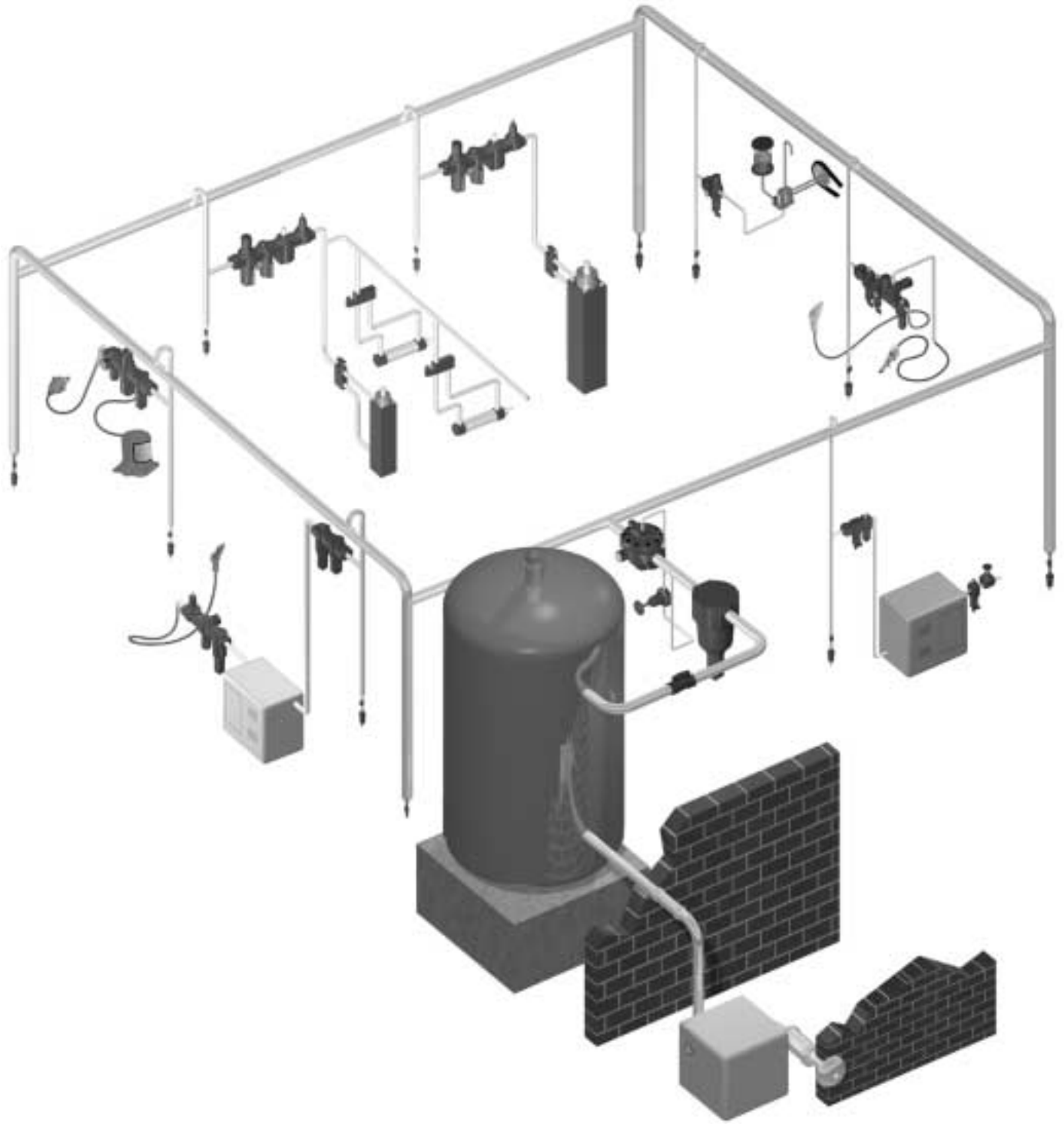
APC-104 Contents
2001

Norgren Air Preparation Products and Accessories

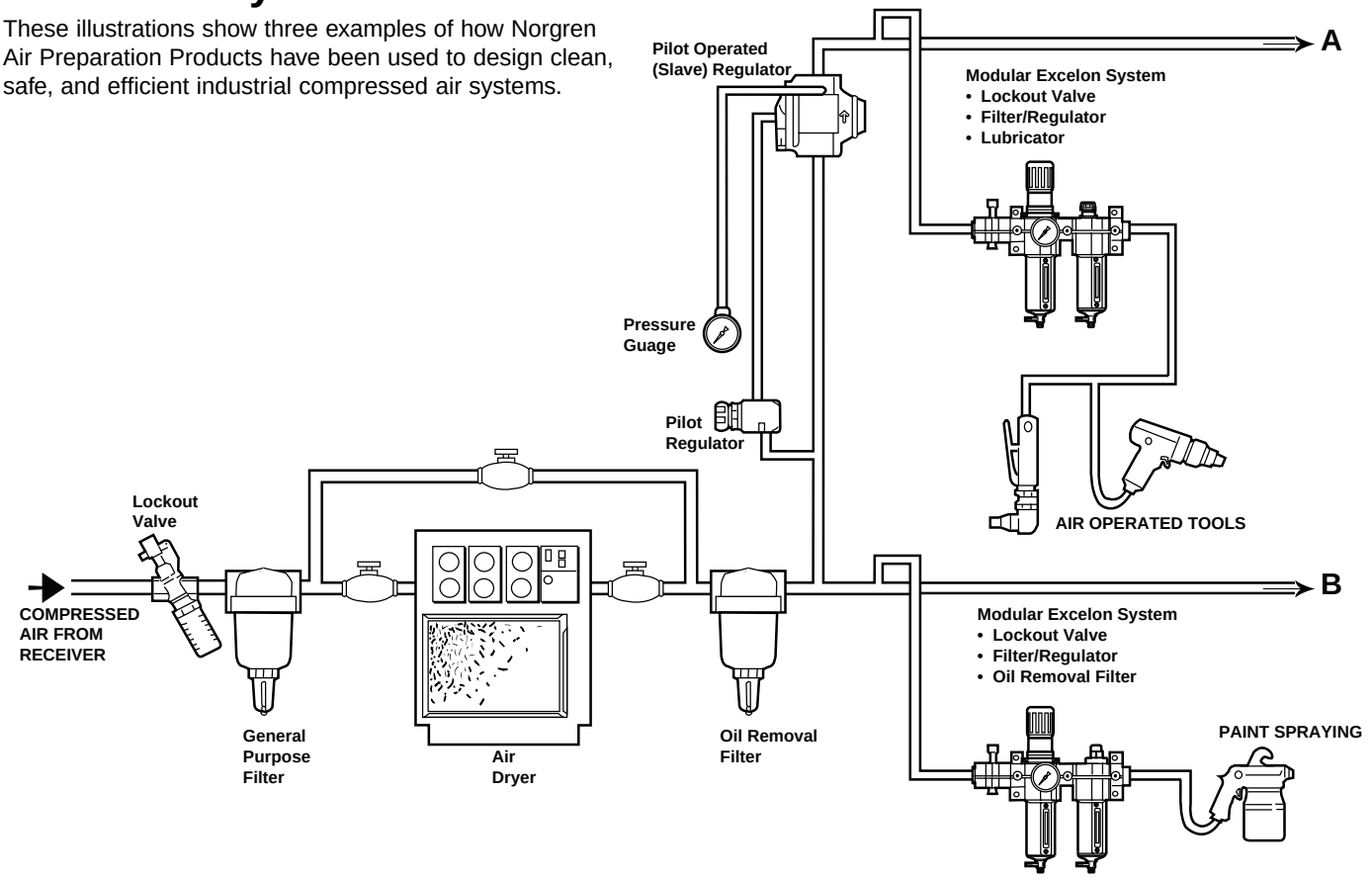
Norgren Air Preparation Products: Protecting your pneumatic system from the hazards of contaminated air.

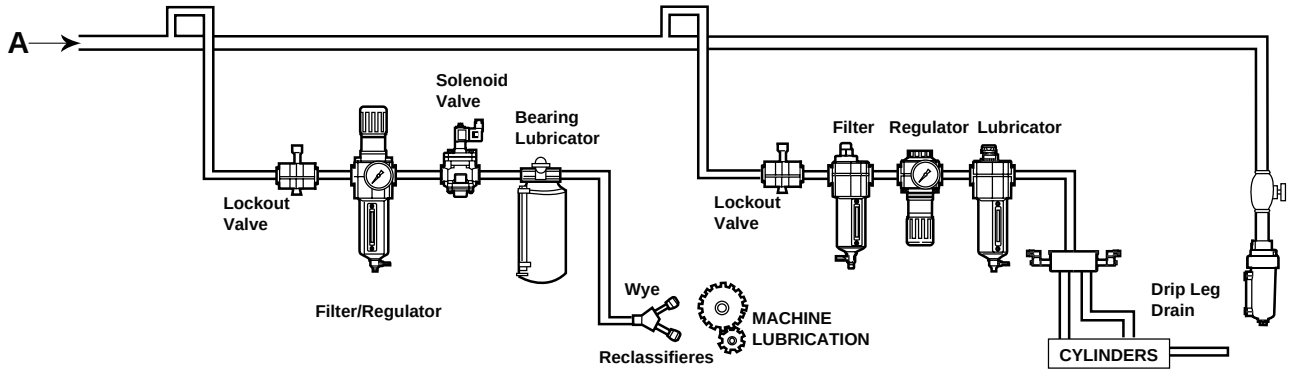
The air leaving a compressor is hot, dirty, wet and generally at a higher pressure than the downstream equipment requires. A typical 100 scfm (50 dm3/sec) compressor will push 1200 gallons (4500 liters) of water and 2 gallons (8 liters) of degraded compressor oil into the system in a year along with considerable amounts of dirt particles. Before this air can be used it needs to be treated to remove the contaminants, have its pressure reduced to the right level, and in many cases have oil added to lubricate downstream equipment.

