



# ***POCKET GUIDE AIR TOOLS INSTALLATION***



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*Atlas Copco*

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## ***INTRODUCTION***

Air tools and compressed air systems are used throughout industry. This booklet has been produced by Atlas Copco as an aid to understanding the operation of compressed air systems, to provide the basic information for the correct design of these systems and to illustrate the drawbacks and additional costs incurred with a poorly designed system.



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# 1. THE IMPORTANCE OF A CORRECT AIR INFRASTRUCTURE

A correct air infrastructure installation is essential to the correct functioning of your tool and the productivity of your application. Having selected the correct tool for your job, some additional effort must be spent on the air infrastructure. The pneumatic tool needs 6.3 (90 psi) bar to operate at rated power. Decreasing the operating pressure by 1 bar (15 psi) leads to a productivity loss of 25-30%.

## PRACTICAL EXAMPLES

### The working cost of a grinder

A test was performed with a grinder. Material was ground off and the work piece was weighed before and afterwards, the results were:

Working pressure (Bar)	Material removal (kg/hr)	Time (sec)
6.3	5.5	11
5.8	4.5	13
5.0	4.0	15

A pressure loss of 1 bar leads to almost 30% less material removed. This means that the operator has to work 40% longer to do the job. A grinder is used efficiently 3 hours per day. If, for example, the cost for a working hour is 20 Euro, the additional 1.2 hours the operator has to work in order to complete the job costs the employer 24 Euro per day. In a month this amounts to 480 Euro and €5760 per year.

**A pressure loss  
of 1 bar can cost  
your company  
€5760 per year!**



## PRACTICAL EXAMPLES



### Drilling

Working pressure (Bar)	Time to make a hole (sec)
6.3	2.0
5.8	3.2

### Assembling

Working pressure (Bar)	Maximum torque (Nm)	Time (sec)
6.3	248	0.8
5.8	240	0.9

When drilling with lower air pressures, there is a risk of adding up to 1.2 extra seconds per hole. That is 60% longer time. If the efficient drilling time per day is 1 hour, the 36

minutes extra time is required per day to complete the same job. That results in a total of €12 extra per day (at a cost per hour of €20).

**WHEN YOUR AIR SYSTEM IS FUNCTIONING PROPERLY, YOU SAVE UP TO €2880 PER YEAR!**

Using a pneumatic screwdriver at a too low air pressure in this example, results in a 12.5 % longer assembling time. Assume the cost for the operator is €20/hour and the efficient assembling time is 4 hours/day. **This means that the cost normally is €80/day. 80 x 0.125 = €10/day of unnecessary work.**



**DECREASED  
WORKING PRESSURE  
SIGNIFICANTLY  
INCREASES  
TIGHTENING TIME!**

**SAVE UP TO  
2400 EURO  
PER YEAR!**



### Impact wrenches

The torque increases with time on impact wrenches. The time to reach the torque increases with declining pressure. Tests with the tool show a 12.5% time increase at 0.5 bar lower air pressure.

At an operator cost of 20 Euro per hour and 4 hours of efficient assembling, this gives 10 Euro unnecessary work every day, **(200 Euro per month, 2400 Euro per year).**

### Pulse tools

Tests performed at Atlas Copco show that decreased working pressure significantly increases tightening time and reduces the torque obtained. Tests were made with an ErgoPulse 8 XS.

Working pressure (Bar)	Time (sec)	Torque (Nm)
6.3	6.5	48.3
5.3	10	44.3
4.3	10	38.2

The tool is at risk of poor performance when recommended air pressure is not maintained.

In this pulse tool example, there is a increase of 50% in cycle time. If the efficient tightening time is 4 hours/day and the wage of the operator is €20/hour, **means that €800 / month and €9600/year can be saved by having the correct working air pressure.**

## 2. USE THE CORRECT AIR PRESSURE

In practice many work sites work with pressures of 3-5 bar which leads to significant wasted energy and productivity. Atlas Copco can help measure the air supply pressure and help secure productivity. In the network, between the compressor and the tool, there are pressure losses due to friction in the pipe restrictions, bendings and pipe walls. The main pressure drop occurs in the part between the pipe end and the tool, i.e., the shut-off valve, the air preparation units, the couplings and the hose. The pressure drop of these components should be kept as low as possible to ensure high productivity and energy savings. The pressure drop in this part should not exceed 0.6 bar (8,6 psi). Reaching 6.3 bar (90 psi) at the tool end then requires 6.9 bar (100 psi) at the network end and this of course demands that the plant has a compressor of sufficient capacity to compensate for the pressure drop in the air net.

### 2.1 What pressure drop is acceptable?

Pressure drop depends on the volume air flow, higher flow – higher pressure drop. Thus the pressure drop in an installation depends on the flow required by the tool. Losses in the air preparation units, coupling and hose should not be higher than 0.6 - 1.0 bar. It is reasonable to work with 7 bar system pressure and to obtain 6.3 bar at the tool end. This will ensure an acceptable productivity of the tool.





