



# Helpful Hints on Preparing Compressed Air

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## Introduction

An efficient compressed air system does not just happen, it is the product of good planning to insure minimum pressure loss in the distribution system and the removal of most contaminants (water, compressor oil, dirt, rust, pipe scale and other foreign materials). Obviously, an inefficient system results in higher costs per unit of compressed air, improper or erratic tool operation, shortened component life, reduced capacity and the formation of rust and sludge in the main and branch lines. These problems all cost industry millions of dollars a year.

The job of laying out a good compressed air system should consider the size of the compressor, how to prepare the air and how to distribute the air. Many systems in operation today are the result of add-on components which are inter-connected as the requirement for air within a given plant is increased.

The tips outlined in this booklet are offered as a guide to upgrade an existing system or as an aid in planning a new compressed air system. Note, however, that this information is not detailed enough to design a total pneumatic system.



## Compressed Air Distribution

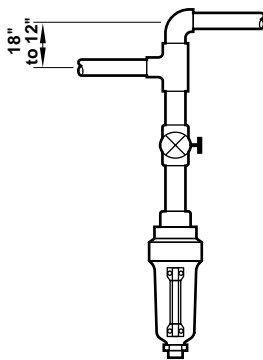
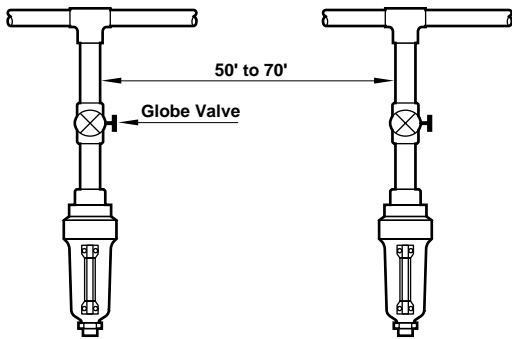
A poorly designed and carelessly installed pneumatic distribution system will cause trouble and result in expensive repairs and costly down-time.

A well designed system, however, provides relatively clean air at the necessary pressure to efficiently operate the components at maximum production capabilities.

### Here are some things to consider when planning a pneumatic distribution system.\*\*

1. Both a general purpose pre-filter and an oil filter and an oil removal filter should be installed just downstream of the compressor aftercooler to remove solid contaminants, water and oil. (Water, of course, promotes corrosion and, in combination with other contaminants, forms sludge.) A dryer should be installed between the aftercooler and receiver.
2. Pressure drop between the receiver and the point of use should be kept at a minimum. The loss should be 3% or less of the line pressure.
3. Pipe sizing is an important factor. You must remember the relationship between pressure drop and air flow. For a given size of line, pressure losses increase as flow increases. Main lines should be sized with future requirements and the effects of aging in mind. As systems age, rust and corrosion affect the inside smoothness of pipe walls causing additional pressure loss. Specify pipe sizes so that pressure drop between the receiver and the farthest point of use in the system is less than 3% of the original line pressure. Branch mains and drop lines should be large enough to handle "peak" compressed air needs.  
(For pipe sizing reference: Compressed Air & Gas HandBook available from Compressed Air & Gas Institute, East 42nd St., New York, NY 10017 or Womack Fluid Power Data Book available from Womack Ed. Pub., P.O. Box 35027, Dallas TX 75235.)
4. An additional accumulator of liberal size should be installed where distribution lines are long. This unit should be mounted at the farthest point from the main receiver. In many installations the demand for air comes in short, heavy bursts. This additional air supply at the end of the line will help to maintain system pressure.
5. Main filters, those with screens or coarse filter elements, should be mounted in the main distribution line after the receiver. Element rating is 50 to 70 microns. Smaller branch or drop line filters should be used throughout the distribution system and be installed as close as possible to the equipment to be protected. These filters are rated 5 to 50 microns. As a general rule, the distance between a drop line filter and the equipment it is to protect should not exceed 20 feet.

\*\* Teflon tape or pipe sealant should be used when assembling piping, etc, to reduce possible leaks. Never use a pneumatic component outside of operating conditions specified by the manufacturer.





## Compressed Air Distribution

6. When installing new piping systems, main lines should slope 1/8" to 1/4" per foot down from the point of origin. Gravity and airflow will then carry condensate to the low points where drop leg should be installed to allow for removal. These drops should be installed every 50 to 70 feet in the system and be taken from the bottom of the main line to insure as much removal as possible.

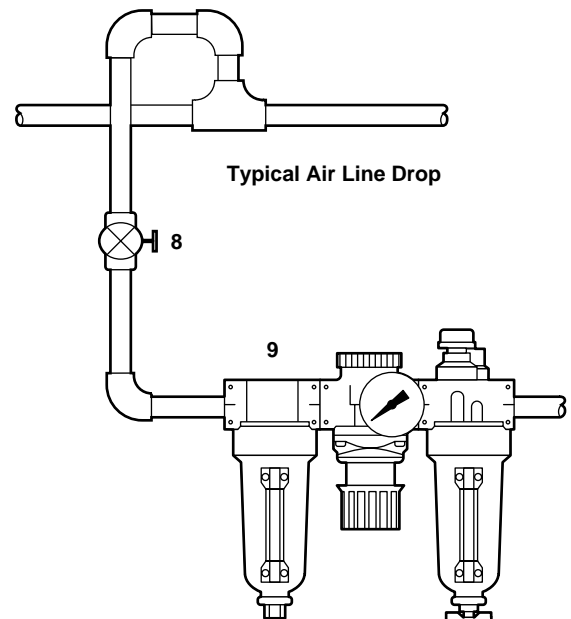
On extremely long lines, the configuration shown can be used to compensate for sloping lines.

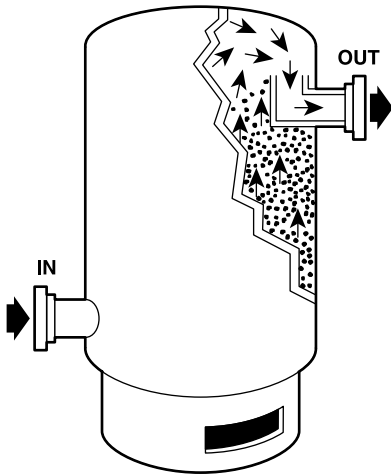
Drip leg drains should be installed at low points in the piping and at the far end of the distribution system where water is likely to accumulate.