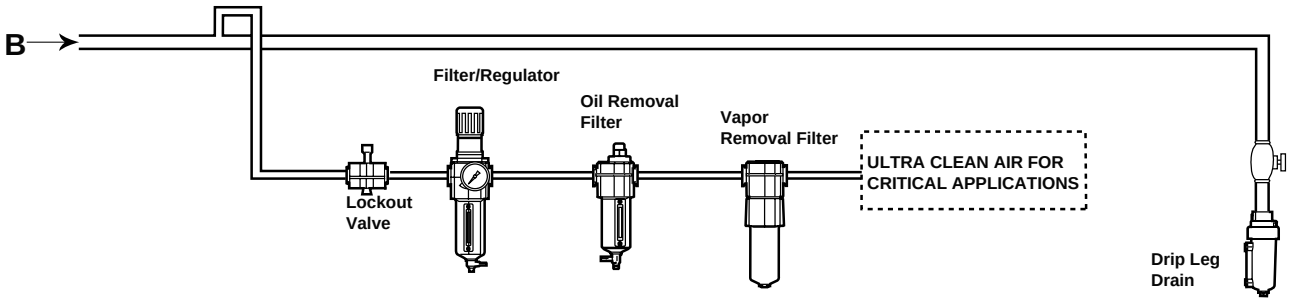


Build Your System!

These illustrations show three examples of how Norgren Air Preparation Products have been used to design clean, safe, and efficient industrial compressed air systems.







Norgren knowledge and products save you money

Compressed air is often wrongly assumed to be a cheap or even 'free' source of power. In fact it can be 10 times as expensive as electricity by the time all generation, transmission, treatment and system costs are taken into account. Good air preparation must therefore consider the energy consumption of the system and air treatment equipment.

The process of air preparation has been at the core of Norgren's business for over 70 years. The aim of this booklet is to offer guidance on the correct, economic and safe treatment of compressed air in industrial applications. Here we can only provide a brief summary of the extensive experience Norgren has as a world leader in FRL technology.

APPLICATIONS

The following section shows several typical systems of a generic type and the equipment normally used for the application. Remember every system should be treated on its merits and broken down into several elements to ensure optimum installation, running and maintenance costs are achieved.

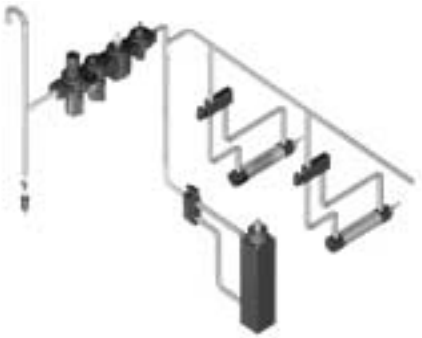
The applications below are typically branches taken off a large works distribution mains and isolating valves are usually placed in front of all branches to permit isolation from the mains to allow for maintenance to take place without recourse to complete plant shut-down.

General Pneumatic Circuits:

eg: directional control valves and cylinders, in multi-valve circuits, machine cleaning, air motors and high speed tools.

A Micro-Fog lubricator is required for the several varying flow paths to ensure full lubrication. (Figure 2)

Figure 2.



Shut-off valve, filter/reg, Micro-Fog lubricator, soft start/dump, relief valve.

Multiple Simple Applications:

eg: OEM machines.

It is often a case that with fairly simple machines, lubricated air is required for valving and pneumatic circuitry and oil-free air for air bearings. To keep costs low two separate lines are unnecessary and a typical arrangement from one air supply only can be arranged as shown.

Other elements such as pressure switches and check valves may be made available within modular systems. (Figure 3).

Figure 2

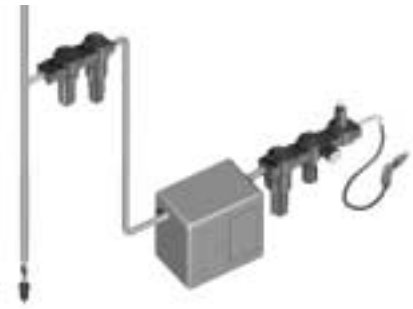
Shut-off valve, filter/regulator, oil removal filter, porting block, Micro-Fog lubricator.

Oil-Free Applications:

eg paint spraying, foodstuffs, film processing, powders.

