

# Solutions

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# Introduction

This manual was developed by Air Line Equipment Division engineers for individuals representing Norgren air preparation in the field.

For those unfamiliar with product operation, overviews open many of the manuals sections. The Norgren offering, and application and performance issues complete the material. This broad range of information benefits both the pneumatic novice and experienced user.

Please note that the control valve information published here applies mainly to modular units available in Excelon and Olympian ranges. Norgren has a broad selection of directional control valves available for majority of compressed air applications.

Keep this reference handy to support your customers in their application of A.L.E. products.

# Filters

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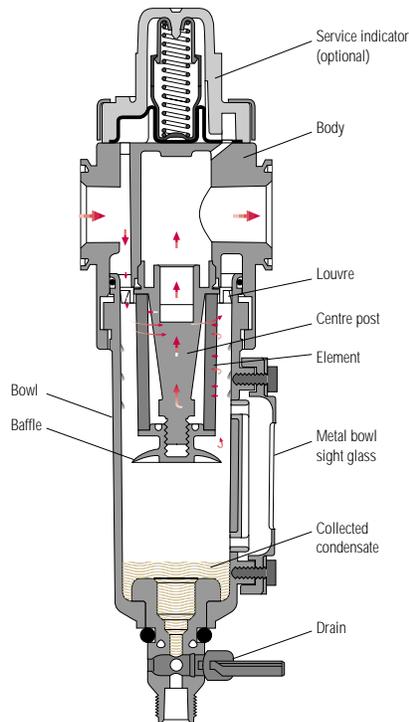
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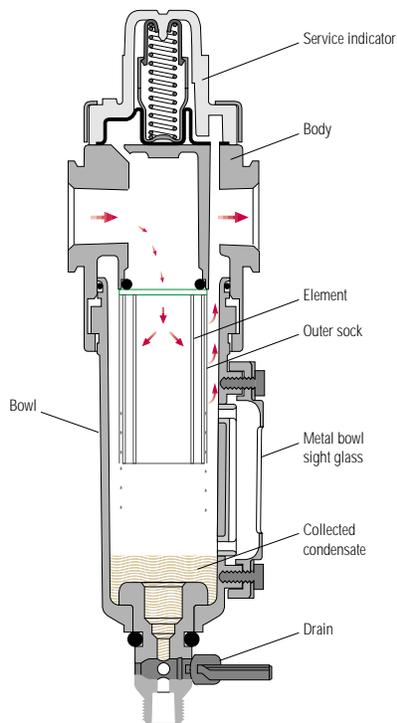
# Filters

## QUESTIONS

### GENERAL PURPOSE FILTER



### COALESCING FILTER



## 2.1 GENERAL OVERVIEW

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.

### 2.1.1 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.

### 2.1.2 How Do Oil Removal Filters Work?

The fine oil mist is coalesced (merged) as it passes through the fine fibrous filtration media. These oil droplets are collected in the outer sock and then drop from the element to the bottom of the bowl for easy removal.

Where a coalescing filter is being used for oil removal, the element quickly becomes saturated which is clearly visible on the outer sock. This is the normal operating condition for oil removal.

2.1.3 How do Vapor removal Filters Work?

Carbon filters are used to remove oil vapors (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.

2.1.4 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 or vapor removal filter.

**2.2 AIR QUALITY**

2.2.1 What is ISO 8573?

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).

ISO 8573 PARTICLE CONCENTRATION  
- Defines Maximum Remaining Particle Content

Class	Maximum Particle Size $\mu\text{m}$	Maximum Concentration mg/m <sup>3</sup>
1	0.1	0.1
2	1	1
3	5	5
4	15	8
5	40	10

ISO 8573 WATER CLASSES

- Defines Maximum Remaining Water Content

Class	Maximum Pressure Dew point 0c
1	-70
2	-40
3	-20
4	+3
5	+7
6	+10
7	not specified

ISO 8573 MAXIMUM OIL CONTENT

- Defines Maximum Remaining Oil Content

Class	Maximum Concentration mg/m <sup>3</sup>
1	0.01
2	0.1
3	1
4	5
5	25

2.2.2 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  $\mu\text{m}$ , will achieve ISO 8573 class 3.7. or class 3. Applying a 40  $\mu\text{m}$  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 0.01 $\mu\text{m}$ , 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.