A 1/2" globe valve should be installed in the drop line just before the drain so that the unit can be isolated for maintenance without shutting off the air pressure in the remainder of the piping system.

The drip leg drain should be cleaned periodically. Most units can be disassembled for maintenance without removal from the air line. **SHUT OFF AIR AND REDUCE PRESSURE TO ZERO BEFORE DISASSEMBLING.**

7. The air line drops are taken from the top of the main line. This prevents any condensate which forms in the main line from following into the branch lines.
8. Individual shut-off valves should be installed at each drop line to isolate it from the rest of the system for maintenance.
9. The air should be filtered at each work station to remove any additional water (which may have condensed in the main and branch lines due to cooling of the air), rust, sludge, pipe scale and other contaminants (some of which are introduced at the time the system is constructed). Tight, secure pipe joints prevent leaks that waste compressed air. If a main air line dryer is used, there should not be any additional condensed moisture unless the air temperature goes below the dewpoint setting of the dryer.





Typical Chemical Dryer

### Chemical Dryers

Moisture laden air is passed through a tank containing a chemical that absorbs the moisture similar to common table salt absorbing water and forms a solution that is drained from the bottom of the tank. This chemical must be regularly replaced. The dewpoint of the air through a chemical dryer is only reduced by about 10 degrees below the inlet temperature, so it seldom reaches as low a dewpoint or removes as much water as other types of dryers. This type of dryer does not require electrical power and usually is selected for its low initial cost. A disadvantage of this type of dryer is chemical carry-over into downstream air lines.

## Compressed Air Drying

When air is compressed, water vapor in the air is also compressed. The moisture may be held in suspension in vapor form because of the heat developed during compression. When the air flows from the compressor, it begins to cool and the vapor condenses. This condensation should be removed since moisture can shorten component life, create rust, clog air lines and reduce air flow which all contribute to costly downtime.

There are basically three types of compressed air dryers: desiccant, chemical and refrigerant. Each of these dryers reduces the dewpoint of the air with varying degrees of efficiency and economy. Dewpoint is the temperature at which water vapor will begin to condense at a given air pressure.

### Refrigerated Dryers

In a refrigerant dryer it is not necessary to replace any chemicals or desiccants. It operates on electricity and is as dependable as a home refrigerator.

#### Refrigerated Dryer Operation

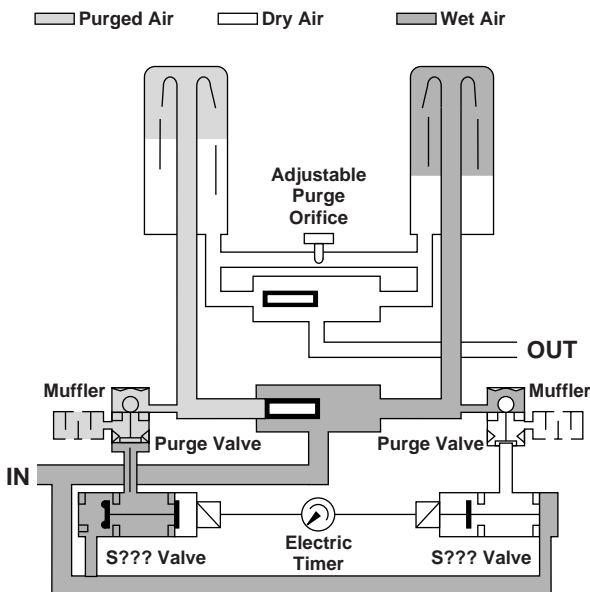
Refrigerated compressed air dryers use a refrigerant circuit to cool compressed air to a lower temperature to reduce the dewpoint of the air and a liquid separator to mechanically remove the condensates (water) formed.

Many refrigerant dryers cool air to about 35°F, just above the freezing point of water. Dewpoint is the temperature at which water vapor will begin to condense at a given air pressure. Refrigerant dryers are generally rated for either 35°F or 50°F pressure dewpoint. To be effective, the dryer must lower the pressure dewpoint of the air to a value lower than the coldest temperature the compressed air might reach downstream of the dryer. The object of drying air is to keep the pressure dewpoint (percentage of saturation of the compressed air) low enough so that condensation will not take place in the user's system.

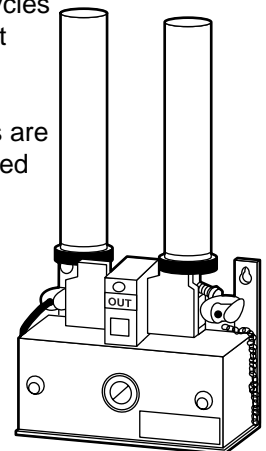
### Desiccant Dryer

Desiccant dryers are filled with an absorbent material such as silica gel or activated alumina, which attracts the water vapor to its surface. These desiccants require replacement every three to five years. Desiccant dryers with regenerative cycles can produce extremely low dewpoints, but at high initial and operating costs. Desiccant dryers should be considered for installation where extremely low dewpoint temperatures are required. An oil removal filter should be placed ahead of this type of filter to prevent oil contamination of the desiccant material.

At left is a diagram of air flow through a NORGREN Heatless Air Dryer. Right chamber shown drying, left being reactivated or purged. Direction of air flow through the two chambers is alternated every two minutes by timing motor controlling two solenoid valves.



Heatless Regenerative Dryer Air Circuit

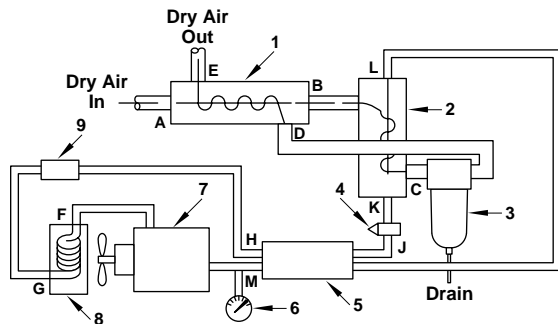


Desiccant or Heatless Regenerative Dryer



## Dryer Circuit and Operation

1. Air-to-Air Heat Exchanger (Precooler)
2. Air-to-Refrigerant Heat Exchanger (Evaporator)
3. Moisture Separator with Automatic Drain
4. Expansion Valve
5. Refrigerant-Refrigerant Heat Exchanger
6. Suction Pressure Gauge
7. Refrigerant Compressor
8. Refrigerant Condenser
9. Refrigerant Strainer-Dryer



## Air Circuit

The warm, wet, compressed air enters the refrigerant dryer at Point A. Here it enters the pre cooler (1) or air-to-air heat exchanger where it is cooled by the chilled dry air leaving the dryer. Next it enters the evaporator (2) or refrigerant-to-air heat exchanger where its temperature is lowered to 35°F. The condensate or water generated by the cooling action is collected in the separator (3) and automatically removed. The cold air then leaves the separator and re-enters the air-to-air heat exchanger where it cools the warm inlet air. Typical temperatures in the air circuit are as follows at designated locations on Figure 1: (A) 100°F; (B) 80°F; (C) 35°F; (D) 37°F; and (E) 70°F.

