the room's temperature. Complying with this standard not only makes it possible to enhance comfort by reducing temperature fluctuations, but also eliminates the need to increase the outside air flow required by ASHRAE standard 90.1 to overcome the problem of hot air stratification.

The price of equipment with advanced options may be significantly higher than for a standard unit; however, a part of this additional cost may be recovered from other advantages in the design:

- elimination of by-pass dampers at the unit;
- reduction or elimination of terminal electric reheating, with possible impact (reduction) on the required electrical supply; and
- reduction of electric peak demand (when combined with terminal electric heating).

Diffusers

If roof units are used to compensate for the main heating needs, special attention should be given to the selection of diffusers so that they can adequately mix the hot air in a room (avoid stratification) and prevent people from feeling drafts.

Validate the choice of diffusers for heating and cooling.

Note: based on the ceiling height, on the diffusers' placement with respect to the occupants, and on expected air supply temperatures, specialized models can be used to obtain an optimized diffusion for heating.

Piping

1. A condensation model when floor drains are available nearby (connection of the condensate drainage).
2. For the design of high- or low-intensity infrared heating systems, consult Article 7.23 of CSA B149.1 and the manufacturer's instructions.
3. Validate the available gas pressure with Energir based on the capacity of natural gas equipment to optimize pipe sizes.
4. Pipe sizing: Refer to Article 6.3 of Code B149.1 and to Energir's calculator for natural gas pipe sizing.
5. Gas pipes must be equipped with expansion control loops in accordance with Article 6.25.3 and Annex G of CSA Code B149.1.
6. See gas meter typical detail.
7. Gas pipes must be supported according to the requirements of CSA code B149.1 and the anti-seismic protection requirements in effect. Refer to the section on pipe mounting requirements.
8. Leave a minimum clearance of 18" as per Article 7.28.4 of CSA B149.1.
9. Locate roof and wall vents in compliance with applicable codes. Coordinate with the architect.

Note

1. Maintain a minimum distance from the edge of the roof so as to facilitate snow removal and the work of technicians, and for aesthetic reasons (Art. 4.14.6 of CSA code B149.1).

List of HVAC units*

ID	Type	Brand	Model	CFM	ESP	HP	Cap. (MBH input)	Mod.	Heating	Electricity	Notes
AC-01	Roof	XXXXXX	XXXX048	1,600	-	2	4	2 stages	Elec. 120 kW	600/3	1, 3, 4, 6, 7, 8, 9, 10
AC-02	Roof	XXXXXX	XXXX102	3,400	-	3	8.5	2 stages	Natural 120 MBH	2 stages	1, 2, 3, 5, 6, 7, 8, 9, 10
AC-03	Roof	XXXXXX	XXXX102	3,400	-	3	8.5	2 stages	Natural 120 MBH	2 stages	1, 2, 3, 5, 6, 7, 8, 9, 10
AC-04	Roof	XXXXXX	XXXX150	5,000	-	5	12.5	2 stages	Natural 180 MBH	2 stages	1, 2, 3, 5, 6, 7, 8, 9, 10
AC-05	Roof	XXXXXX	XXXX240	10,000	-	7.5	20	4 stages	Natural 300 MBH	2 stages	1, 2, 3, 5, 6, 7, 8, 9, 10, 11

- Notes
- * Economizer with outside air components controlled by the 0-10 V signal
 - CO₂ sensor integrated in the unit
 - Outside air components qualified according to ASHRAE standard 90.1
 - Barometric exhaust component with BACHNET BTL centralized control system compatibility and/or smart internal controller (to be determined)
 - Exhaust fan for units of 7.5 tons or more
 - Hinged doors with handles enabling a airtight closing
 - Roof base with a minimum height of 18" with Rockwool insulation
 - Disconnector integrated into the unit
 - Sealing of the unit's base with insulating polyethylene foam by a general contractor
 - Unit controller with BACHNET BTL centralized control system compatibility and/or smart internal controller (to be determined)
 - Variable-speed fan controlled by the activation of heating and cooling stages

List of radiant panel heating devices*

ID	Brand	Model	Cap. (MBH input)	Tension Volts	Notes
IRF-01	XXXXXX	XXXX150-50	150	120/1/60	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