2.2.3 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.

2.2.4 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 0.7 bar and the element should be replaced.

2.2.5 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 not a substitute for scheduled maintenance.

2.2.6 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 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.

2.3 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 Air Line Division.

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 the catalogue sheets.

## 2.4 DRAINS

### 2.4.1 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.

### 2.4.2 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.

### 2.4.3 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 2.5.7.)

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 0.7bar (10psig). This results in a flow through the drain to atmosphere of about (0.84dm<sup>3</sup>/s) until the valve automatically closes. (See 2.4.4 below.)

### 2.4.4 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.

### 2.4.5 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.

### 2.4.6 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.

## 2.5 PERFORMANCE

### 2.5.1 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.

### 2.5.2 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 catalogue 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.

## 2.6 SIMPLE FILTER TROUBLESHOOTING

Malfunction	Possible cause	Remedy
Excessive pressure drop.	Micron rating of element too small for application.	Use larger micron size element.
	Filter element blocked.	<ol style="list-style-type: none"> <li>1. Clean element (not coalescing element).</li> <li>2. Replace with new element.</li> </ol>
	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).	<ol style="list-style-type: none"> <li>1. Replace seal</li> <li>2. Tighten element.</li> </ol>
	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 incompatible with polycarbonate.	Replace bowl. Eliminate source of problem or 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.

# Regulators

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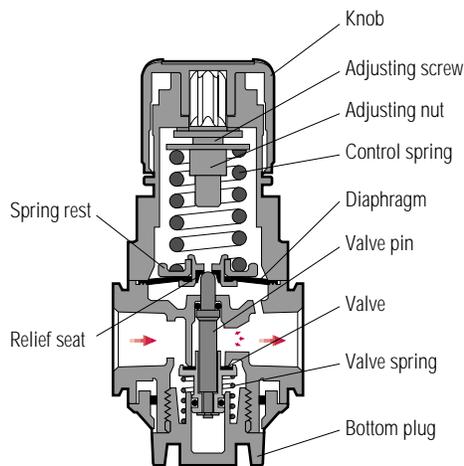
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### 3.6 SIMPLE REGULATOR TROUBLESHOOTING

# Regulators

## QUESTIONS

GENERAL PURPOSE REGULATOR



### 3.1 GENERAL OVERVIEW

Regulators ideally provide a constant outlet pressure independent of variations in inlet pressure or flow.

Regulators are typically used to:

- i. reduce pressure to the level required for downstream equipment.
- ii. limit the force of cylinders.
- iii. minimize pressure variation at the point of use.

The range of different regulators and options within each type are wide and varied, but each can broadly be put into one of 3 categories.

- General Purpose Regulators
- Pilot Operated Regulators
- Application Specific Regulators

#### 3.1.1 General Purpose Regulators:

General purpose regulators are designed to give the maximum flow capacity (for their size) while maintaining, to a reasonable accuracy, the outlet pressure to the set level.

They are used to control pressures in compressed air line installations to different parts of machines or to pneumatic tools and motors.

General purpose regulators are available in relieving or non-relieving types. Relieving regulators can be adjusted from a high pressure to a low pressure. Even in a dead end situation relieving regulators will allow the excess downstream pressure to be exhausted. This causes a loud hissing sound which is perfectly normal.

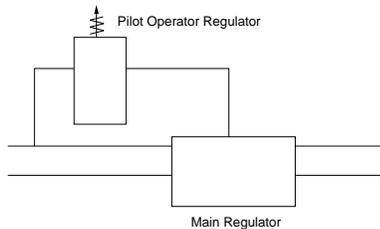
Non relieving regulators when similarly adjusted will not allow the downstream pressure to escape. The trapped air will need to be released in some other way, e.g. by operating a downstream valve.

General purpose regulators have a control spring which acts on a diaphragm to regulate the air pressure. The rating of this control spring determines the adjustment range of the regulator. The outlet pressure setting is obtained by turning the knob (or T handle) clockwise to increase pressure, counter clockwise to decrease pressure.

