TOPRING AIR LINE
DESIGN GUIDE
SERIES 5

TOPRING

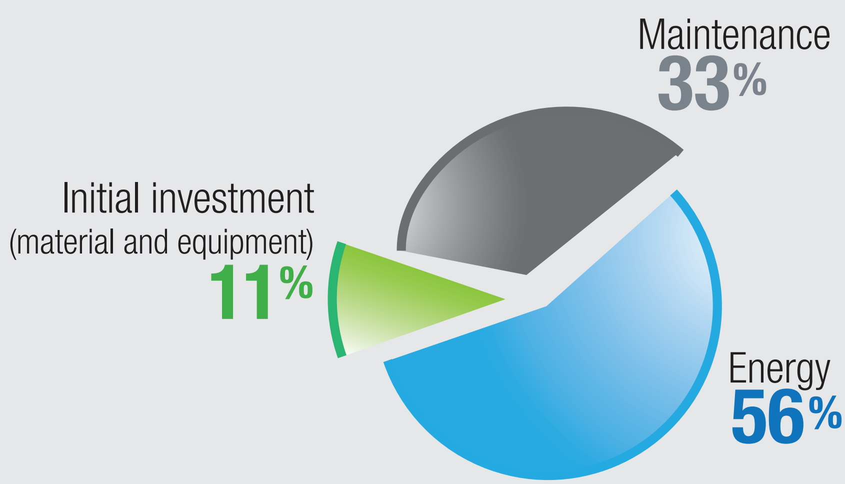
COMPRESSED AIR HAS A COST

Compressed air is a significant source of energy that is used by many different industries. A properly planned compressed air system is energy-efficient and reduces the cost of producing and distributing compressed air. The chart below shows the distribution of costs for a compressed air system.

Because energy and maintenance costs can represent up to 90% of total costs, the compressed air system must be leaktight, durable, and built with high-quality materials.

Electricity costs will be 1% higher for every additional 2 PSI maintained in the system.

Breakdown of costs associated to compressed air system over 10 years



Compressed air accounts for about 10% of industrial electricity consumption, which can represent tens of thousands of dollars every year

Source: approximate costs, Hydro-Québec

The **AIR LINE** piping system delivers an efficient, durable compressed air system.
The polyamide pipes and push-to-connect fittings are corrosion-resistant and easy to install.

This design guide details the elements to consider when building a compressed air system with the **AIR LINE** piping system.

To find out more about the benefits of this series, refer to the Series 5 **AIR LINE** catalogue on **TOPRING**.com.

SYSTEM PLANNING

1. Estimating air requirements by application

Every compressed air system project is unique because user needs vary widely and can be met through a number of configuration options. The first step is to identify the types of applications involved in the project. Consider:

1. The number of pneumatic tools and equipment to be used
2. The total air volume required (SCFM)
3. The air quality required
4. The operating conditions
5. The choice of compressor

TECH TIP

The volume of air produced by the compressor will affect the choice of pipe diameters for the main system. Typically, a compressor produces about 4 SCFM per HP when air is produced at 100 PSIG.

2. Determining the layout of the plant and workstations

A plant layout showing the location of workstations is needed to determine the system's length in linear feet. In addition, the following information must be known:

1. The structure of the building
2. Whether it's a ceiling- or wall-mounted installation
   - If the system is installed on the ceiling, what is its height?
   - If the system is mounted on the walls, are there any obstacles to bypass or avoid (e.g., beams)?
3. The location of the compressor room: is it in an open or closed space? On the main floor or on a mezzanine?
4. The number of stories in the building
5. The location of workstations: are they close to walls, or in the middle of the space?
6. Is a future expansion planned? If so, at least 25% to 50% extra capacity should be added.