## 2.2 How to improve the air line

The capacities of Atlas Copco air line products and accessories have been measured and the flow is stated with the corresponding pressure drop. This makes it possible for the user to choose the correct accessories for the application and to achieve an acceptable pressure drop.

Restrictions such as small size couplings, too long and small diameter hoses create pressure losses. Spiral hoses are, due to their shape, very long and thus they create a large pressure drop. The alternative, a normal PVC hose should in every case be considered with regards to the pressure losses. Every coupling in an installation creates a pressure loss. For example a whip hose makes it easier to work with the tool but the extra coupling and small bore hose can create a pressure drop of 0.2-0.5 bar depending on size and air consumption.



## 2.3 KEY QUESTIONS

When the tool of the correct size and power for the application has been selected, the air line of the right size must be chosen. The parameters for choosing are:

### Does the tool need lubrication?

Air tool manufacturers make tools with special vanes not needing lubrication. Turbines do not need lubrication either. Some tools do need lubrication and those with short operating times require direct lubrication, long operating times require an oil-fog lubricator.

### Distance between the tool and the offtake?

The distance between the tool and the offtake should ideally not be more than 3-5 meters. Real life shows that in many cases this is not possible, for instance at shipyards, where distances of 20 meters or more are quite common.

### Inlet thread dimension of the tool?

The connection between the hoses and the tools vary in size, from 1/8" up to 1/2". The correct nipple must to be chosen for each tool.

### Air consumption?

The size of accessories is determined by the air consumption of the tool. Larger air consumption results in larger size accessories.

### Working environment?

The choice of accessories is influenced by the working environment. Outdoor use or rough environments like foundries require more resistant air line accessories than indoor benchwork assembling light machinery.

### Allowable pressure drop?

The tool requires sufficient pressure to function properly. The system pressure can be set high if the system pressure drop is large but in any case, the maximum allowable pressure drop of the accessories must be determined and they should be chosen accordingly.



## 3. AIR TOOL INSTALLATIONS

### 3.1 Assembly tools

Small couplings are suitable for assembly tools which require low air flow rates. Large impact wrenches require larger size couplings. The hose sizes for an assembly tool can in most cases be between 6 to 13 mm and the length is usually 3-5 m. In some few cases the hoses are larger and longer.

An installation with a straight plastic hose and couplings is the most common, when working with pistol grip assembly tools with low levels of vibrations.

Hose reel balancers is used for straight screwdrivers, the need for couplings depends on if the operator needs to change tool or not.

Main hoses together with a short whip hose is recommended where there are hard impacts on the couplings (impact wrenches) or when the tools are very heavy and the weight of the tools can break the couplings.

Spiral hoses can be used with a straight screwdriver together with a balancer. Another way is to use a larger spiral hose with pistol grip tools. The need of couplings is dependent on whether or not the operator needs to change tool.



### 3.2 Material removal tools

Couplings of larger size must be used as air consumption is higher than on assembly tools, smaller couplings are used for smaller grinders such as LSF die grinders. The hose sizes for a material removal tool can in most cases be between 10 to 20 mm and the length is usually 5 - 10 m. In some few cases the hoses are larger and longer. This installation is common when working with material removal tools with low levels of vibrations.

A main hose together with a short whip hose is recommended where there are hard impacts on the couplings (percussive tools and some grinders) or when the tools are very heavy and the weight of the tools can break the couplings. An extra hose can be used where there is long distance to cover. Remember to keep the dimensions large on the extra hose.



## 4. HOW DO YOU BUILD YOUR AIR LINE?

A good air compressor and air line will increase the tool and operator productivity. A high air pressure is not always the best, the correct air pressure will be most beneficial in the long run.

Usually the operator wants to maximize the productivity and raise the air pressure of the tool. But this is not the best solution in the long run, in terms of lifetime of the tool and ergonomic aspects. The best tool performance is reached at 6.3 Bar (90 psi). Optimizing the air line will both save money and raise productivity, and below are the components that we recommend you to use in a really good air line.

### Quick rules/tips:

- ✓ Avoid leaks
- ✓ Avoid long hoses
- ✓ Use correct type of hose (plastic or rubber) depending on the application
- ✓ Use full flow couplings
- ✓ Use clean compressed air
- ✓ Use a regulator to set and monitor the air pressure (with lubrication also if needed)

## 5. AIR LINE INFRASTRUCTURE

### 5.1 Air preparation units

In the range of air preparation units, Atlas Copco offer the Midi Optimizer, it is suitable for most assembly tools, percussive tools, drills, nibblers, saws, and small grinders (in fact, approximately 90% of all applications).