### 3.1.2 Pilot Operated Regulators:

Pilot operated regulators are used in high flow applications and where access to the main regulator is limited or difficult. This type of regulator does not have a control spring to regulate, instead an air pilot signal is used to control the outlet pressure of the main regulator.

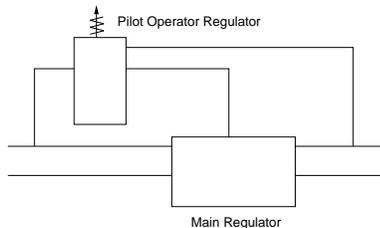
This air pilot signal is controlled by a small 'pilot operator' regulator typically of a precision type eg 11-018. The flow through the pilot operator is negligible. The better the pilot, the better the performance from the main regulator.



The pilot signal for the main regulator valve is usually onto a large diaphragm area. This results in pilot operated regulators having better regulation characteristics than spring operated general purpose regulators.

### 3.1.3 Feedback Pilot Regulators:

For even greater control of the outlet pressure a 'feedback' pilot operator can be used. Here the outlet pressure from the pressure critical point in the system can be fed back to the controlling pilot operated regulator.



Feedback systems are very responsive to downstream pressure requirements. If performance does not meet expectations, consult with Application Engineering.

Very few applications require feedback and it is usually better to recommend a standard 11-400 or a general purpose regulator as a pilot operator.

### 3.1.4 Application Specific Regulators:

Norgren produces a wide range of application specific regulators, each having some enhanced feature over a general purpose regulator. Some of them are listed below.

- 
- |             |   |
|-------------|---|
| 11-018/-118 | - extremely accurate outlet pressure control, with high flow for a precision regulator. Requires oil-free air, pre-filtered to 5µm. |
|-------------|---|
- 
- |     |  |
|-----|--|
| R38 | - Instrument regulator, aluminum body (also available in stainless steel to NACE standard), excellent regulation, no constant bleed to atmosphere. |
|-----|--|
- 
- |     |  |
|-----|--|
| R24 | - Good regulation, extremely high relief capacity. Available in spring or pilot operated versions. |
|-----|--|
- 
- |         |   |
|---------|---|
| R05/R22 | - General purpose regulators with stainless steel bodies to NACE specification. |
|---------|---|
- 
- |         |  |
|---------|--|
| R06/R91 | - Brass or plastic bodied specifically for water. Potable and non potable water options available. |
|---------|--|
- 
- |                      |  |
|----------------------|--|
| Miniature Regulators | - Generally based around a modification to a basic R07 including low flow (with improved regulation), plastic bodied (for water), different elastomeric materials (for fluid compatibility). |
|----------------------|--|
-

## 3.2 WHAT CAN WE PRODUCE?

### 3.2.1 Do Norgren Produce Regulators for Inlet Pressure above 400 psig?

The R38, R43 and R18 can accept inlet pressures of up to 450 psig. Norgren has higher pressure regulators for industrial gases up to 3000 psi. Consult Application Engineering for details.

### 3.2.2 Do we Produce Units for Low/High Temperatures?

Low or high temperature units may be possible in some ranges. Material selection is critical. Consult Air Line for details.

**Note:** changing to viton elastomers does not in itself make a unit suitable for higher temperatures.

### 3.2.3 Can we Produce Sub-Base Regulators?

The USA R40/R41 pilot and feedback pilot regulators are available. A sub-base R06 is also available.

### 3.2.4 Can we Produce Manifolding Regulators?

Manifolding regulators are designed to have a straight through primary pressure with secondary outlets at 90 degrees. Norgren has:

- Excelon 72 R72M - manifold using Quikclamps.
- R30M Plastic R91 style with integral PIF. Manifold using adapters.
- R06 type brass bodied R06, manifold using fittings.

### 3.2.5 Do we Produce Liquid (water) Regulators?

Norgren has regulators suitable for liquids, primarily water.

These include plastic bodied miniature regulators eg R91G/W and 11-044, as well as brass R06's and R43's.