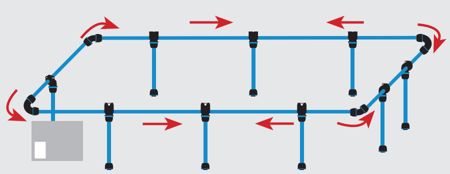
CAUTION

The piping system should never support loads other than its own weight, or be exposed to movement other than the normal expansion of its components. When planning the layout of a workstation, flexible hoses should be connected through sturdily attached hose reels or manifolds to isolate piping from tool weight and movement.

3. Configuring the system

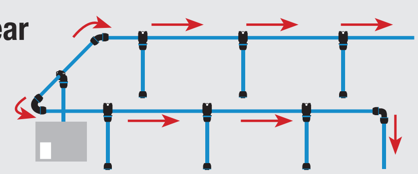
Depending on the workstation layout, there are two options for the optimal configuration of a compressed air system:

Closed loop (recommended)



- Compressed air flows through several lines simultaneously
- Pressure and airflow are balanced throughout the system
- Drops are powered by multiple sources
- Air supply is more efficient, which allows for the installation of pipes with smaller diameters (reducing costs)
- This type of system is easy to modify
- This type of system reduces pressure loss

Linear



A linear system is an option when a closed loop configuration is impossible.
To power the air in both directions, the compressor must be located in the center of the system (from the compressor to the farthest point of use).

For more information on the advantages of a closed loop configuration, see the "Menuiseries Belisle" case study on **TOPRING**.com.

4. Establishing pipe diameter sizing

The following information is needed to determine the pipe diameter for the main system and service outlets:

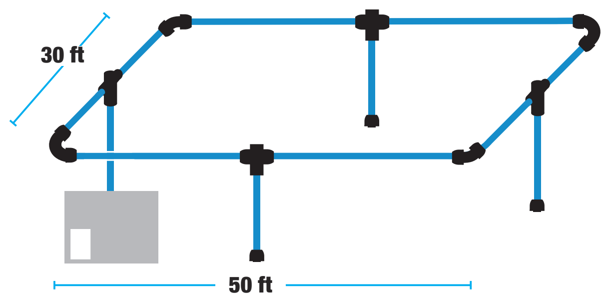
- The total airflow (SCFM) required by pneumatic tools and equipment
- The maximum length between the compressor and application
- The total length of the main line (linear feet)

Example of 5-step calculation for pipe diameter sizing

Step 1 Calculate the linear feet for the main line

Example:
Closed loop system with 4 drops in a plant measuring 50 ft x 30 ft

Total length of the line in linear feet
2 x 30 ft and 2 x 50 ft **= 160 ft**



Step 2 Calculate the total airflow required in SCFM

The pipe diameter must be big enough to transport sufficient air at the required pressure to all points of use. The required number of SCFM is indicated by the manufacturer of the pneumatic tools or equipment. As a reference, see table **C** on page 11.

Based on our example:

Four impact guns 1/2":	28,6 SCFM	x 4	=	114,4	SCFM
	Total required airflow		=	114,4	SCFM
	Total with extra 25 %*		=	143,0	SCFM

* It is preferable to add 25% to 50% extra to accommodate future needs.

Step 3 Establish the diameter of the main line

Based on the data in Table **A** on page 10 (closed loop system) and our example, for an air pressure demand of **143 SCFM** and a main line measuring **160 linear feet** in length, a diameter of **28 mm** is necessary.

TOTAL LENGTH OF THE NETWORK (FEET)

REQUIRED SCFM	100'	150'	200'	250'	300'	400'	500'
40	22	22	22	22	22	22	22
60	22	22	22	22	28	28	28
80	22	22	28	28	28	28	28
100	22	28	28	28	28	28	28
125	28	28	28	28	28		
150	28	28	28	28			
200	28	28					

Step 4 Calculate the equivalent lengths (fittings)

System fittings must be considered when calculating the total length of the line in linear feet. Each change in direction and each coupler will cause an additional pressure drop equal to an addition to the total length (see Table B on page 11).