#### Highest recommended air flow:

MINI up to 12 l/s  
MIDI up to 43 l/s  
MAXI up to 80 l/s



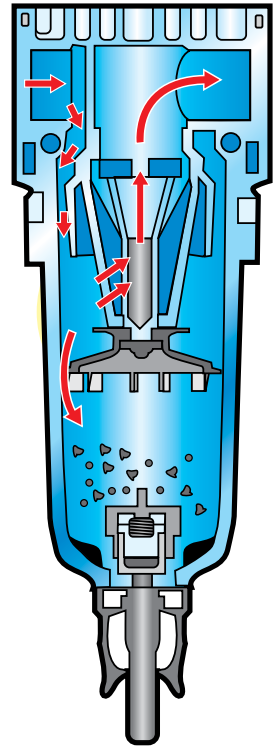
## 5.2 Air filters

The filter separates impurities such as water and solid particles. Not using filters in combination with air tools leads to shorter service life, higher maintenance costs and a lower efficiency. Old air systems with cool dryers generate a lot of rust. Running tools without installing a filter could damage the tool in less than a week. Well maintained air systems supply clean air. Although the difference might not be obvious, the tiniest rust flake can damage a tool. Intermediate air quality will result in shorter service intervals with higher costs.

Atlas Copco filters separate up to 98% of the water when operating within the design working range. Filters are usually equipped with a semiautomatic drain. All filters come with a kit enabling simple conversion from semiautomatic to manual drainage.

Semi-automatic drainage takes place automatically when the pressure in the bowl drops below 0.2 bar (requiring the air supply to be switched off regularly). With automatic drainage the bowl is emptied when the accumulated water reaches a certain level.

A metal bowl guard is used when there is a possibility that there are solvents in the environment. Solvents which make the polycarbonate bowl brittle are chemicals containing acetone, benzene, glycerine, some hydraulic and some synthetic oils, chloroform, methyl alcohol, carbon tetrachloride and similar solvents, carbon disulphide, perchlorethylene, toluene, trichlorethylene, xylene (nitrocellulose thinner) and acetic acid. If the standard bowl breaks, a metal bowl should be used. Metal bowl guards are standard in some markets.



### 5.3 Air pressure regulators

The air pressure regulator ensures that the pre-set working pressure remains constant – regardless of pressure variations in the intake air and minor variations in the air flow rate. By preventing unnecessary consumption of air, the air pressure regulator improves overall operating economy.

Tool pressure (bar)	Air consumption (%)
6.3	100
7.0	110
8.0	125

Piston regulators use the air to regulate and therefore react more slowly. On the other hand, they have improved regulating characteristics, such as maintained outlet pressure over a wide range of air flows. Piston regulators should be used in air flow operations where precision is essential and slow response can be accepted, typically for air motors.

Spring controlled regulators are quick acting and therefore should be used for all types of air tools. This type of regulator is also the most common.

### 5.4 Lubricators

If lubricators are not used the vanes have to be changed more often. The life of the vanes may decrease to as little as 1/10th of the normal working time. Tests in Atlas Copco laboratories showed that the power output of a grinder decreases by 15-20% after 20 minutes when not lubricated.

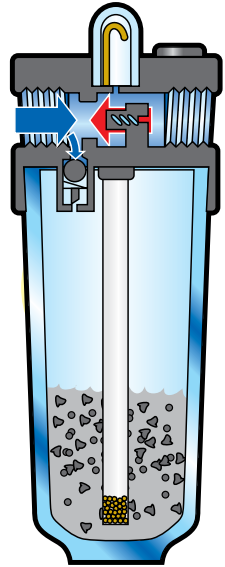
The most common type of lubricator, the oil fog lubricator, supplies drops of oil to the air hose. It is used to lubricate air tools which have a normal operation time and is the standard method of lubricating air tools. Metal bowls should be used when there is an aggressive environment, (see filters). A glass sight dome can be used with units with a metal bowl.

For air tools that are started and stopped at short intervals or have a very low air consumption, an one point lubricator should be used. This supplies oil in drops through a capillary tube in the hose directly to the tool and is controlled by the tool starting frequency. Many assembly tools, but not those with lube free vanes, can be used in combination with



a direct lubricator. When using long hoses it is easy to get a dip (i.e. a hose loop forming a low point where the oil is collected). In this case it is better to have, if possible, a portable oil fog lubricator or manually drop some oil drops into the air tool inlet every hour.

F/R units are combined filter / regulators assembled together. F/R units are recommended in every case where both filters and regulators are needed. Filtering and regulating and lubricating properties are almost the same as for individual units.



## 5.5 Hoses

Hoses should be chosen to meet the demands of the working environment. The hoses should have a length of 3-5 m (10-30 ft) to ensure sufficient mobility at the workplace and limited pressure drop. For light air tools, CABLAIR, a soft light-weight PVC hose is recommended. It is 30-50% lighter than conventional PVC hose, and should be used for clean bench operations.

PVC hoses are suitable for general applications, from simple grinding to heavy assembly. Rougher applications require rubber hoses of which Atlas Copco supplies two types, RUBAIR and TURBO.

TURBO is lighter and very strong while RUBAIR is even more resistant to a rough environment and can be supplied in a larger range of dimensions. To avoid too large a pressure drop, the hose size should be increased by one size for a length of 5-10 m (32-50 ft), two sizes for a length of 20 m (65 ft), and three sizes for lengths of 20-40 m (65-130 ft).



General rules are to keep hose diameters large, to use high flow rate couplings, to use air preparation units with low pressure drop. All these measures make the overall pressure drop in the installation low and thus productivity is increased and energy saved.