These applications need to be free from any water deposits in the downstream system. For many installations this will require air drying. The drying medium (for desiccant or deliquescent dryers) will need protecting from oil to allow it to work efficiently and the downstream system will also need protection from accidental migration of the material into it. A typical arrangement would be as figure 26 and in some instances it might be worth considering an oil vapour removal filter too. (Figure 4)

Figure 4.



Shut-off valve, general purpose filter, oil removal filter, drier, oil removal filter, regulator, relief valve.

Heavy Duty Lubrication:

eg: large slow moving cylinders.

In such applications large amounts of lubricant are required for effective lubrication. Again a soft start/dump valve is shown but is dependent upon the application. (Figure 5).

Figure 5.

Shut-off valve, filter/reg, Oil-Fog lubricator, soft start/dump valve, relief valve.

Critical Pressure Control (Instrumentation):

eg: precision regulation, fluidic systems, air gauging, process control.

A typical arrangement is shown, where oil aerosols which can prevent fast response of downstream devices, need to be removed. Dependant upon air quality drying may not be required. (Figure 6)

Figure 6.

Shut-off valve, general purpose filter, oil removal filter, drier, oil removal filter, precision regulator.

Direct Injection Lubrication:

eg: conveyor chains.

The application does not allow for 'fog' type lubrication because of the surrounding environment and absence of a lubrication chamber. (Figure 7).

Figure 7.

Shut-off valve, filter/reg + direct injection lubricator.

Continuous Processes

Another facet of Norgren's Olympian Plus is the ability to make duplex systems. This is invaluable for systems which cannot be shut-down, such as continuous process plant. Two identical air sets are joined together and one may be isolated (and serviced) whilst the other set is in operation. (Figure 8)

Figure 8.

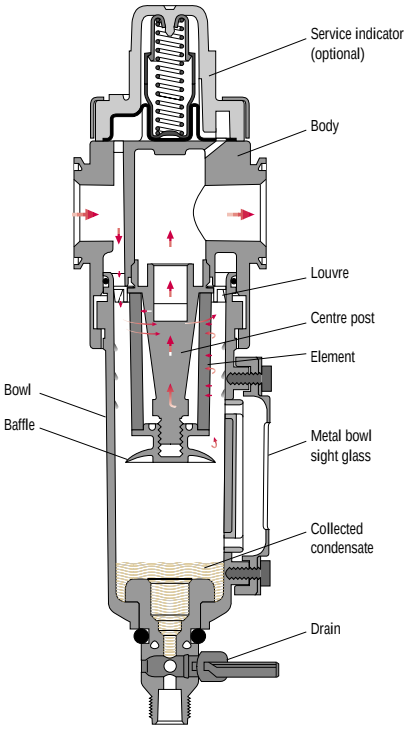
Duplex system: shut-off valve, filter/reg, lubricator, porting block, oil removal filter and shut-off valve x 2 with manifold block connectors.

Filters

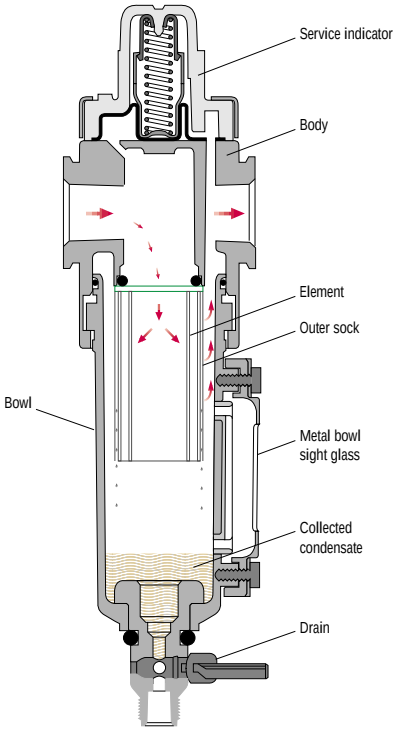
General Purpose Filters, Oil Removal (Coalescing) Filters, Oil Vapor Removal (Adsorbing) Filters, and Compressed Air Membrane Dryers

1.1 GENERAL OVERVIEW

GENERAL PURPOSE FILTER



COALESCING FILTER



Three main types of filters exist: The general purpose filter for water and particles, the coalescing oil removal filter for oil aerosols and the activated carbon filter for the removal of oil vapors.

The general purpose filter is used for most filter applications and is available from 1/8" to 2" pipe sizes. Uses are main headers, branch lines, tools, cylinders, valves and valve circuits, air agitators etc. Oil removal filters are used where very clean, oil-free air is required, such as for the supply to fluidic devices, instrumentation, air gauging equipment and air bearings.

Activated Carbon filters are used for systems where the oil vapors in the air are not acceptable; such as instrumentation and paint spraying.