For our example with 4 water trap tees, four 90° union elbows and a predetermined diameter of 28 mm, linear feet must be added as follows to the initial length:

Four water trap tees:	2,2 ft x 4	=	8,8 ft
Four 90º union elbows:	1,4 ft x 4	=	5,6 ft
Equivalent total length		=	14,4 ft
+ Main line		=	160,0 ft
New total length in linear ft		=	**174,4 ft**

Based on Table **A** on page 10, the pipe diameter for the main line will will stay the same as 28 mm for a length of 174,4 linear feet and a consumption of 143 SCFM.

TOTAL LENGTH OF THE NETWORK (FEET)

REQUIRED SCFM	100'	150'	200'	250'	300'	400'	500'
40	22	22	22	22	22	22	22
60	22	22	22	22	28	28	28
80	22	22	28	28	28	28	28
100	22	28	28	28	28	28	28
125	28	28	28	28	28		
150	28	28	28	28			
200	28	28					

Step 5 Determine the diameter for each drop

Using the data in Table **C** on page 11, SCFM is calculated based on the number of tools per drop. Next, Table **A** on page 10 shows the pipe diameter based on the total SCFM.

Example: Drop #1

One impact gun 1/2": 28,6 SCFM x 1 = **28,6 SCFM required**
Rounded up to 30 SCFM
The pipe diameter sizing for this drop would then be 15 mm

TOTAL LENGTH OF THE NETWORK (FEET)

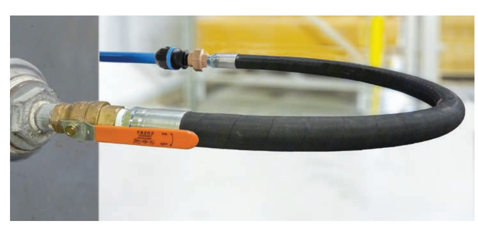
REQUIRED SCFM	100'	150'	200'	250'	300'
5	15	15	15	15	15
10	15	15	15	15	15
15	15	15	15	15	15
20	15	15	15	15	15
30	15	22	22	22	22
40	22	22	22	22	22

5. Installing anti-vibration hoses

CAUTION

An anti-vibration hose and a receiver tank must be installed before the piping system to protect the system from excessive heat and the effects of thermal variations.

Anti-vibration hoses are available in steel-reinforced rubber with or without a Canadian Registration Number (CRN). Also available in stainless steel (without CRN).



Anti-vibration hoses are also used for changes in direction and to bypass obstacles (see Adding expansion loops or expansion connectors under Point 6).

6. Planning for thermal variations in the system

Explanation of thermal expansion and contraction

Comparison of the linear expansion coefficients for materials frequently used in compressed air systems

Steel	1.3×10^{-5} m/m-°C
Copper	1.7×10^{-5} m/m-°C
TOPRING PPS 100% aluminium	2.3×10^{-5} m/m-°C
AIR LINE PA (polyamide)	**1.2×10^{-4} m/m-°C**
ABS	1.5×10^{-4} m/m-°C
PVDF	1.5×10^{-4} m/m-°C
PP	1.7×10^{-4} m/m-°C
PE	1.1×10^{-4} m/m-°C

The linear expansion coefficient (d) is 0.12 mm / m °C, or 0.12 millimeter per meter, per degree Celsius.

System design must factor in the phenomenon of expansion, which is calculated with the formula:
DL = d x L x DT

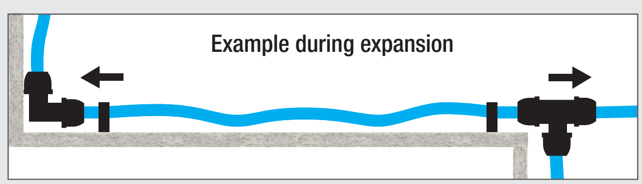
Example with a polyamide pipe (PA):
Installation temperature: +10 °C
Pipe length: 20 m
Service temperature: 35 °C
Linear expansion coefficient: 0.12 mm/m