## 5.6 Whip hoses

Percussive tools and impact wrenches tend to destroy the coupling if it is directly connected to the tool (due to the percussive action and impacts). Also, if the tool weighs more than 3 kg (large grinders or nut runners) the coupling can break if the tool is dropped and hits the coupling. A short whip hose is therefore recommended for these types of tools. It is important to note that air flow decreases if you split the hose in two. If for instance a 13 mm, 5 m long hose which has a capacity of 21 l/s, were to be split into whiphose + hose, the capacity would decrease to 16 l/s (to  $\approx 80\%$ ). A typical length for whip hoses is 0.3-0.7 meters.

## 5.7 Spiral hoses

A spiral hose together with balancers is ideal for vertical applications. Spiral hoses are, due to their shape, very long and thus have very high pressure drop. To avoid big losses, choose a short spiral hose.



## 5.8 Hose reel balancers

In some applications, (preferably vertical), a hose is suitable in combination with a balancer. A typical application is a straight screwdriver. In this case a hose reel balancer is used. The air line is connected to the balancer block and led through the wound hose which can be pulled out to a suitable length. Hose reel balancers are chosen according to the required air flow and the weight of the tool.

## 5.9 Blow protectors

When a fitting comes loose from a pressurised hose, the hose starts to blow compressed air in an uncontrolled way, whipping around. This can injure people, damage the work-piece and destroy the environment. A way to ensure this does not happen is to use a blow protector. Normally air hoses must be sized according to air flow, hose size and hose length. Couplings with a low pressure drop must be chosen, or the blow protector will not work properly. Care must be taken in selecting blow protectors for use with impact wrenches and pulse tools. The air flow under load must be increased by 50% to obtain the design air flow rate or the fuse will shut off at free running.

## 5.10 Swivels

For screwdrivers, pulse tools, drills or small die grinders the hose is sometimes clumsy and in the way when working, for instance sitting at a work bench. In such cases a swivel, allowing a certain angle tolerance between the hose and the tool, is used. Swivels should not be used in applications where there is a pulling force on the hose or high levels of vibrations, since the hose will wear out quickly and start to leak.

## 5.11 Couplings and nipples

### Assembly tools

Assembly tools normally have a limited air consumption and smaller quick couplings are therefore suitable. Big impact wrenches should be used with bigger size couplings and a whip hose.

### Material removal tools

Material removal tools require a lot of air and the application is rough. It is therefore of vital importance to choose large couplings for them to function correctly.



## 5.12 Safety nipples

When the hose is longer than 3 meters, the pressurised air left in the hose could create such a bang when the hose is disconnected, that a safety nipple should be used. The safety nipple lets the air out very slowly when the hose is disconnected. When using safety nipples, the air flow is reduced by 20%. When for instance a 16 mm, 5 m hose is used with safety nipple and a whip hose the following will happen: The normal maximum air flow rate of 43 l/s is reduced to 80% because of the safety nipple => 35 l/s, and further reduced by 20% due to the whip hose => 28 l/s.

## 5.13 Hose clamps

Hose clamps are available in three types: pleated type for hoses with outside diameters of 7-27 mm, screw-strip types for hoses with outside diameters of 8-65 mm; and two-part cast iron clamps with a galvanised bolt and nut for hoses with outside diameters of 22-40 mm. Single lugged, medium pressure clamps are recommended for use with small PVC hoses. Medium pressure clamps (worm drive) are recommended for PVC hoses and smaller rubber hoses up to 16 mm diameter. For rubber hoses above 16 mm, heavy duty clamps should be used.

## 6. RECOMENDED AIR INSTALLATION BY ATLAS COPCO

A recommended pneumatic tool installation uses an air preparation unit with shut off valve, blow protector, a hose and sometimes a balancer.

The shut off valve can be mounted with the handle upwards or downwards according to choice. The direction of air flow is marked with arrows on the air preparation units and the blow protector. The mounting order for air preparation units is firstly the filter then the air regulator followed by a lubricator.

The filter and regulator can be replaced by a filter/regulator combination unit. When using installations with lubricators it is important to avoid dips in the hose, (i.e.. a hose loop forming a low point where the oil could collect). If a low point is created, the oil will not be used for lubricating the tool but remain in the hose.



# 7. MAINTENANCE

## 7.1 Leakage

A well-designed and properly maintained air distribution system has a leakage of no more than 5% of the capacity of the installation. Unfortunately, 15-20% leakage is quite common. Leakage translates into a loss of air capacity. This means increased utilisation of the compressor as it works to compensate, which in turn leads to significantly higher energy costs.

Leakage rates and equivalent hole diameters			
Hole diameter mm	Air leakage at 6.3 bar L/s	Additional compressor power req.	Typical energy kW cost per year *
1	1	0.3	91 Euro
3	10	3.1	937 Euro
5	27	8.3	2510 Euro
10	105	33.0	9979 Euro

\* 1kWh = 0.035 Euro \*\* Calculation based on 24 h/day. For example, a hole with a diameter of 5 mm results in a leakage of 27 litres of air per second from the air distribution system. To compensate for this loss of air flow capacity, 8.3 kW of additional compressor power is required. With an average price per kWh of 0.035 Euro, this relatively small hole results in an additional, annual energy cost of 2510 Euro.