1.1.1 How Do General Purpose Filters Work?

The dirt and moisture-laden air enters the inlet port and is directed into the louvers which centrifugally separate the entrained liquids and dirt which fall to the bottom of the bowl. Near the bottom of the bowl a baffle creates a quiet zone, preventing the turbulent air re-entraining the contaminants. The air, now free of water droplets and large dirt particles, passes through the filter element which removes small dirt particles. Solid particles eventually plug the element necessitating replacement.

1.1.2 How Do Oil Removal Filters Work?

Air enters the filter and passes through the element from inside to outside, where oil aerosols impinge on the borosilicate micro-fibers and are coalesced into larger drops. The drops are carried through the element until they reach the outer porous sock. The outer sock, because of its cellular construction, retains these liquids and allows them to drain by gravity to the bottom of the bowl.

Solid partilces are retained in the element and cause the pressure drop to slowly increase throught the working life of the element. When the pressure drop across the element reaches 10 psid, the service life indicator on top of the filter will show more red than green and the element should be replaced.

1.1.3 How do Vapor removal Filters Work?

Carbon filters are used to remove oil vapors and odors. The activated carbon has a porous structure which results in a large surface area. The oil vapors are attracted and adhere to this surface. There is usually a small sintered medium included in an activated carbon element to prevent the carbon particles from migrating downstream. The carbon filter reduces the maximum oil content of air leaving the filter to 0.003ppm at 70°F, i.e. To ISO 8573 class 1.7.1. If protected upstream by general and oil removal filters life is between 400 and 1000 hours.

1.1.4 Why use a Pre-Filter?

A pre-filter is simply a general purpose filter placed upstream of a higher grade filter to remove the majority of the water and larger particle contaminants and thus lengthen the life of the higher grade filter element.

A 5 micron pre-filter should always be used ahead of an oil removal filter.

An oil removal (coalescing) filter must be used ahead of a vapor removal adsorbing filter.

1.2 AIR QUALITY

1.2.1 What is ISO 8573?

(See ALE-1-G for specification)

This is an international standard on air quality. It covers compressed air for general industrial use.

The air quality is specified using a 3 digit code expressing the remaining content of a specific contaminant after the filter (or dryer).

1.2.2 Air Classes for Norgren Filters:

Particulate filters condition compressed air to different degrees, dependent on the micron rating of the filter. The finer filter, 5 µm, will achieve ISO 8573 class 3.7. or class 3. Applying a 40 µm filter will result in ISO 8573 class 5.7. or class 5 air.

Coalescing filters improve the quality of downstream air to ISO 8573 class 1.7.2, the particle size is reduced down to 0.01µm, with a remaining oil content of less than 0.01ppm. Coalescing filters cannot remove oil which is in the vapor state in the supply air. One way to remove vapor is to reduce the temperature of the air flow allowing the vapor to condense, alternatively remove the vapor chemically using an activated carbon filter.

1.2.3 What Micron Ratings are Available?

The standard Norgren general purpose elements are 40 and 5 microns, with 40 microns being suitable for most industrial applications. Certain industries have 25 or 75 micron as a standard and some product ranges have these options available.

For a given element size, the smaller the micron rating the higher the pressure drop across the filter. The service life between cleaning is also less for the smaller micron filters, as small holes plug more quickly than bigger holes.

Figure 1.
RECOMMENDED FILTRATION LEVELS.

Application	Typical Quality Classes	
	Oil	Dirt
Air agitation	1	3
Air bearings	2	2
Air gauging	2	2
Air motors	4	4
Brick and glass machines	5	4
Cleaning of machine parts	3	4
Construction	4	5
Conveying, granular products	2	4
Conveying, powder products	1	3
Fluidics, power circuits	2	5
Fluidics, sensors	2	3
Foundry machines	4	5
Food and beverages	1	1
Hand operated air tools	5	5
Machine tools	5	4
Mining	5	5
Micro-electronics manufacture	1	1
Packaging and textile machines	5	3
Photographic film processing	1	2
Pneumatic cylinders	3	5
Pneumatic tools	5	4
Pneumatic tools (high speed)	4	3
Process control instruments	2	3
Paint spraying	1	1
Sand Blasting	4	5
Welding macines	5	5
General Workshop air	5	4

1.2.4 How do Service Life Indicators Work?

The service life (pressure drop) indicator found on top of coalescing or general purpose filters is green when the filter is new. As a pressure differential develops across the filter element with use, a spring biased red outer sleeve is pushed up. When more red is visible than green, then the pressure differential across the element is in excess of 10 psi (0.7 bar) and the element should be replaced.

1.2.5 When does the Carbon Pack Indicator Turn Pink?

The white ring around the base of the vapor removal carbon pack turns pink in the presence of liquid oil. Therefore if the ring turns pink the coalescing filter is passing liquid oil and needs replacing. If this occurs soon after the filter has been installed then it usually indicates a seal failure in the coalescing filter. Remember that visual detection is a not a substitute for scheduled maintenance.