- Notes
- Fine tube made of aluminum steel (or equivalent)
 - Induction fan with negative pressure without maintenance
 - Electronic ignition
 - Safety cut-off switch in case of blockage of the air flow
 - 1 Gas valve with two heating stages
 - Aluminum reflectors with over 95% reflectivity
 - Reflectors ending below the level of the radiant tube
 - Guarantee of 10 years for the burner
 - Guarantee of 5 years for the tubes
 - Infrared heating devices are eligible for a grant under Energir's Efficient Devices +
 - Business energy efficiency programme
 - For more details, please see the information sheets on installing commercial natural gas equipment

List of water heaters*

ID	Brand	Model	Cap. (MBH input)	Mod.	Notes
CE-01	XXXXXX	XXXX199	199	120/1	1, 2, 3, 4, 5, 6, 7, 8, 9, 10

- Notes
- Condensing water heater
 - Stainless steel exchanger
 - Low NO_x emission burner (20 ppm)
 - Pressure gauge, observation door for the burner and detection of gas leaks
 - Electronic ignition
 - Mechanical exhaust duct for combustion gases (equivalent to up to 100 feet of pipes)
 - Integrated circulator
 - Microprocessor control for at least 5 cascading units
 - Minimum guarantee of 10 years for the heat exchanger
 - High-efficiency water heaters are eligible for a grant under Energir's Efficient Devices + Business energy efficiency programme

List of unit heaters*

ID	Brand	Model	Cap. (MBH input)	Effectiveness	Tension Volts	Notes
AE-01	XXXXXX	XXXX150	150	82%	120/1/60	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
AE-02	XXXXXX	XXXXX75	75	see note 11	120/1/60	2, 3, 4, 5, 6, 7, 8, 9, 10, 11

- Notes
- Aluminum steel heat exchanger
 - Single-stage gas valve
 - Electronic ignition
 - Mechanical exhaust duct for combustion gases
 - Vent cap approved by the manufacturer
 - Separate combustion
 - Outside air cap approved by the manufacturer
 - AL29-4C stainless steel heat exchanger
 - Condensate neutralizer kit
 - Guarantee of 10 years for the heat exchanger
 - Condensation models are eligible for a grant under Energir's Efficient Devices + Business energy efficiency programme

* Recommended for efficient projects

* Recommended for higher-efficiency projects

Thank you to our partners.

Project
Efficient Design Guide

Title
Small commercial buildings with rooftop units

Plan number: CE-8796-02-PCBUT-01-EN

Revision : 07

Creation date: September 2019

Last update: January 2020

By: Mathieu Rondeau, P. Eng for Energir

FOR TRAINING PURPOSES

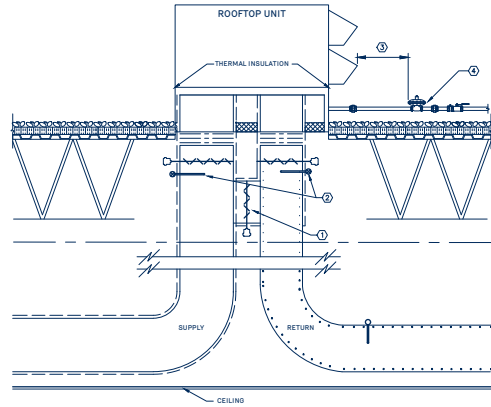
This is a training document only. It must not be used for construction, manufacturing or installation purposes. It is your responsibility to validate the provided information with appropriate professionals and if codes and standards identified in this document were modified or replaced. This document does not replace, in whole or in part, the regulations in force.

* Estimates and assumptions for illustrating concepts.

energir

Roof unit and primary distribution

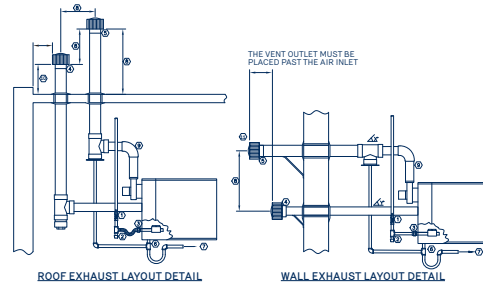
- By-pass dampers for units with a constant-flow fan. See the reverse side of the HVAC unit tables.
- Install temperature sensors between the unit and by-pass valve. A bypass component located directly between supply and return is not a good practice as the unit's cycling takes place at the roof. It is preferable for the bypass to be located two-thirds of the way through the supply duct's air flow passage and for the air to be released directly into the ceiling space.
- Ensure the minimum clearance (See Art. 8.14.8 of CSA code B149.1).
- Ensure installation at a height where the regulator is above the snow level.