## 7.2 Maintenance schedule

Regular maintenance should be carried out on the air system.



### ONCE EVERY DAY:

Drain applicable filters.

### ONCE PER WEEK:

The area closest to the workplace should be checked for leakage once per week.

Joints between tools and nipples, in couplings, hoses and air preparation units should be checked. Lubricators should be filled with oil.

### EVERY TWO MONTHS:

The whole air system should be checked every two months. First, listen for leaks after working hours, feel by hand on suspected areas. A soap and water solution can be used to detect the exact point of leakage, (bubbles). Take the necessary measures to repair the leak.

Every workplace should be checked with the air tool simulator every two months. The air tool simulator should be connected to the hose and the required air flow (given in a table enclosed with the air tool simulator) should be set by a certain number of revolutions of the knob. The pressure has to be 6.3 bar (90 psi) at the hose end for the tool to function properly.

Take the necessary measures by changing FRL, hose and/or coupling.

### EVERY SIX MONTHS:

Filter elements should be cleaned with a blowgun every 6 months. This is to avoid increased pressure drop.

The relief valve of the blow protector should be blown clean every 6 months. This is to avoid disturbances of the automatic resetting of the blow protector.

Atlas Copco offers to provide a maintenance schedule for a site and, if required, to implement it.

## 8. SAFETY

**Ball valves:** When not working, shut off the compressed air with the ball valve. Open all ball valves slowly in order to discover improperly tightened devices.

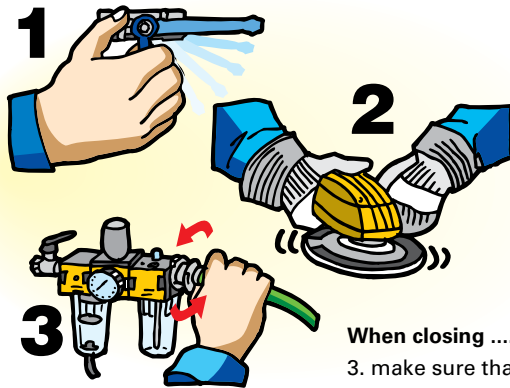
**Air preparation units:** Be aware of solvents which can change the structure of polycarbonate bowls making them brittle. When using aggressive solvents special equipment is required. Polycarbonate has good chemical resistance to all solvents except chemicals containing acetone, benzene, glycerine, some hydraulic and synthetic oils, chloroform, methyl alcohol, carbon tetrachloride (and similar solvents) carbon disulphide, perchloroethylene, toluene, trichlorethylene, xylene (nitrocellulose thinner) and acetic acid. It is important to check that the bowls are properly tightened and all units are assembled together before turning on the compressed air with the ball valve.

**Quick couplings:** Quick couplings are normally very safe devices. Extra care, however, should be taken when working with hose diameters larger than 16 mm or hose lengths longer than 3 m. In these cases a safety nipple which vents the air from the hose in a controlled way is recommended.

**Claw couplings:** Claw couplings are always open and must be used very carefully. The following order should be followed:

### When opening ....

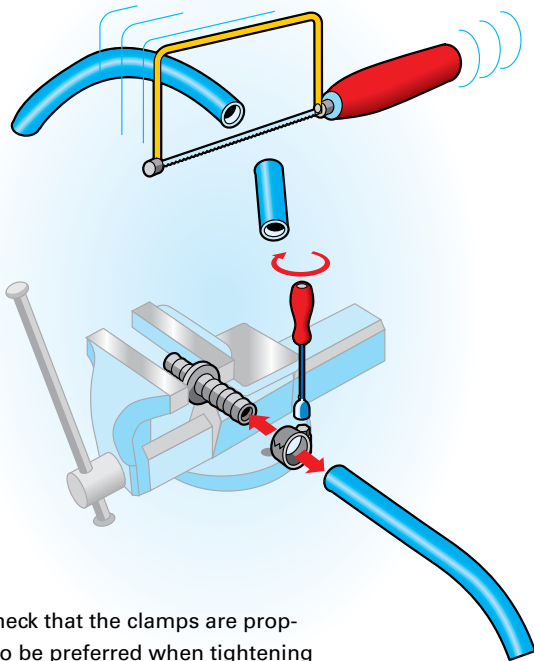
1. close the ball valve
2. run the tool so that air vents
3. release the claw coupling



### When closing ....

3. make sure that the two couplings are mounted together properly
1. open the valve slowly





**Clamps and connections:** Check that the clamps are properly tightened. A wrench is to be preferred when tightening clamps using a screwdriver can lead to slipping and injuries. If a screwdriver must be used, place the clamp in a vice to prevent injuries.