1.2.6 How Long does an Element Last?

This depends entirely on the quality of the inlet air. If it is very poor the elements will need replacing more frequently.

In general, air service equipment should be maintained annually. Use, quality of air and condition at examination may indicate adjustment of the maintenance interval.

The following guidelines can be given:

General Purpose Filter:	Replace/maintain annually. The element can lose 15% efficiency each time it is cleaned. Elements are low cost, so it is advisable to replace them.
Coalescing:	Evaluate after 12 months of servicing. If the pressure drop across the element exceeds 10 psig (0.7bar) then the element requires changing.
Activated Carbon Packs:	Should be changed every 1,000 hours usage or when odor is detected. The life depends significantly on ambient temperature.

1.3 PLASTIC BOWLS

Norgren transparent plastic bowls are made from polycarbonate. Some competitors use other materials such as Grilamid.

Both these materials are extremely resilient and have an excellent safety record. However these transparent plastics will degrade when subjected to excessive heat, solvents and some chemicals, which can lead to crazing and finally bowl failure.

Over the last few years metal bowls and guarded plastic bowls have become increasingly popular driven by the emergence of guidelines recommending the use of guards.

Some organizations have their own internal standards which call for guarded plastic or metal bowl and the general market trend is away from plastic bowls in the $^{1}/_{2}$" or above port size units. This trend is reflected in our latest Excelon 74 and Olympian Plus product ranges. Plastic bowls remain the most common option for $^{1}/_{4}$" and smaller units.

Never use polycarbonate bowls at conditions which exceed the maximum rated pressure and temperature of 150 psig (10 bar) and 125°F (50°C).

Certain chemicals, common in some oils and solvents, can attack polycarbonate and cause the bowl to burst. If the compressor intake is located in an area containing incompatible vapors, these contaminants can be drawn into the compressor and conveyed to the bowl in the compressed air. This can result in bowl failure.

Synthetic compressor oils may be drawn in from the compressor and can also result in bowl failure.

If doubt exists as to the compatibility of certain fluids with polycarbonate, please contact Applications Engineering.

Metal bowls should be used where temperatures exceed 125°F (50°C) and/or pressures exceed 150 psig (10 bar), or when materials are present which are incompatible with polycarbonate. Maximum rated operating conditions for metal bowls depend on the range; check APC-104.

1.4 DRAINS

1.4.1 Semi Automatic:

A semi-auto drain is one which operates when the air-line is depressurized eg at the end of a shift. It is a normally open two-way valve which is held closed by 7-10 psig (0.7-0.8 bar). When the filter is pressurized, the drain may be operated manually by pushing the tube, which protrudes outside the bowl, upwards.

1.4.2 Automatic:

An automatic drain is a two-way valve, which will close when the system is pressurized. The drain opens when the float rises due to accumulated liquid and on depressurization.

1.4.3 Where should an Automatic Drain be Used?

Automatic Drains should be used where the filter location may make servicing difficult, where filters may be hidden from view and consequently be overlooked or where equipment is in continual use. Areas where large quantities of liquid may accumulate over a short period of time should also be equipped with auto-drain filters. High labor costs for draining a large number of filters manually will generally justify the use of auto-drains.

Machines which have been shut down for a long period of time, such as over a weekend, can draw slugs of water during start-up which can overload a filter unless drained immediately. (This situation can normally be handled by a drip leg drain, see.)

Norgren float type automatic drains are 'normally open' type drains. During periods when the air line pressure is shut off, the automatic drain will open allowing liquids to drain rather than flood the air line piping system. When re-pressurizing the air line, the automatic drain valve will close when pressure reaches approximately 10 psig (0.7bar). This results in a flow through the drain to atmosphere of about 1.77 scfm (0.84dm^3/s) until the valve automatically closes. (See 1.4.4 below.)

1.4.4 Where should a Low Flow Automatic Drain be used?

In systems where the compressor capacity is insufficient to close a number of standard auto drains a 'low flow' drain is available which requires only 0.5 scfm flow before closing. An ultra low flow auto drain is also available. 'Low flow' drains have less clearance around the valve for expelling contaminants, so should only be used where the standard unit cannot be used. 'Low flow' drains can be identified by red plastic parts.

1.4.5 07 Automatic (spitter) Drain:

When a rapid increase in flow occurs through the filter it results in the pressure above the drain's diaphragm being less than that below it. This differential pressure causes the drain to momentarily lift and 'spit' out the condensate collected underneath the drain.

1.4.6 Where should a Drip Leg Drain be Used?

The drip leg drain is a system protection device. Most compressed air distribution systems have varying flows and/or are shut down at the end of a working day. As the system cools, water in the compressed air condenses and collects in the distribution pipe work. This water will run along the pipe work and settle at the low point(s). On start up of the plant this water can be pushed under pressure into the nearest device or process and cause malfunction or damage.