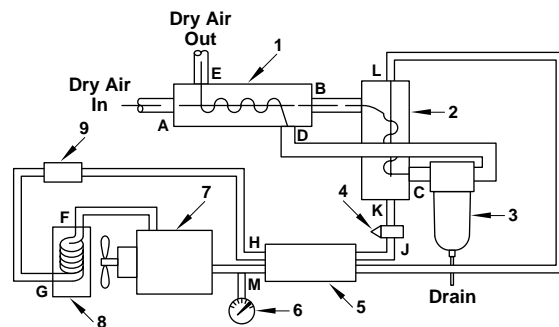
## Refrigerant Circuit

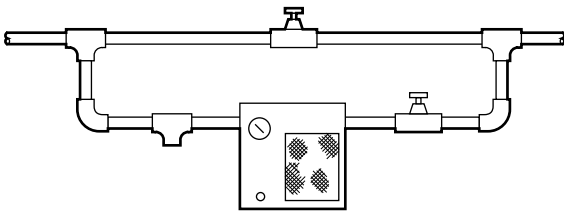
The compressor (7) in figure 1 compresses refrigerant vapor to a high pressure. The vapor then flows through the condenser (8) and is cooled, forming a liquid. After this it is filtered and any traces of moisture and contaminants which may have been introduced during the charging of the compressor unit with refrigerant are removed by the strainer-dryer (9). The refrigerant-to-refrigerant heat exchanger (5) cools the liquid still further. The expansion valve (4) lowers the pressure so that a cold liquid vapor mixture is formed with a temperature of 33° to 36°F. It remains at this pressure and boils as it flows upward through the evaporator (2) absorbing heat from the air being dried. The cold vapor then flows back through the refrigerant-to-refrigerant heat exchanger (5) where it is warmed sufficiently to vaporize any remaining

liquid refrigerant and the cycle then repeats. Typical temperatures in the refrigerant circuit are as follows at designated locations on figure 1: (F) 175°F; (G) 120°F; (H) 120°F; (J) 100°F; (K) 33°F; (L) 38°F; (M) 40°F.

A refrigerant suction pressure gauge is provided as standard equipment on every NORGREN dryer. For Refrigerant 12 units the refrigerant suction pressure in psig shown on the gauge closely approximates the refrigerant temperature in °F. The gauge setting should read between 31 and 36 psig for these units. For Refrigerant 22 the gauge should read between 55 and 65 psig.

Figure 1





## Compressed Air Dryer Installation

Refrigerated dryers should be installed in areas where the ambient temperature doesn't fall below 50°F, or exceed 110°F. For ambient temperatures in excess of 110°F, a water cooled condensing unit is recommended. Refrigerated dryers are not recommended for applications where compressed air lines must run out of doors in freezing temperatures.

A refrigerant dryer is more effective at high air pressures than at low, but must never be used where the air pressure rating of the dryer is exceeded. Inlet air temperatures and ambient temperatures exceeding 100°F place additional heat load on the dryer and require oversizing to compensate for the additional load. For inlet temperatures in excess of 115°F, an after cooler in the compressed air line upstream of the dryer is recommended.

A general purpose air line filter installed upstream of the dryer is recommended for removing liquid water and solids from the air entering the dryer. This also reduces the cooling load on the dryer. When using an oil lubricated air compressor, an oil removal coalescing filter is recommended to keep oil and sludge from fouling the dryer heat exchanger.

The use of three manual valves allows the dryer to be isolated for service and maintenance without disruption of air service.

## Servicing

Periodic cleaning of the condenser coils with a blow gun or soft hand brush is recommended to keep the dryer in good operating condition.

Ambient temperatures below 50°F or air flow less than 15% of the rated capacity of the dryer may cause the dryer to freeze-up. The symptom of freeze-up is a large pressure drop across the dryer and no air flow due to ice forming in the heat exchanger coils. This malfunction can be corrected by increasing the refrigerant suction pressure by manual adjustment of the expansion valve. Turning the expansion valve adjustment screw clockwise increases the refrigerant suction pressure and turning the expansion valve adjustment screw counterclockwise reduces the refrigerant suction pressure. With Refrigerant 12, the suction pressure in psig is roughly equivalent numerically to the suction temperature in degrees Fahrenheit.



# Compressed Air Filtration

To remove condensed water and contaminants, a filter-separator is used. A filter-separator or "filter" separates solid particles and water by centrifugal action and then filters additional impurities out of the airstream by the filter element.

Operation of an air line filter is simple - air entering the filter passes through louvers (1) which direct the air into a swirling pattern. Centrifugal force throws the liquid droplets and particulate matter outward to the inside of the filter bowl (2). There they run downward into a "quiet zone" (3) at the bottom of the bowl where they are drained away. A baffle prevents the turbulent air from picking up the liquid and returning it to the system. As the pressurized air leaves the bowl, it passes through a filter element which removes additional solid impurities before it re-enters the air line.