**Hoses:** We recommend applying soap and water when joining a hose to a nipple. This makes it easier to slip the hose on to the nipple. Do not use oil since it does not dry out afterwards. Leaking hoses should be removed – a small leakage can easily become a large hole!

**Blow protector:** When a fitting comes loose from a pressurised hose, the hose starts to blow compressed air in an uncontrolled way, whipping around. This can injure people, damage the work-piece and destroy the environment. A way to ensure this does not happen is to use a blow protector. It is also recommended to use a blow protector when working with claw couplings since this minimizes the risk of free blowing.

## 9. WHAT IS COMPRESSED AIR?

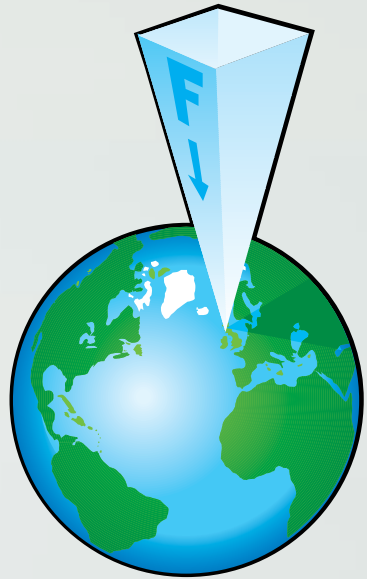
Air is vital to life on earth and we breathe it all the time. It is a colourless, odourless and tasteless gas mixture consisting mostly of nitrogen, oxygen and some water vapour. Air is always contaminated with solid particles, such as sand, soot and salt crystals; its composition is relatively constant from sea level to an altitude of 25 km. When air is compressed, it becomes a safe, versatile medium for transmitting and storing energy. But what is compressed air? Quite simply, the atmosphere at work.

### 9.1 Gravity at sea level

All material, including small air particles, is attracted to earth by gravity. The gravitational force exerted on an object is determined by its distance from the earth - the further away from earth, the less the gravitational force.

Imagine an area of one square centimetre at sea level and travelling away from earth to form a column of air to the edge of the atmosphere. Imagine gravity pulling the atoms within the column to earth.

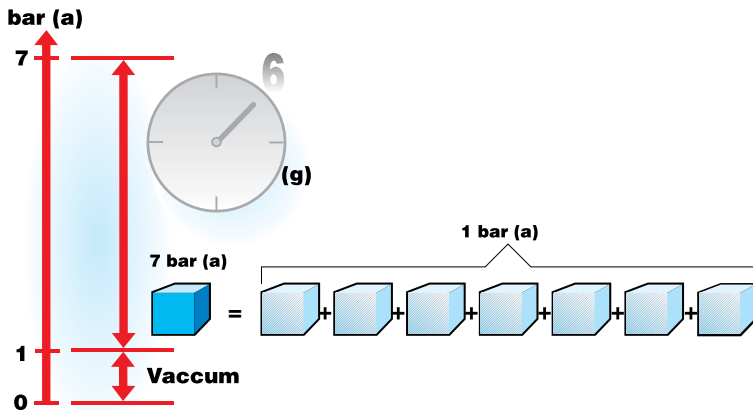




**10 N/cm<sup>2</sup> = 1 bar**

## 9.2 Difference between gas and liquid

Measured in Newton, the force exerted on one square centimetre at sea level is about 10.13 N. Therefore the absolute atmospheric pressure at sea level is approximately  $10.13 \times 10^4$  N per square meter, which is also called 1 Pa (Pascal), the SI unit for pressure. The most common unit for measuring pressure is, however, the bar. The atmospheric pressure at sea level is thus 105 Pa or approximately 1 bar, an air pressure which is referred to as the absolute pressure.



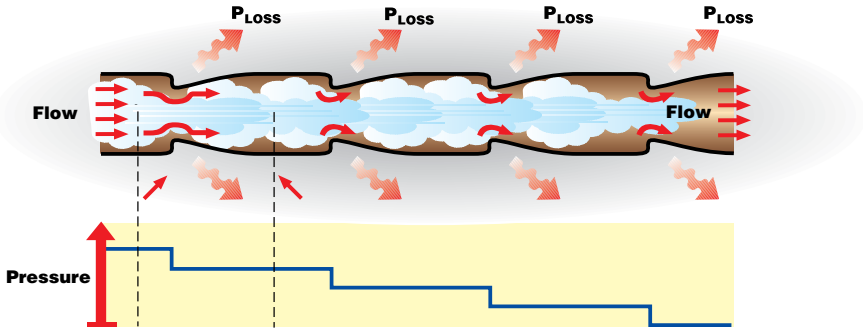
Since air is a gas, it is made up of relatively free molecules. When it is “squeezed” or compressed by gravity, the force is not only towards earth but in all directions. If air, or any other gas, is compressed further – mechanically or by temperature changes, the pressure obtained is measured as the one bar at sea level plus the extra pressure. It is important to distinguish between a = absolute pressure and g = gauge pressure. Typically used to measure pressure in an air distribution system, gauge pressure is defined as the absolute pressure in the

system minus the absolute pressure outside the system. In other words, absolute pressure is used in making calculations. Gauge pressure is the value read from a pressure gauge or manometer on e.g. an air preparation unit.