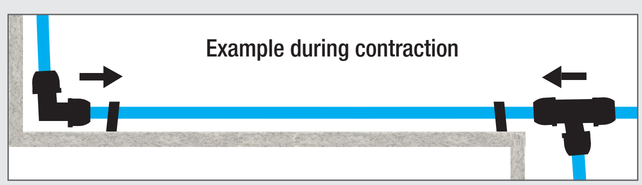
Calculation:
DT = 35 – 10 = 25 °C
DL = 0,12 x 20 x 25 = 60 mm

LEGENDE	DESCRIPTION
d	Linear expansion coefficient
L	Length of the pipe
DT	Temperature difference in degrees Celsius
DL	Difference in length (expansion or contraction)

Effects of expansion or contraction if the expansion coefficient is not considered:

- Strain of pipes between two fixed points
- Compression of clamps or equipment with risk of strain, sag or rupture





Solutions to counter the effects of thermal variations

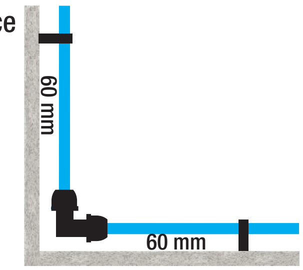
Leave space between pipe and wall

To prevent the effects of expansion/contraction and make sure there is enough room, space should be left between the pipes and walls at the time of installation.

Example using the calculation on the previous page:

DL = 0.12 mm/m coefficient for a polyamide pipe x 20 m x 25 °C = **60 mm**

Since the difference in length (DL) is 60 mm, the space between pipe and wall must be at least 60 mm.



Adding expansion loops or expansion connectors

When the length of a polyamide pipe exceeds 30 m, the pipe will be affected by thermal expansion and contraction. Adding expansion loops reduces stress to the system caused by the expansion and contraction.

For systems with a pipe diameter of 16 to 28 mm (1/2 to 1 in)

Series 8 rubber anti-vibration hoses should be used. They are available in 24- and 48-inch lengths, with or without a Canadian Registration Number (CRN).

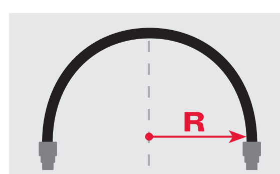
Table of minimum bending radius by rubber hose diameter

Inside diameter Pipe / Connector		Minimum bending radius	
mm	in	mm	in
15	1/2	178	7
22	3/4	241	9-1/2
28	1	305	12

Table of minimum bending radius by CRN approved rubber hose diameter

Inside diameter Pipe / Connector		Minimum bending radius	
mm	in	mm	in
15	1/2	89	3-1/2
22	3/4	121	4-3/4
28	1	152	6

CRN CANADIAN REGISTRATION NUMBER



CAUTION

An anti-vibration hose and a receiver tank must be installed before the piping system to protect the system from excessive heat and the effects of thermal variations.

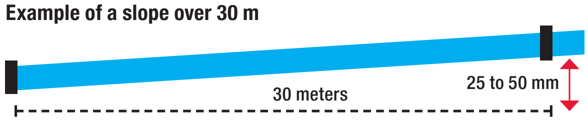
TECH TIP

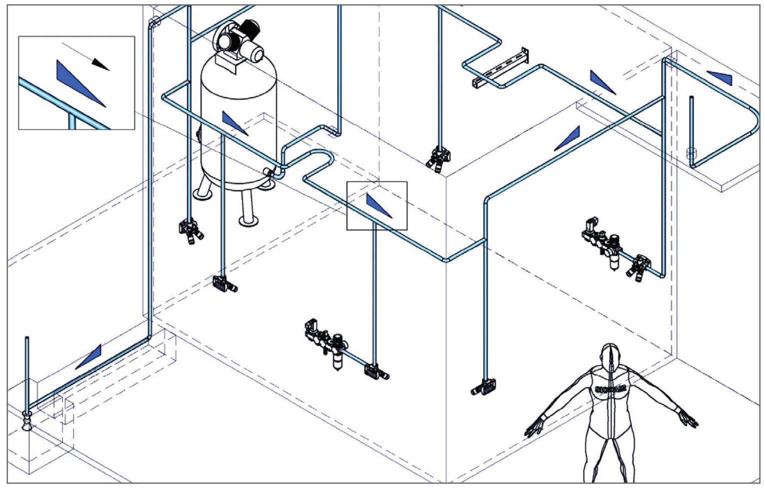
The anti-vibration hose must not be overly bent (too squared or not rounded enough). This hose is used to change direction and bypass obstacles.
It is installed at the compressor to neutralize vibrations (see Point 5).