For most industrial applications a 40 micron filter element is sufficient. One micron ( $\mu$ ) is equal to .000039 inch or 1/1,000,000 of a meter. Here are some relative sizes listed in microns:

- Viruses . . . . . $.1\mu$  and less
- Tobacco Smoke . . . . . $.2\mu$  and less
- Coal Dust . . . . . $.1-100\mu$
- Human Hair . . . . . $.40-300\mu$

The following list gives several applications with recommended element micron ratings:

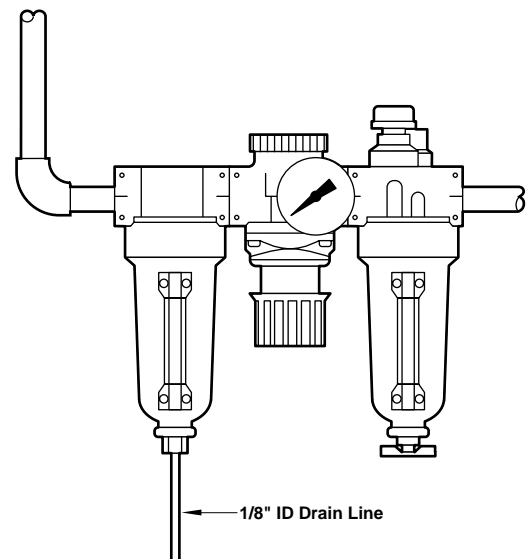
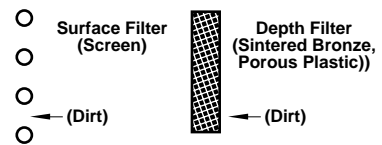
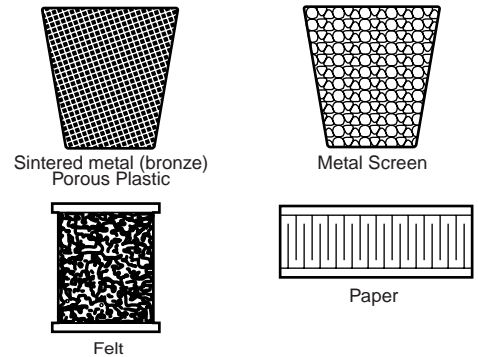
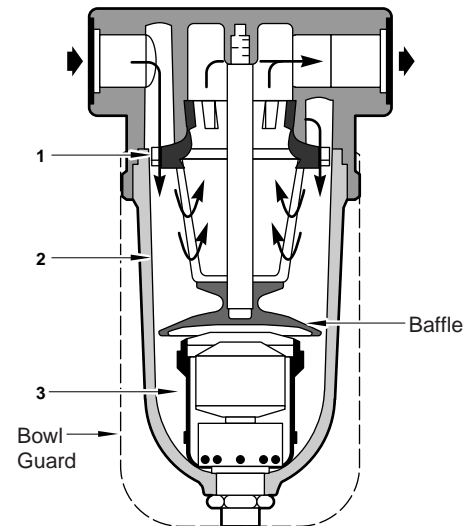
- Power Valve Circuits . . . . . $.40\mu$
- Heavy-duty Air Tools . . . . . $.50\mu$
- Small Air Tools . . . . . $.25\mu$
- Pre-filters . . . . . $.5-40\mu$
- Precision Pressure Regulator . . . . . $.5\mu$
- Pneumatic Sensors & Interface Devices . . . . . $.5\mu$

Filters remove solid particles down to the rating of the element and most of the condensed moisture in the air line. Water in vapor form passes through general purpose filters.

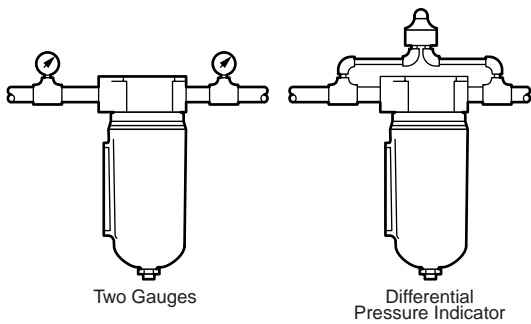
There are several types of filter elements on the market. Construction materials are porous (sintered) metal, metal screen, porous plastic, paper, felt, etc. They can be either cleaned or thrown away, depending on the material. On most filters, the element can be removed for cleaning or replacing without removing the filter body from the air line.

The elements are categorized as either surface filtration or depth filtration types. Surface filtration elements are usually made of screen and will allow long, thin particles to penetrate. Depth filtration elements are made of sintered bronze or plastic and the tortuous path through this type element will prohibit long, thin particles from penetrating and are, therefore, more effective. NORGREN uses depth filters made of sintered bronze or high density polyethylene as the standard filter element.

Air line filters can be equipped with an automatic drain to save time and labor in draining collected water, especially when the filter is mounted in a hard to reach location. All filters should be mounted vertically, and when equipped with automatic drains, a drain line of at least 1/8" I.D. should be used to plumb drain away from immediate area.







### Filter Servicing

To insure maximum operating efficiency of a filter, it is essential to monitor its operation, drain the bowl, and clean or replace the element when necessary. Therefore, the filter should be installed, whenever possible, where this maintenance can easily be performed. When a filter becomes clogged, it can affect the operation of downstream equipment (air motors, valves, cylinders, etc.) to the point that the equipment appears to be malfunctioning. A good rule to follow is to clean or replace the filter element whenever the pressure drop across a filter at rated flow is approximately 10 psid. Pressure drop can be monitored by the use of two pressure gauges, one mounted on either side of the filter, or by installing a differential pressure indicator (designed specifically for this purpose) across the filter.

### Filter Sizing

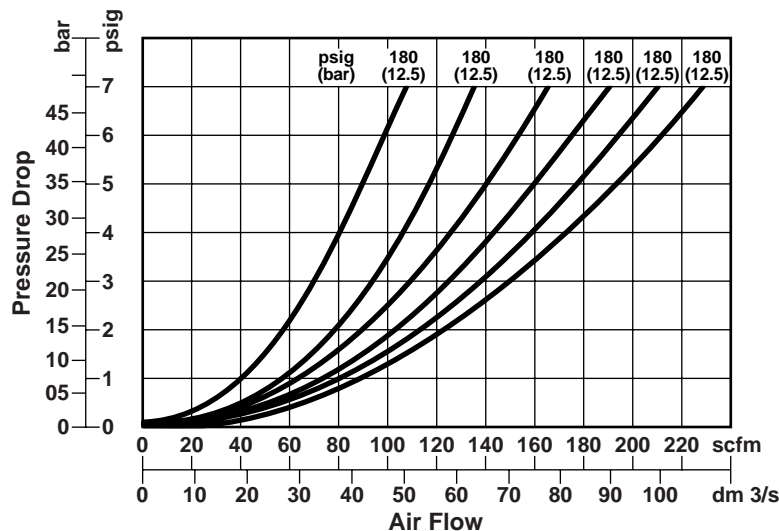
Selecting the proper size of filter for any application should be done by determining the maximum allowable pressure drop which can be caused by the filter. The pressure drop can be determined by referring to flow curves provided by the manufacturer.