If you compress a gas (such as air) the volume decreases and the free oxygen and nitrogen molecules are squeezed together into a smaller volume, (higher pressure). A liquid on the other hand, does not occupy a smaller volume at a higher pressure.

### 9.3 Relationship between tool pressure and air consumption

Tool pressure (bar)	Air consumption (%)	Action
8.0	125	Turn down regulator
7.0	111	Turn down regulator
<b>6.3</b>	<b>100</b>	<b>Optimal performance!</b>
6.0	96	Increase pressure; change air line infrastructure
5.0	77	Increase pressure; change air line infrastructure
4.0	61	Increase pressure; change air line infrastructure
3.0	44	Increase pressure; change air line infrastructure



## 9.4 Pressure drop

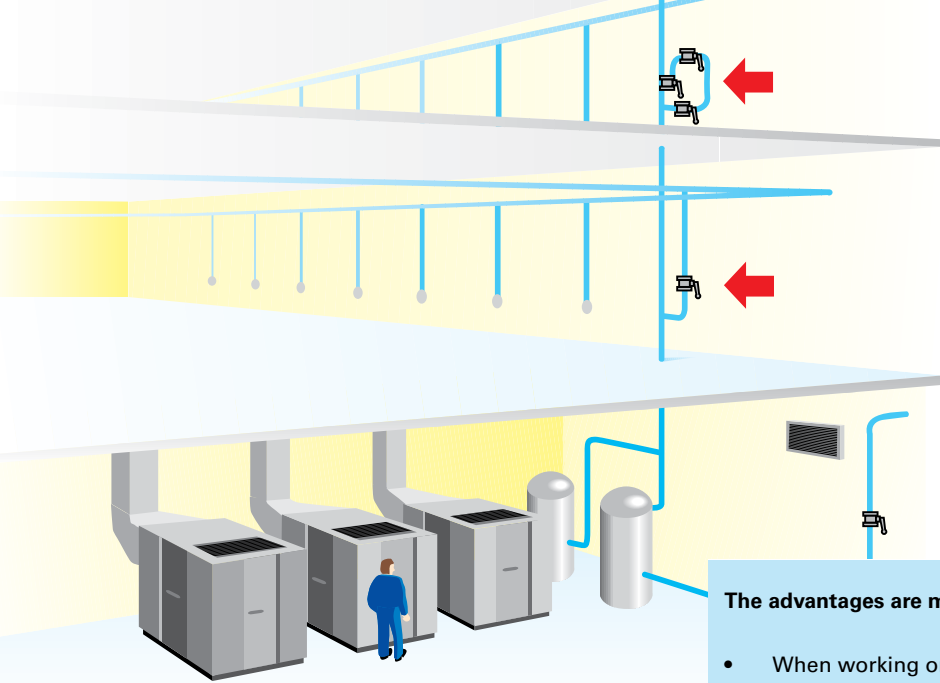
Working pressure is generated in the compressor and fed through pipework and hoses to the user (tool). When transporting air at pressure, the pressure is reduced by obstacles such as restrictions, bends, narrow passages etc.) This reduction in pressure is called the pressure drop. Pressure drop always occurs in the supply of compressed air, and the losses increase if the supply length is very long or if the supply system passage is very small.

## 9.5 Definitions

**Static pressure:** is the pressure obtained in a closed system when no air is used. **Dynamic pressure at offtake:** is the pressure obtained at the offtake tapping point from the main line or header when air is used at a tool or other user.

**Dynamic pressure at FRL-unit:** is the pressure obtained at the FRL unit, (pressure gauge on regulator) when air is being used.

**Dynamic pressure at tool inlet:** is the pressure when the tool is in operation, this pressure needs to be 6.3 bar for the rated performance. The pressure shown on the pressure gauge on the regulator is not the same as the pressure at the tool. First of all, the pressure at the gauge is higher when the tool is not running, then there is a pressure drop in the hose leading to the tool. To obtain the dynamic pressure at the tool a pressure gauge with a T-inlet has to be used.



## 10. AIR DISTRIBUTION

Air distribution is the critical link between the compressor installation and the machine or tool. It is based on an effective system of air lines and accessories. The performance of air power tools is largely dependent on the ability of the system to supply an adequate quantity of air of the correct quality and the right pressure. The design principles for an air distribution system are best understood by first considering what happens to compressed air as it flows through a pipe.

### 10.1 The system

The main line distributes the air from the compressor and the equipment to the ring main, i.e. to the premises in which the air will be used. In a large, compressed air system serving several premises or departments, the main line should be arranged so that each unit can be shut off without affecting the rest of the system. In order to separate water from the compressed air, water traps are built into the system. Pipes are installed with a fall and a container (water trap) is installed at the lowest point.

**The advantages are many:**

- When working on the piping system, only the unit involved has to be cut off.
- Leakage may be decreased by cutting off non-running units.
- Finding a source of leakage is facilitated; it becomes possible to have the most important unit supplied with air if the compressor capacity is insufficient for the whole system.
- If a compressor station is to supply air to several different premises, a separate main line must be run to each of the premises. This makes it possible to adjust air quality and air pressure according to the demand of each unit.