7. Determining the slopes

All horizontal pipes must have a slope of about 25 to 50 mm per 30 m to drain condensate. Downward slopes must lead to condensate drains installed as low as possible at the base of manifolds (not illustrated in the diagram shown here).

Example of a slope over 30 m



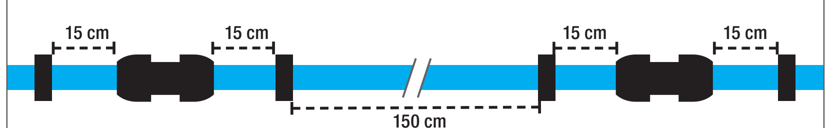


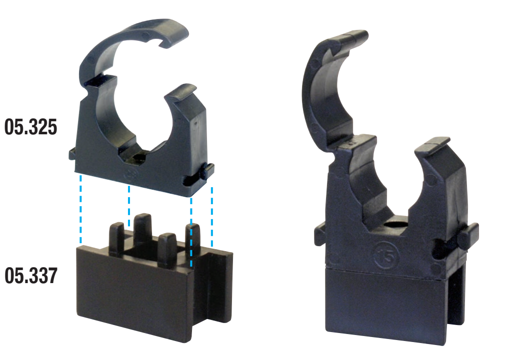
8. Adding mounting clips

The maximum distance between each mounting clip must follow the chart below, regardless of pipe diameter.
Mounting clips should be installed 15 cm from a fitting (upstream and downstream) to prevent pipes from bending.

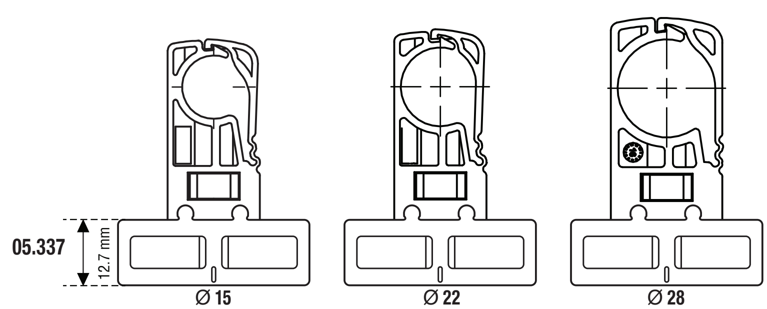
Pipe diameter	Maximum distance between each mounting clips
15 mm	90 cm
22 mm	120 cm
28 mm	150 cm