By running a vertical pipe down from these low points water will flow into the drip leg drain where the automatic drain will expel it.

A filter screen within the drip leg drain prevents particles interfering with the auto-drain operation. A ball valve should be included above the drip leg drain to allow for maintenance when the system is running.

1.5 PERFORMANCE

1.5.1 Performance of General Purpose Filters

Filters have their flow measured in terms of the pressure drop across them. As the flow increases then the pressure drop also increases. These pressure drops are energy losses in the system.

A well designed filter not only removes water and particles efficiently, but also has a low pressure drop at a given flow. The flow figures quoted in Norgren catalogues for general purpose filters are at a pressure drop of 5 psig (0.3 bar), from a 100 psig (7 bar) inlet pressure.

Beware! not all competitors quote their flows under the same conditions. If a higher inlet pressure is used or a higher pressure drop is quoted then the apparent flow will be higher. This does not mean it is a better unit , simply that a different point on the curve has been selected. Often the only way to compare units is to test them under the same laboratory conditions.

1.5.2 Performance of Coalescing Filters:

The maximum flow of an oil removal filter is usually determined by the oil removal efficiency under saturated conditions. In the catalog there are maximum flows quoted 'to maintain stated oil removal characteristics.' These are the steady state flows which should not be exceeded to guarantee that the oil in the outlet air remains below the 0.01ppm (parts per million) quoted. Cyclic or pulsating flows will result in oil carry over, as will elevated temperatures.

If a higher oil carry over is acceptable (or there is no oil in the air-line) then higher flows are achievable, and will be determined by the 'acceptable' pressure drop. For a new (dry) element a flow which gives a pressure drop of less than 5 psid (0.3 bar) is recommended.

1.6 FILTER SIZING

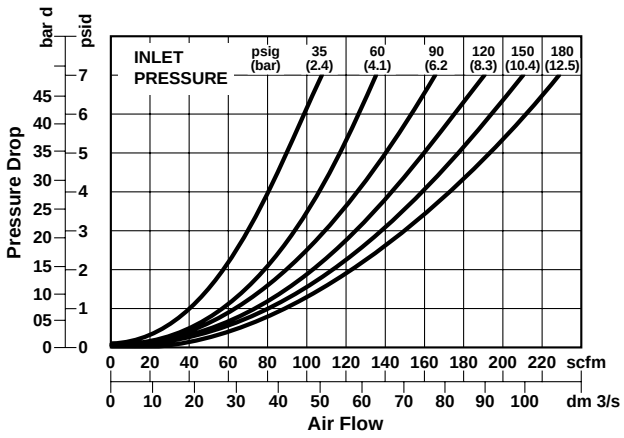
Selecting the proper size of filter for any application should be done by determining the maximum allowable pressure drop which can be caused by the filter. The pressure drop can be determined by referring to flow curves provided by the manufacturer.

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 (6.2 bar) and when 50 scfm (24 dm^3/s) is flowing through the filter.

Answer Locate 50 scfm (24 dm^3/s) on the horizontal axis. Read up to the intersecting point on the 90 psig (6.2 bar)operating curve. The pressure drop (or Δ p) is approximately .6 psid (.04bar) on the vertical axis on the left of the graph. (See graph)

Flow Characteristics



1.7 MEMBRANE DRYERS

For those applications where a low-pressure dewpoint and low installation/operational cost are required, Norgren provides an Excelon® Membrane Dryer. This new product can provide dewpoint suppression up to 800F (260C) below ambient temperature and is available with nominal flows of 2, 5, 10, 20, and 30 scfm.

The Membrane Dryer is a variable dew point suppression device constructed of an anodized aluminum body with end caps. Inside the body are bundles of special hollow fibers (membranes) which are semi-permeable. Moisture-laden air enters the fibers and water vapor permeates through the walls to the outside of the fibers. Dry air exits the device through the outlet port. A small percentage of dry air is diverted across the outside of the fibers to sweep away and vent water vapor to atmosphere.

This device provides variable dew point suppression inversely related to flow. Lower flows through a unit will increase contact time with the membrane fibers, resulting in greater dew point suppression. Higher flows will result in a decreased level of dew point suppression. Additionally, dew point suppression is directly related to operating pressure. Increasing the pressure applied will result in a greater level of dew point suppression. Therefore, it is always recommend placing regulators downstream of a membrane dryer to ensure the highest pressure possible through the membrane dryer.