Unit heater



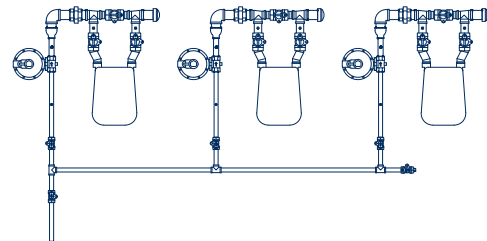
- Manual shut off valve.
- Drip and dirt pockets. See Art. 6.13 of CSA code B149.1.
- Gas connector complying with CSA 6.10.
- Outside air cap approved by the manufacturer (see the equipment table for separate combustion units).
- Vent cap approved by the manufacturer.
- Condensate drain.
- Towards the neutralization and drain system for condensation devices.
- Follow the manufacturer's recommendations and code provisions for the required clearances.
- ULCS636-certified fume stack Materials based on manufacturer's requirements.
- To keep leaves or snow from obstructing the air inlet, particular attention must be given to ground clearance (typically 18 inches).
- Be mindful of the required clearance. See Art. 8.14.8 of CSA code B149.1-15.



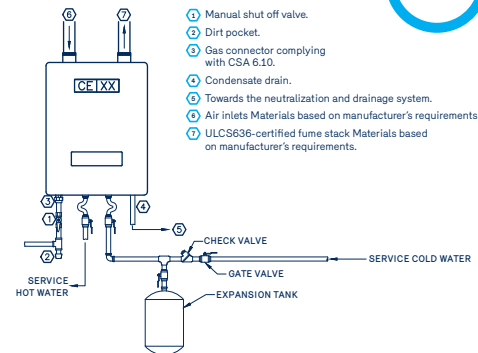
For more details, please refer to Énergir's information sheets on "Fiches d'installation des équipements à gaz naturel - Commercial"
 ✎ Validate based on the manufacturer's requirements. Example: ¼ in. per linear foot.

Connection of the gas meter

- Respect the minimum distances between the vent outlets of the exhaust duct regulators and the air inlets (See Art. 5.5.9, Table 5.2, and Art. 8.14.8 of CSA code B149.1).
- For emergency generators, please refer to the relevant presentation for details on connection.
- For the characteristics of connection types and suggestions for layouts in buildings, consult Énergir's guide on integrating natural gas to buildings.



Tankless condensation water heaters



For the design and selection of plastic combustion gas vent systems, see GA-12 of the CMMTO and RBO in partnership with Énergir.

Standards

Standards to consider (not limited to):

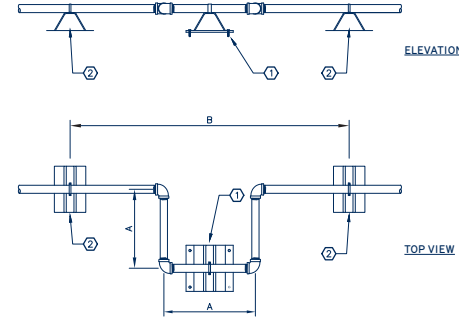
- ASHRAE Handbook HVAC Applications, 2019 edition, Chapter 51, Service Water Heating
- ASHRAE Handbook Systems and Equipment, 2016 edition, Chapter 16, Infrared Radiant Heating
- ASHRAE Handbook Systems and Equipment, 2016 edition, Chapter 49, Unitary Air Conditioners and Heat Pumps
- ASHRAE 62.1 Ventilation for Acceptable Indoor Air Quality. The 2004 version is cross-referenced in the National Building Code, modified for Québec, 2010 version
- ASHRAE 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings, the most recent standard

Natural gas pipes

Expansion loop for natural gas pipes installed outdoors or exposed to the cold Art. 6.25.3 of CSA code B149.1.

- Anchors for seismic requirements (see typical details) can be installed in the middle of the loop so as to enable adequate expansion.
- Pipe supports on the roof. See typical details on the reverse side for "B" spacing.