The flow characteristic curves should relate to the fluid used, pressure, pipe port size and micron rating of the filter element. Often the parameters of pressure and flow are labeled in metric and imperial units. The vertical axis is the pressure drop across the filter, and the horizontal axis is the air flow through the filter. Each curved line represents the filter flow and pressure drop characteristics for different operating pressures.

Example Find the pressure drop across the filter when operating at 90 psig and when 50 scfm is flowing through the filter.

Answer Locate 50 scfm on the horizontal axis. Read up to the intersecting point on the 90 psig operating curve. The pressure drop (or  $\Delta p$ ) is approximately .6 psid on the vertical axis on the left of the graph.

Flow Characteristics





### Oil Removal Filters

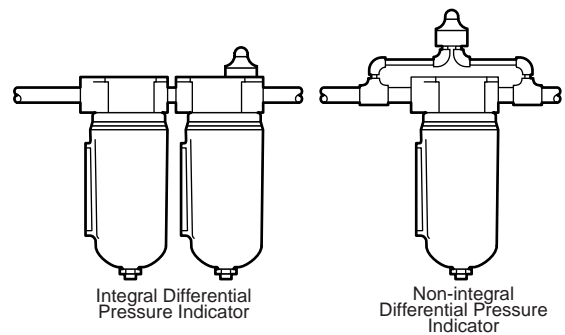
Some applications require compressed air which is free of oil mist and particles. Air bearings, pneumatic gauging equipment, air agitation and conveying of powders and granular products, blow guns used for cleaning electronic equipment, film processing, fluidic and miniature pneumatic logic, instrumentation equipment, and paint spraying are a few of the types of applications requiring compressed air which is as oil free as possible. Failure caused by oil in compressed air in these applications would cause heating in air bearing, erroneous reading in pneumatic gauging equipment, lumping and spoilage in air agitation and conveying, contamination of equipment and film, short life for fluidics, pneumatic logic and instrumentation equipment, and rejected work in paint spraying.

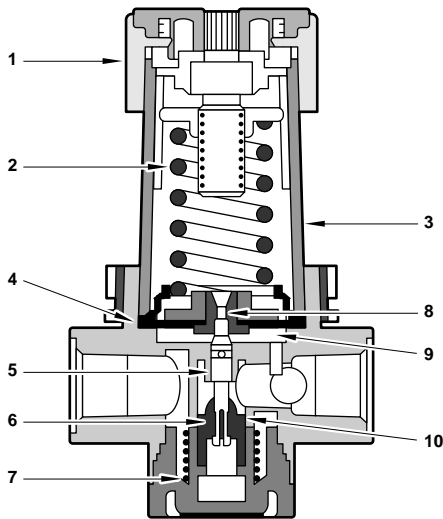
Most oil removal filters have a nominal rating of well below one micron and remove oil mist and particles in a coalescing process. A material made up of many fine synthetic fibers is used for the filter element. As oil laden air passes through the filter, oil particles collect on the fibers and grow until they become drops of oil draining into the bottom of the filter bowl. Coalescing filters do not become ineffective when they are saturated with oil because the coalesced oil drains away from the filter element.

Because oil removal filters have a submicron Rating, a prefilter with a Rating of  $5\mu$  should be used and installed just ahead of the oil removal filter. A prefilter can be a general purpose type finer and is used to extend the life of the oil removal filter.

Oil removal filters are selected by flow capacity in the same way as general purpose filters. New filters will flow more air than their rating until they become saturated. Size these filters by the saturated or wet flow ratings.

Filters should be serviced when the pressure drop exceeds 10 psid at rated flow. Oil removal filter elements cannot be cleaned and should be replaced. A pressure drop indicator may be used to determine when replacement is necessary. This device mounts directly on the filter or can be remote mounted with lines to upstream and downstream sides of the filter.





## Operation

Outlet pressure is controlled by the adjusting knob (1). Clockwise rotation increases and counterclockwise rotation decreases outlet pressure.

When the adjustment (1) is rotated fully counterclockwise, no force is applied to the regulating spring (2), and the valve (6) is held closed by the valve spring (7). Clockwise rotation of the adjustment (1) compresses the regulating spring (2) which applies a downward force on top of the diaphragm (4). The diaphragm (4) and valve pin (5) move downward forcing valve (6) off its seat (10) which allows air to flow thru the regulator to the downstream system.

Outlet pressure increases in the downstream system and sensing chamber (9) and applies an upward force on the bottom of the diaphragm (4). The diaphragm (4), valve pin (5), and valve (6) move upward, compressing the regulating spring (2). Upward movement stops when the forces below the diaphragm balance the forces above the diaphragm. When there is no downstream flow demand, the balance of forces occurs with the valve (6) closed. When there is downstream flow demand, the balance of forces occurs when the valve opens sufficiently to compensate for demand, thus maintaining the desired outlet pressure.

## Compressed Air Regulation

Pneumatic equipment is designed to work at a certain pressure. Most equipment will operate at pressures in excess of that recommended. However, operating at this higher pressure can cause excessive torque, force and wear and can waste compressed air. The best operation and life of this equipment can be gained by using the proper pressure level. To control the pressure level, the right choice of a regulator is important to the compressed air user.

The following is a discussion of the operation of a general purpose regulator.

### Relieving Type Regulators

With relieving regulators, outlet pressure can be reduced even though the system is dead ended. When the adjustment (1) is turned counterclockwise, the force on the regulating spring (2) is reduced, and air pressure under the diaphragm (4) moves the diaphragm upward. This upward movement of the diaphragm opens the relief passage (8) in the diaphragm and allows air to escape from the outlet side of the regulator through the relief passage (8) and vent passage (3) to atmosphere. As the outlet air pressure decreases to the reduced pressure setting, the diaphragm moves downward and closes the relief passage.