## 10.2 Ring main and offtakes

The ring main which distributes the air within the working premises should be installed so that the air reaches the workplace, i.e. the tool, without excessively long offtakes. Usually, the ring main is run as a ring line round the premises, hence the name. This means that if an unexpectedly large air usage occurs in any service line, air can be fed from two directions. This will reduce the pressure drop and provide a level, more stable air pressure in the entire system.

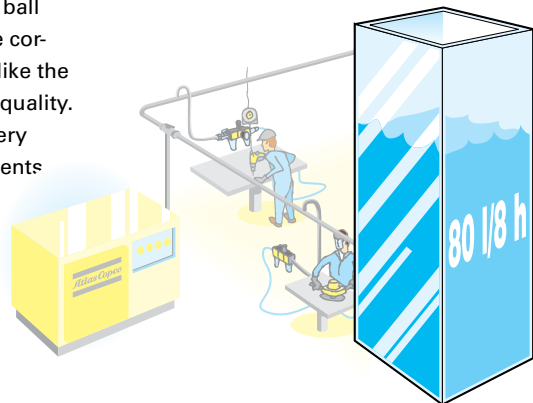
## 10.3 The service line

The offtake, or service line, is the final part of the permanent installation and should be run as close to the workplace as possible. This is to avoid a long hose to the tool which would result in a greater pressure drop. If there is any risk of condensation in any part of the system, the offtake should be connected to the top of the main or distribution line.

## 10.4 Air users

The users in an air distribution system are the air tools together with their air preparation units or any other equipment consuming compressed air. In other words, everything installed after the ball valve. To prevent leakage and to maintain the correct pressure, the air line infrastructure, just like the tools and the compressor, should be of high quality. The air line infrastructure required depend very much on the type of tool and its air requirements to meet the needs of the application.

*Typical air line accessories include: a filter combined with a water trap, pressure regulator, oil fog lubricator or direct lubricator system, hoses and quick couplings.*



## 10.5 Compressed air treatment

All atmospheric air contains water vapour – more at high temperatures and less at low temperatures. When air is compressed, the concentration of water increases. For example, a compressor with a working pressure of 7 bar and a capacity of 200 l/s that draws in air at 20°C with a relative humidity of 80% will produce 80 litres of condensed water in the compressed air line during an eight hour working day.

The amount of water in pressurised air does not present a problem - as long as it remains in a vapour state. But if it condenses, the result can be corrosion in the pipes, interference with the lubrication of air tools, and a constant risk of freezing in pipes and tools. Thus, water should be separated as soon as possible - directly after the compressor and before entering the air distribution system.

### *10.6 Removing the water from compressed air can be done in different ways:*

#### **Air receiver**

An air receiver stores the air after the compressor. When the hot compressed air is cooled in the air receiver the condensation water is collected and separated out in the bottom of the air receiver. An air receiver is used in combination with water traps in the pipes. This is the cheapest way and an old method, which also gives lowest degree of water separation.

#### **Aftercooler**

Uses water or air cooling to cool off the hot compressed air. An aftercooler removes 65 – 75% of the condensation water. An aftercooler is used in virtually all stationary compressor installations, in modern compressors an aftercooler is built into the compressor as standard.

#### **Refrigerant dryer**

Refrigerant drying means that the compressed air is cooled, whereby a large amount of the water condenses and can be separated. After cooling and condensing the compressed air is reheated to around room temperature so that condensation does not form on the outside of the pipe system. Refrigerant dryers are used with dew points between +2 to +10°C.



## 10.7 Adsorption drying

There are two types of adsorption dryer: cold regenerative and hot regenerative. Hot regenerative dryers are best suited to large air flow rates. Hot regenerative adsorption drying regenerates the desiccant by means of electrical heat or when using oil-free screw compressors only the by compressor heat. Very low dew point  $-20^{\circ}\text{C}$  or lower can be obtained. An adsorption dryer with a capacity of 1000 l/s only requires 120 W. Guaranteed separation and drainage of the condensation water shall always be arranged before the adsorption drying. If the compressed air has been produced using oil lubricated compressors, an oil separating filter should also be fitted before the adsorption dryer. In most cases a particle filter is required after adsorption drying.

## 10.8 Other methods

Other methods are over-compression, which can be used for very small air flow rates and absorption drying which has a high consumption of absorption material.

## 10.9 The need for water traps and filters

Some methods described above give a very good result in providing dry air. However it is always recommended to have water traps and filters installed in the air distribution system. A small drop in performance or a stand-still results in water and particles in the pipes which must be separated by filter if a tool service is to be avoided. Small amounts of water can also be converted to rust flakes and particles in the pipes which needs to be removed by a filter.

## 10.10 Cost of pipework

Installing a new air distribution system is an investment which pays off with the improved productivity obtained from low weight, small size tools. Heat recovery makes the compressor installation more efficient.

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