Example of mounting and maximum distance between clips for a 28 mm pipe





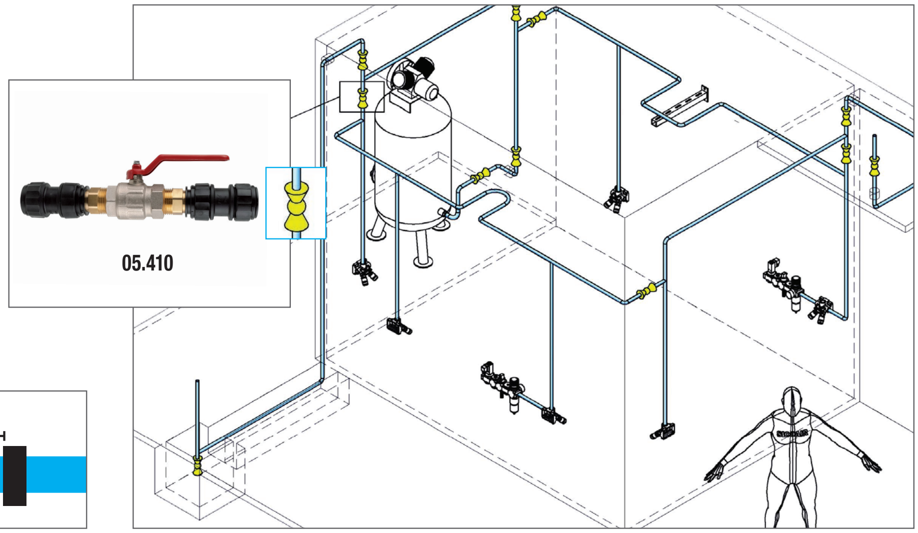
MOUNTING CLIP WITH SPACER

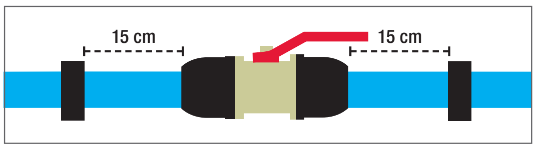


9. Planning maintenance

Ball valves should be installed in order to facilitate maintenance and isolate the system into sections.

For a drop, a mounting bracket should be installed on both sides of the ball valve to prevent pipe distortion and vibration at the application.





BUYER AND/OR USER LIABILITY

Anyone who purchases and/or uses a TOPRING product and/or system (hereinafter “TOPRING Product(s)”) must carefully read the user instructions for that TOPRING Product and, where the product relates to compressed air, must be familiar with the associated health and safety risks prior to use.

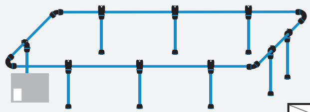
By purchasing and using a TOPRING Product, the buyer and/or user acknowledges that he or she understands and accepts his or her sole liability for installation, identification, maintenance, and use of the TOPRING Product as well as for configuration of any system that uses a TOPRING Product. Subject to the limits of public policy as expressed in the law, the buyer and/or user assumes the risk and liability that may arise from loss, damage, or injury caused by improper installation, identification, maintenance, and/ or use of a TOPRING Product, or by misconfiguration of any system using a TOPRING Product, and holds harmless TOPRING and its subsidiaries and affiliated corporations (hereinafter “TOPRING”). The buyer and/or user must consider, among other factors, current regulations, the user instructions for the TOPRING Product, safety measures, the specifics of the premises or location, and the activities or operations conducted there.

By purchasing a TOPRING Product, and subject to the limits of public policy expressed in the law, the buyer and/or user hereby acknowledges and agrees that TOPRING cannot be held liable for any damages whatsoever (including damages caused by loss of profits, business interruption, loss of information, or any other loss) arising from improper installation, identification, maintenance, and/or user of a TOPRING Product, misconfiguration of a system that uses a TOPRING Product, or the impossibility of such a configuration, installation, identification, maintenance, and/or use.

The buyer and/or user of a TOPRING Product is responsible for informing any persons concerned of the risks, warnings and safety measures for TOPRING Products, including but not limited to employees using one or more TOPRING Products.