The diaphragm will likewise move upward in response to an increase in outlet pressure above the regulator setting, allowing air to escape to the atmosphere as described above. However, the flow capacity of the relief passage is limited, and depending upon the source of the overpressure condition, the outlet pressure might increase to a point significantly higher than the regulator setting. For this reason, the relief feature of a regulator must not be relied upon as an overpressure safety device. Relieving type regulators are the most common regulator used.

### Nonrelieving Type Regulators

With nonrelieving regulators, outlet pressure cannot be reduced if the system is dead ended. The nonrelieving type regulator is identical to the relieving type with the exception of the diaphragm which is not equipped with relief passage (8). This type of regulator will not vent the outlet air pressure as described under **Relieving Type Regulators** and some other means of venting the outlet air pressure must be provided. Nonrelieving regulators are used when it is desirable not to vent the fluid to atmosphere such as if used with nitrogen or water.



## Regulator Selection

In selecting a regulator there are two basic operating characteristics to be considered. These characteristics are **Regulation and Flow**.

The regulation characteristic indicates the ability of the regulator to maintain a relatively constant delivery pressure as the supply pressure changes due to the cycling of the compressor or to upstream pressure changes caused by other equipment.

Flow characteristic indicates the ability of the regulator to maintain a relatively constant delivery pressure as the downstream flow demand changes. This can occur when downstream air tools or other devices are being turned on and off.

Choosing a regulator requires knowing what type of features are needed in addition to the correct regulation and flow characteristics. These features could be flow capacity, pressure and temperature rating, fluid compatibility, relieving or nonrelieving, pilot operated, balanced valve, diaphragm or piston sensor, high relief flow, full flow gauge ports, ease of adjustment, locking and tamper proofing capability and mounting.

### Pilot Operated

These regulators use air pressure instead of a spring to create force for operation. This type of regulator is often mounted in overhead lines with another regulator mounted in a more convenient place controlling it.

### Balanced Valve

A regulator with a balanced valve design will have good regulation characteristics. A balanced valve design has equal pressure above and below the valve. These pressures cancel out the force acting in each direction on the valve; therefore, the valve is balanced. This feature reduces the effect of varying primary pressure on the secondary pressure.

### Diaphragm or Piston Pressure Sensors

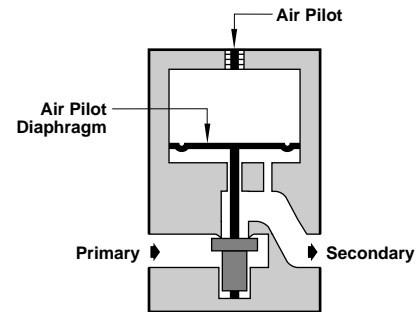
Most regulators use a diaphragm as the pressure sensor. Diaphragms are sensitive and do not have seal friction to overcome before responding to pressure changes. Piston sensors do not respond to changes in pressure as readily as diaphragm sensors because of seal friction.

### High Relief Flow

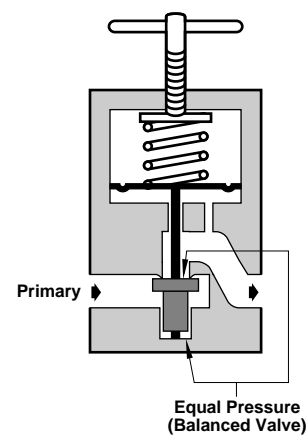
Some applications require a high relief flow such as when deflating tires during manufacturers' testing. The "Microtrol" regulator, among others, has a high relief flow capability.

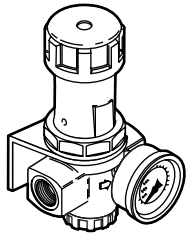
### Full Flow Gauge Ports

These ports are full open to the secondary pressure and can be used as an additional outlet for 1/4" piping.

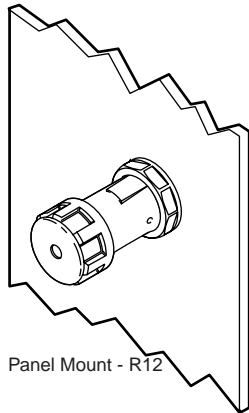


Pilot Operated Regulator





R12 in Mounting Bracket



Panel Mount - R12

**Ease of Adjustment**

Some regulators have a very large diaphragm area which requires high adjusting spring forces to move. Regulators with smaller sensing areas require lower adjusting spring forces to move and are much easier to adjust such as the NORGREN Designer series.

**Tamper Resistant Pressure Setting & Factory Preset, Non-adjustable Pressure Settings**

The pressure setting on regulators with a knob adjustment can be made temper resistant in the field by the addition of seal wire, a feature not available with some competitors' regulators. In addition, some regulators can be set at the factory at a specified pressure setting. These regulators are not field adjustable, as the adjusting screw is pinned or otherwise locked in place.

**Mounting**

Not all manufacturers offer both bracket and panel mounting. Look for these features to give a choice of the best mounting style.

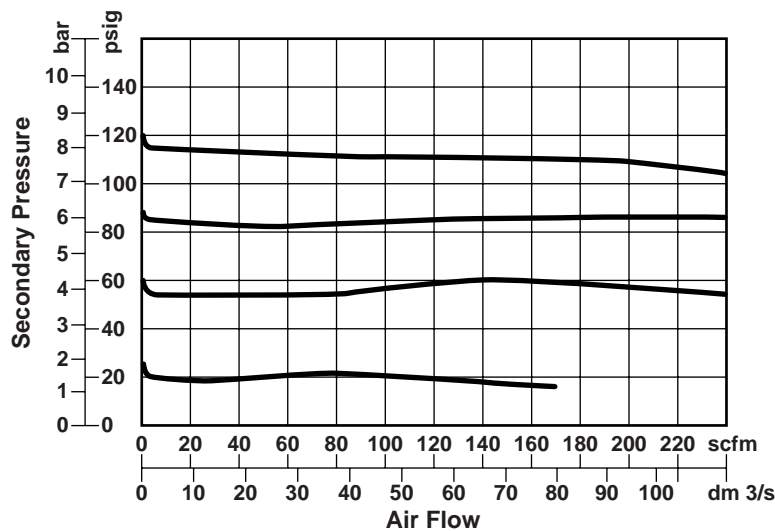
**Regulator Sizing**

Regulators are sized by the downstream flow and pressure requirements. A regulator too small for the job cannot maintain the required pressure under maximum flow conditions. A regulator larger than required will cost more than what is necessary to do the job.