All are suitable for non potable water some for potable water. Check catalogue sheets for details.

A number of units already have the approval of some water control bodies eg WRC (Water Research Council) UK and NSF USA.

Water regulators can be used with other liquids but it is necessary to check corrosion resistance and material compatibility. Differences in viscosity may effect performance.

Water regulators can be used on air but normally have poorer performance characteristics than air regulators.

### 3.2.6 Can we do 11-818 Precision Regulators with Gauges?

Yes, we do have some special models, contact Application Engineering for details.

### 3.2.7 Can we Produce Back Pressure Regulators?

Yes, a back pressure regulator behaves as a very precise relief valve and so controls the rate of relief. With automatic adjustment of its outlet flow to atmosphere the system pressure remains substantially constant. These can be produced as specials.

### 3.2.8 Can we Produce Reverse Flow Regulators?

Reverse flow regulators allow the outlet pressure to flow back, through the regulator (via an internal check valve) when the inlet pressure is switched off. This is important when the regulator is placed between a valve and cylinder.

This option is available in Excelon 74, 73 and 72 Series and Olympian Plus. The R07, being an unbalanced valve regulator can also be reverse flowed.

## 3.3 ADJUSTMENT MECHANISMS

### 3.3.1 What Different Adjustment Mechanisms are Available?

A non-rising knob is the standard adjustment mechanism for most general purpose regulators. A T-handle will provide added leverage and is standard for regulators with 250 psig springs. They are also a common alternative to a knob in applications where the operator is wearing gloves, or has greasy hands.

A slotted adjusting screw enables the customer to adjust using a screwdriver and a hexagon-headed screw is also available. Handwheels can be fitted to most units and are standard on precision regulators.

### 3.3.2 What is the Difference between Tamper Resistant, Tamper Evident, and Tamperproof?

Tamper Resistant: a device which makes alterations of set pressure difficult.

Units which normally have a T-bar can have the T-bar replaced by a screw driver slotted adjusting screw over which a metal cap is fitted. In this way the set pressure can be protected from accidental adjustment.

Units with adjusting knobs are made tamper resistant by preventing the knob being pulled into its unlocked position for example:-

- R07 insert self tapping screw through the top of the knob.
- R72/73/74/64 use tamper resistant kit and seal with a padlock or seal wire.

Tamper Evident: shows if the set pressure has been altered by the breaking of a seal.

Tamperproof: something which cannot be tampered with at all. It is difficult to describe anything as tamper proof because if someone is intent on making regulator adjustments then they can always find a way. As a result we do not call our regulators tamper proof.

### 3.3.3 What Presetting Options are Available?

Most regulators can be 'set' in some way, if in doubt contact Air Line Division as this is generally a factory operation.

- Max Set: unit is modified to prevent the regulator being adjusted above a specified maximum.
- Min Set: unit is modified to prevent the regulator being adjusted below a specified minimum.
- Min/Max Set: unit can only be adjusted between two specified upper and lower units.
- Preset (Factory Set): unit outlet pressure is set and locked prior to despatch. These units are not tamper resistant (unless requested).

## 3.4 REGULATORS IN APPLICATIONS

### 3.4.1 Can the Regulators be Adjusted Outside the Recommended Range?

The recommended range is that at which the regulator will perform at its optimum. These are not the maximum and minimum values. Regulators can be set outside these limits. For units which cannot be set outside of a specified range see 3.3.3.

### 3.4.2 Will Regulators Shut Off?

Yes, screwing the adjustment 'up' (counterclockwise) closes the valve. It is possible to achieve zero psig with a regulator, however they are not designed to fulfill this function. If shut off is required use a shut off valve.

### 3.4.3 Will Regulators Work Mounted Upside Down?

Regulators can be mounted in any orientation without affecting their function.

### 3.4.4 How do you Set a Regulator?

Always set on a rising pressure, i.e. on an increasing spring load.

To adjust a regulator from 100 psig to 70 psig, back the regulator off to below 70 psig and adjust back up to the required pressure.