Typical Flows for Membrane Dryers

Model	Port	Outlet Flow	Inlet Flow	Purge Flow	Press. Drop
W07M2ANNNA	1/4"	2 scfm	2.2 scfm	0.2 scfm	0.4 psid
W72M2ANNNB	1/4"	5 scfm	5.6 scfm	0.6 scfm	0.32 psid
W72M2ANNNC	1/4"	10 scfm	11.2 scfm	1.2 scfm	0.90 psid
W74M4ANNND	1/2"	20 scfm	22.2 scfm	2.2 scfm	0.65 psid
W74M4ANNNE	1/2"	30 scfm	33.4 scfm	3.4 scfm	1.35 psid

1.7 SIMPLE FILTER TROUBLESHOOTING

Malfunction	Possible cause	Remedy
Excessive pressure drop.	Micron rating of element to small	Use larger micron element size for application.
	Filter element blocked.	1. Clean element (not coalescing element). Note: Some residual contamination will remain. 2. Replace with new element.
	Flow requirement greater than filter capacity.	Use larger filter.
Dirt passing through filter.	Element seals missing or defective. (N.B. Seals not required on some units).	Replace seal 2. Tighten element.
	Damaged element.	Replace element.
Water passing through filter.	Water level in bowl above baffle.	Drain water.
	Flow capacity of filter exceeded.	Maintain flow within capacity of filter or change to filter capable of handling desired flows.
Crazing of Polycarbonate bowl or milky appearance.	Bowl has been cleaned with incompatible fluid.	Replace bowl. (Clean only in clean warm water and soap.)
	Bowl is being used in an area containing fumes or vapors incompatible with polycarbonate.	Replace bowl. Eliminate source of problem or convert from plastic to metal bowls.
	Compressor oil vapor may be causing problem.	Replace bowl. Eliminate source of problem or convert from plastic to metal bowls.
	Air intake to compressor may contain fumes or vapor	Replace bowl. Eliminate source of problem or incompatible with polycarbonate.convert from plastic to metal bowls.
Water beyond the filter	Inlet air has a high temperature and as it cools downstream, moisture condenses to water.	Fit dryer, pre-cool air or fit filter immediately prior to application.

Absence of an Industrial Standard for Rating Pneumatic Filter Elements

There is not an industry wide standard for establishing the micron rating of pneumatic filter elements. Standards by various industry associations, including the National Fluid Power Association (NFPA) and International Standard Organization (ISO), are in discussion. In the absence of an industry standard, some manufacturers of pneumatic filters make claims concerning the micron rating of their so called “standard” element which can not be substantiated and are probably not valid.

Norgren’s Method of Rating and Testing Pneumatic Filter Elements

Norgren particle removal filter elements are rated by the size of the particle they will trap (i.e., a 40-micron element will remove particles 40-microns and larger). Norgren tests filter elements by using ***standard coarse*** and ***fine*** test dusts of known particle size distribution. ***Coarse*** dust consists of 12% particles smaller than 5-microns; ***fine*** grain dust consists of 39% particles smaller than 5-microns. Test results show that a Norgren filter element rated at 40-microns actually removes over 98% of particles 5-microns and larger.

How to Size a Filter Element

The downstream equipment being protected determines the micron rating of the filter element. Industrial tools, such as air hammers and drills, typically require only a 40-micron element. Air operated instruments and small, high speed tools typically require a 5-micron element. Always consult the equipment manufacturer for filtration requirements.

Generally, the smaller the micron rating of the element,

- the higher the pressure drop across the filter,
- the shorter the element service life.

Therefore, the use of a 5-micron element where a 40-micron is adequate penalizes the customer in increased pressure losses and frequent down time for changing or cleaning the filter element.

ISO Standard 8573-1. Compressed Air for General Use

Contaminant’s found in industrial compressed air systems include solid particles, water, and oil. ISO 8573-1:1991 provides a simple method of classifying these contaminant’s. A quality class required for a particular application can be defined by listing, in order, the class required for solids, water, and oil.

Table 1. Summary of ISO 8573-1:1991 Air Quality Classes *

Quality Class	Solid Particle Maximum Size µm	Water Maximum Pressure Dewpoint °F (°C)	Oil Maximum Remaining Oil Content mg/m³ ** (ppm)
1	0.1	-94 (-70)	0.01 (.0084)
2	1	-40 (-40)	0.1 (.084)
3	5	-4 (-20)	1 (.84)
4	15	38 (3)	5 (4.2)
5	40	45 (7)	25 (21)
6	—	50 (10)	—

* See ISO standard 8573-1 for complete information.
** At 1 bar absolute pressure.

Examples:
Air of Quality Class 2.2.2 is filtered to 1µm solid particle size, dried to -40°F (-40°C) pressure dewpoint, and filtered to an oil concentration of 0.1mg/m³.

Air of Quality Class 5.3.4 is filtered to 40µm solid particle size, dried to -4°F (-20°C) pressure dewpoint, and filtered to an oil concentration of 5mg/m³.

When a class for a particular contaminant solid, water, or oil is not specified, the number designating the class is replaced with a hyphen.

Example: Air of Quality Class 1.–.1 does not specify the pressure dewpoint.