The Flow Characteristics curve gives the flow information necessary to choose the proper size. In the curve sample, the flow is on the horizontal axis and secondary pressure is on the vertical axis.

Enter curve on required flow rate (horizontal axis).

Flow Characteristics



Example: 50 scfm. go up vertically to intersect with the 90 psig secondary pressure horizontal curve line. Read the difference between the pressure at 50 scfm flow and 0 scfm flow for 90 psig secondary pressure line. This is the drop in pressure and should be limited to approximately 10% of the set no flow pressure. In this example the drop is approximately 7 psig.



### Regulator Installation

Install the regulator as close as possible to the tool or device it is to service. The regulator may be mounted in any convenient angle for easy accessibility and maintenance.

### Adjustment

1. Before turning on system air pressure, turn regulator adjustment counterclockwise until all load is removed from the regulating spring.
2. Turn on system air pressure.
3. Turn regulator adjustment clockwise until the desired outlet pressure is reached while tool is operating.
4. To avoid minor readjustment after making a change in pressure setting, always approach the desired pressure from a lower pressure. When reducing from a higher to a lower setting, first reduce to some pressure less than that desired, then bring up to the desired point.

To determine the proper secondary pressure setting, check the recommendations of the manufacturer of the equipment being used.

If outlet pressures in excess of the regulator pressure setting could cause downstream equipment to rupture or malfunction, install a pressure relief device downstream of the regulator. The relief pressure and flow capacity of the relief device must satisfy system requirements.

### Regulator Servicing

Proper pressure settings should be checked from time to time to insure correct operation. If secondary pressure control is erratic, shut off the air supply to the regulator and repair the regulator.

### Regulator Troubleshooting

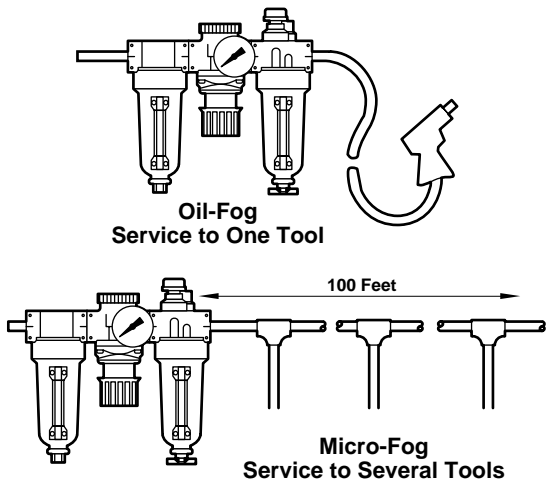
1. Excessive pressure drop between no flow and flow conditions.  
Probable Cause
  - a. Regulator too small for application.
  - b. Valve failing to open fully due to lack of lubrication or blockage such as rust build-up.
  - c. Application requires precision regulator.
2. Creep - Downstream pressure builds up above set pressure when there is no flow in the downstream side.  
Probable Cause
  - a. Defective valve seat or elastomer-foreign object on valve seal area.
  - b. Weak, damaged or missing valve spring.
  - c. Lack of lubrication of valve o-rings.
  - d. Damaged or worn o-ring on balanced valve.
  - e. Piston type o-ring damaged.
3. Leak through bonnet vent port.  
Probable Cause
  - a. Same as Creep.
  - b. Diaphragm pulled or damaged.
  - c. Leak through center rivet of diaphragm.
  - d. Foreign particle on relief valve.
  - e. Piston type o-ring damaged.



## Compressed Air Lubrication

Most moving parts require some type of lubrication. The efficiency of cylinders, valves and air motors can be greatly improved if they are supplied with adequate lubrication.

Pneumatic components can be lubricated by using an air line lubricator, a device for adding lubricating oil in aerosol form into a compressed air line. The air passing through the lubricator transports the lubricant to air tools, cylinders or other air operated equipment where the lubricant is deposited on moving and sliding surfaces to reduce friction and wear. Most lubricators have a proportional oil delivery feature which automatically provides a nearly constant oil-to-air ratio over a wide range of air flows.



### Lubricator Operation

Air flowing through an automatic air line lubricator creates a differential between air line pressure and pressure to the lubricator reservoir. The pressure differential causes oil to be lifted from the reservoir into a sight feed dome and dripped into a body section where the oil atomizes and mixes with the air flowing through the lubricator. The oil fog/mist is carried by the air stream to the device to be lubricated.

There are several basic types of lubricators. The most popular are the Oil-fog and Micro-fog types and the liquid injection type. The Oil-fog and Micro-fog types atomize the oil at the lubricator as described above. The injection type of lubricator pumps discrete quantities of liquid oil and delivers it to the point of use via a small tube.

The Oil-fog type lubricator puts out a somewhat coarse droplet size of oil and is used with one tool or device located within 10 to 15 feet of the lubricator. The Micro-fog type lubricator puts out a very fine oil mist which can be carried over a much longer distance (100 feet) and can service several tools at one time.

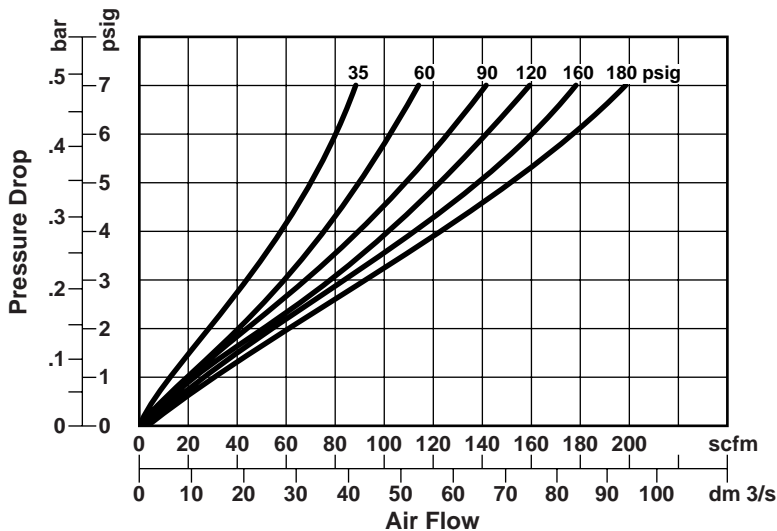
### Lubricator Sizing

Lubricators are sized by downstream flow requirements. An analysis of air flow use must be made. After determining how much

air flow is needed, a lubricator can be chosen. Manufacturers' curves will be like the one shown. For example, 50 scfm of 90 psig lubricated air is required. Enter the curve on the horizontal axis at the required flow. Read up to intersect the 90 psig line. Read the pressure drop on left, vertical axis as approximately 2.3 psid. Pressure drop should be less than 5 psid. If pressure drop is more than 5 psid, choose a larger lubricator.