Table A
Pipe diameters according to length and required SCFM

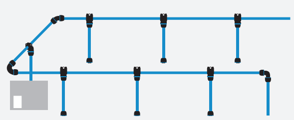
Closed loop network



TOTAL LENGTH OF THE NETWORK (FEET) / TOTAL FLOW REQUIRED SCFM

SCFM \ FEET	100'	150'	200'	250'	300'	400'	500'	600'	700'	800'	900'	1000'	1250'	1500'	2000'
5	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
10	15	15	15	15	15	15	15	15	15	15	15	15	22	22	22
15	15	15	15	15	15	15	15	22	22	22	22	22	22	22	22
20	15	15	15	15	15	22	22	22	22	22	22	22	22	22	22
30	15	22	22	22	22	22	22	22	22	22	22	22	28	28	28
40	22	22	22	22	22	22	22	22	28	28	28	28	28	28	28
60	22	22	22	22	28	28	28	28	28	28	28	28	28	28	
80	22	22	28	28	28	28	28	28	28	28	28				
100	22	28	28	28	28	28	28	28							
125	28	28	28	28	28										
150	28	28	28	28											
200	28	28													

Linear network (dead end)



TOTAL LENGTH OF THE NETWORK (FEET) / TOTAL FLOW REQUIRED SCFM

SCFM \ FEET	25'	50'	75'	100'	150'	200'	250'	300'	400'	500'	600'	700'	800'	900'	1000'
5	15	15	15	15	15	15	15	15	15	15	15	22	22	22	22
10	15	15	15	15	15	22	22	22	22	22	22	22	22	22	22
15	15	15	22	22	22	22	22	22	22	22	28	28	28	28	28
20	15	22	22	22	22	22	22	22	28	28	28	28	28	28	28
30	22	22	22	22	28	28	28	28	28	28	28	28	28		
40	22	22	22	28	28	28	28	28	28						
60	22	28	28	28	28	28									
80	28	28	28	28											
100	28	28	28												
125	28														
150	28														
200															

CAUTION

Installation of a **AIR LINE** compressed air piping system must be made according to the assembly instructions as indicated in the installation guide. Carefully read the design and installation guides prior to proceeding (available on **TOPRING**.com).

REFERENCE TABLES

Table B
Equivalent lengths of AIR LINE connections






Pipe O.D.		Straight union	90º Elbow union	Tee Union	Water Trap Tee	Female Reducer
15 mm	1/2 in	0.43	1.15	0.56	1.80	0.59
22 mm	3/4 in	0.56	1.41	0.79	2.20	0.72
28 mm	1 in	0.72	1.80	1.12	3.08	0.98
		Feet measurements				

Table C
SCFM required by type of tool



SANDERS	FLOW SCFM
Sander	9.6
4-1/2" angle grinder	18.4
10mm belt sander	18.9
7" angle sander	29.6
NAILERS/STAPLERS	
Nailer/stapler (18 Gauge)	2.5
Stapler (22-18 Gauge)	3.5
Finishing nailer	3.5
Roofing nailer	6.0
Framing nailer	11.0
IMPACT TOOLS	
Miniature 1/4" ratchet	12.5
1/4" impact gun	14.0
3/8" ratchet	19.2
Zip gun	21.9
1/2" impact gun	28.6
3/4" impact gun	34.7
1" impact gun	87.5



POLISHING TOOLS	FLOW SCFM
Orbital polisher	16.6
Oscillating sander	23.0
DRILLS	
3/8" air drill	17.3
3/8" reversible air drill	23.8
1/2" reversible air drill	26.4
OTHER TOOLS	
Riveter	4.0
Grease gun	4.0
Caulking gun	0.1
HVLP paint gun	9.5
Screw driver	9.6
Gravity fed sand blaster	12.0

Note: Airflow (SCFM) may vary among tool brands.
Check against the manufacturer's data.

TOPRING can help you plan, design, and select the right compressed air piping system.

INSTALLATION SUPPORT

Download the **AIR LINE** piping system installation guide on **TOPRING**.com.

The technical information explains each installation step, making assembly of system components easy to understand.

TECHNICAL SUPPORT

For technical support with a specific project, contact us at 1 800 263-8677 or visit the "Piping Systems" section of **TOPRING**.com to consult or download installation guides, white papers, and practical tools.

This design guide is also available in French: code 96.602

TOPRING

T 450 375-1828 / 1 800 263-8677 / **F** 450 375-1408

solutions@**TOPRING**.ca / www.**TOPRING**.com