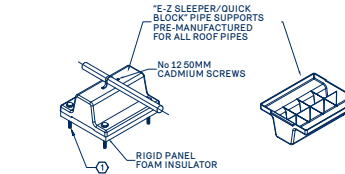
DIAMETER OF IRON PIPE, inches	WALL WIDTH (SCHEDULE 40), inches (mm)	DIMENSION A, feet (mm)
3/4	0.133 (3.38)	4.5 (1.37)
1	0.133 (3.38)	6.0 (1.83)
1 1/4	0.140 (3.56)	6.0 (1.83)
1 1/2	0.145 (3.68)	6.0 (1.83)
2	0.154 (3.91)	6.5 (2.00)



Pipe supports

- Seismic restraints anchors required every 40 feet. Anchors must be securely fastened to the building's structure and prevent any movement.

SPACING OF PIPE SUPPORTS	
PIPE DIAMETER (NPS)	DIMENSION B MAXIMUM SUPPORT SPACING, feet (mm)
1" OR (1) INSTALLED ON ROOFS - HORIZONTAL	4 (1.23)
1/2" OR LESS - HORIZONTAL	6 (2)
3/4" TO 1" - HORIZONTAL	8 (2.5)
1 1/4" TO 2 1/2" - HORIZONTAL	10 (3)
3" TO 4" - HORIZONTAL	16 (5)
6" TO 8" - HORIZONTAL	20 (6)
10" OR MORE - HORIZONTAL	26 (8)
STANDARDS TO CONSULT (NOT LIMITED TO):	
ALL DIAMETERS - VERTICAL	AT THE LEVEL OF EACH FLOOR, A MAXIMUM OF 20% OF HORIZONTAL SPACING
TUBES - ALL DIAMETERS - VERTICAL AND HORIZONTAL	6 (2)



ELEMENTS SUPPLIED AND INSTALLED BY THE PLUMBING CONTRACTOR:
 GALVANIZED STEEL CONNECTOR. PAINT THE CONNECTORS WITH NON-CORROSIVE PAINT.

Codes and Specifications to respect

Codes and Specifications to consider (not limited to):

- The National Building Code, modified for Québec, 2010 version
- Québec Construction Code (CCO), Québec version, current edition
- Code B149.1-2015 Natural gas and propane installation code, which forms an integral part of Chapter II, Gas, of the CCO
- Québec Construction Code (CCO), Chapter III, Plumbing, current edition

Other documents

Technical data sheets, installation and operating manuals of equipment manufacturers

Grants

Financial assistance is available for the integration of efficient design elements recommended in this guide as part of Énergir's "Efficient Devices - Businesses" energy efficiency programme. Consult your client's Énergir Sales representative or Certified Partner for natural gas before you install any equipment. Simplified forms are also available to you on our website.

Recommendations and specifications of responsibilities

Anyone can apply for a grant for an Énergir client. However, to ensure the application is made before the work begins, specify in your quote who is responsible for applying for the Énergir grant. The application can be made by:

- the client,
- the contractor in charge of supplying the client with gas;
- the client's general contractor;
- or the client's engineer.

It is also important to specify who will submit the "Déclaration de travaux Installations de gaz" to the Régie du bâtiment du Québec (RBQ) and Énergir within the required time frames to obtain financial assistance.

For the incorporation of measures recommended for rooftop units, the engineer must provide the supporting documents required in the Participant's Guide, study and implementation to obtain the grant.

If there are changes to the equipment brands, models or capabilities during the course of the work, the contractor must notify Énergir of the changes and inform the client of any change with respect to the financial assistance granted.



Thank you to our partners.

Project
Efficient Design Guide

Title
Small commercial buildings with rooftop units

Plan number: CE-8796-02-PBCUT-02-EN

Revision : 07

Creation date: September 2019

Last update: January 2020

By: Mathieu Rondeau, P. Eng for Énergir

FOR TRAINING PURPOSES

This is a training document only. It must not be used for construction, manufacturing or installation purposes. It is your responsibility to validate the provided information with appropriate professionals and if codes and standards identified in this document were modified or replaced. This document does not replace, in whole or in part, the regulations in force.

* Estimates and assumptions for illustrating concepts.