Always be sure that the lubricants in your system are compatible with the materials in the lubricator you choose. This is especially important for plastic lubricator reservoirs. If in doubt, check with the factory or use a metal reservoir.

Flow Characteristics

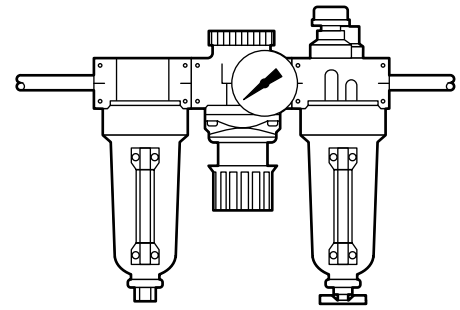




### Lubricator Installation

Lubricators that put out a coarse fog (**Oil-fog**) should be mounted as close as possible to the equipment they are to serve and should be mounted above the work station so condensed oil will flow easily toward the point of use. Air lines to tools, etc. should be straight without loops or bends and free of excess fittings.

Lubricators that put out a fine mist (**Micro-fog**) can be installed above or slightly below the work station. The lubricator should be located so that its fill plug is readily accessible. Lubricators are mounted downstream of the regulator in a filter-regulator installation.



### Drip Rate Adjustment

Most modern air line lubricators incorporate an automatic sensor which maintains a constant oil-to-air ratio. After the initial oil-to-air setting is made, no additional adjustments are needed if there is a change in air flow through the lubricator. The initial oil drop adjustment is made under actual air flow conditions. Refer to manufacturers' spec sheets for drip rate settings.

### Filling Lubricator

Most oil-fog type lubricators can be filled when the system is under pressure. Simply remove the fill plug and pour in the oil.

The Micro-fog lubricator cannot be filled under pressure except when using a pressure fill or button head plug and a pump which allows you to pump in oil under pressure.

A third method of filling can be done on either type of lubricator by using an automatic fill device and a centrally located and pressurized source of oil.

### Lubricator Servicing

Lubricators require some servicing to insure maximum operating efficiency. Mist type lubricator reservoirs should be periodically drained of condensate, plastic reservoirs should be cleaned only with warm water and should be replaced with metal reservoirs if any signs of cracking, deformation or cloudiness are shown. The reservoir oil level should be checked regularly.

### Troubleshooting

#### 1. No drip rate.

##### Probable Cause

- Oil adjustment shut-off, oil level, air flow through lubricator too low.
- Plugged oil delivery tube and/or siphon tube circuit.
- Plugged air filter screen.
- Air leaking from reservoir.

#### 2. Reservoir will not pressurize.

##### Probable Cause

- Reservoir charge check valve has plugged orifice (oil-fog type lubricators).
- Cycle rate too great to permit pressurization of reservoir.
- Reservoir seal leaking.



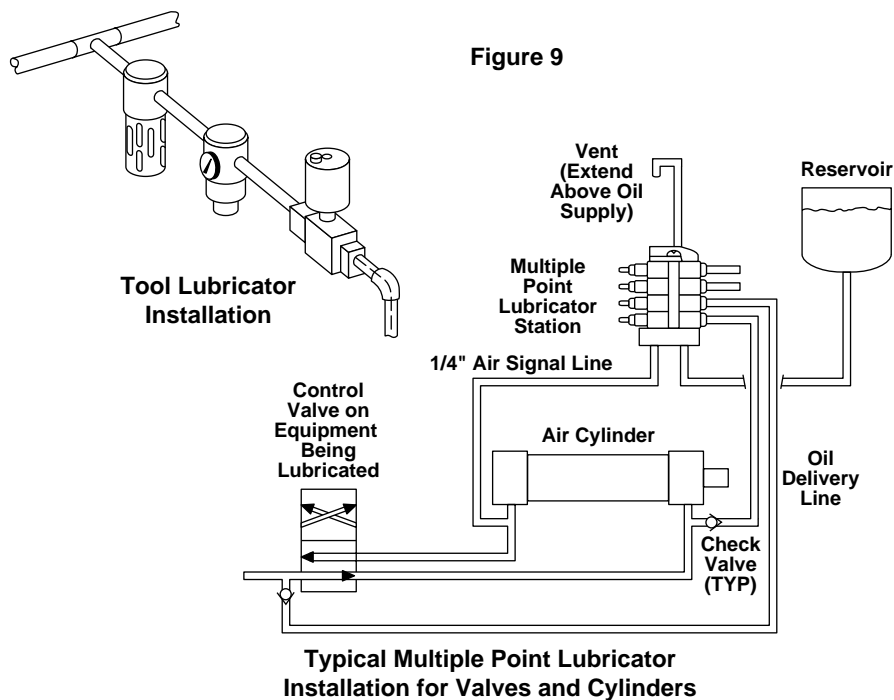


## Injection Type Lubricators

These lubricators can be supplied as tool lubricators or as lubricators to service valves, cylinders, guide ways and chains.

A separate lubricator is required for each tool to be operated. A separate line housed inside the tool air supply line carries the oil to within a foot or so of the tool. Each time the tool is actuated, the lubricator injects a pre-set amount of oil to the tool.

A coaxial, quick-disconnect can be used to connect longer tool supply lines or just to connect the tool. These disconnects have a small connector in them to carry the oil through to the downstream side oil delivery line.



## Conclusion

In this booklet we have attempted to highlight the various equipment necessary to develop an efficient and economical compressed air system. Obviously, there is a wide range of sizes, types and capacities of such units in order to satisfy all the varying needs of the industry.

If you would like further assistance in the selection of the proper equipment to fit your specific needs, contact your nearest NORGREN distributor. He is listed in the Yellow Pages of the telephone directory.