### 3.4.5 Can Air Regulators be used on Water?

Generally the answer is no for air regulators with balanced valves. It is possible with the R06 type which does not have a balanced valve and is considered dual service. See 3.2.5.

### 3.4.6 Can we use Air Regulators on other Gases?

Air regulators are generally suitable for use with CO<sub>2</sub>, argon, nitrogen or other inert gases. However units are designed and tested to compressed air standards only (unless specified in the literature) and external leakage rates may vary depending on the gas involved.

Compressed air regulators should never be used with flammable or noxious gases eg LPG, hydrogen etc.

### 3.4.7 Instability - what is it and how can it be prevented?

Instability (humming or whistling) is the rapid cyclic fluctuation of the outlet pressure from around the set pressure.

Instability is ultimately a problem occurring due to the flow path through the regulator or system. The usual solution is to change the regulator characteristics by replacing the control spring with one of a higher rating to increase the force on the diaphragm or changing the diaphragm material.

There is no magic answer, it is a case of trial and error in those applications where instability occurs.

### 3.4.8 What is a Constant Bleed Regulator?

Constant bleed in regulators is designed to provide improved response. A hissing noise is normal. R24 and 11-018 are all constant bleed regulators.

## 3.5 PERFORMANCE

### 3.5.1 Flow Quoted?

Flow characteristic is the measurement of the flow through the unit for a given deviation from the set outlet pressure.

For example, take a regulator and set the pressure at 90 psig under no flow conditions. As the flow through the unit is increased then the actual outlet pressure falls away from the set pressure. This is called droop (from set). Normally Norgren quotes regulator flow measured under the following conditions: Inlet pressure = 150 psig, set pressure = 90 psig and a 15 psig droop from set.

See note on competition performance in 2.6.1.

### 3.5.2 What are Regulation Characteristics?

Regulation characteristics show how the outlet pressure from the regulator varies when the inlet pressure varies (under constant or no flow conditions).

For example, take a regulator set at 60 psig outlet pressure, with 150 psig at the inlet. If the inlet pressure reduces, ideally the outlet pressure would remain the same.

However, in regulators with an unbalanced valve (eg R07) the outlet pressure actually increases slightly as the inlet pressure decreases. In regulators with balanced valves this variation is reduced.

Standard regulators have an acceptable deviation for most pneumatic application and customers tend to be interested in regulation characteristics in critical applications only. Where this is so, consider using a precision regulator, or consult Application Engineering about ways to improve the performance of standard regulators.

### 3.5.3 What is the Repeatability of a Regulator?

Repeatability can be defined in terms of changes in flow, inlet pressure or time. It is important to understand which the customer requires.

- a. *Repeatability with Respect to Changes in Flow:* ie the ability of a regulator to hold a set pressure with increasing or decreasing flow.
- b. *Repeatability with Respect to Time Changes:* ie the ability of a regulator to hold a set pressure over a time period.
- c. *Repeatability with Respect to Inlet Pressure Changes:* ie the ability of a regulator to hold a set pressure with changes in supply pressure.

For more information refer to catalogue graphs, or consult Application Engineering.

### 3.6 SIMPLE REGULATOR TROUBLESHOOTING

Problem	Problem Cause	Remedy
Regulator creep (increase in secondary pressure due to leak from primary).	Dirty or cut valve elastomers. Nick in valve seat.	Replace or clean valve. If body or valve seat is damaged it can be replaced on some models. On others replacement of complete regulator is required.
Won't relieve secondary pressure.	Non-relieving diaphragm assembly.	If this feature is required, replace with relieving type diaphragm assembly.
Won't reach desired pressure.	Regulating spring with low spring rate.	Use regulating spring with spring rate designed to cover desired range.
Excessive leak from relief hole.	Damaged relief seat. Ruptured diaphragm.	Replace diaphragm assembly.
	Leakage past valve causing secondary to increase somewhat and open relief seat.	Replace or clean valve.
Regulator chatter.	A resonant condition is generally only encountered under a certain set of conditions of flow and pressure and then only in some applications in which regulator couples with other system components.	Replace spring with a higher pressure range spring.
		Replace with a piston type regulator since they have less tendency to chatter.
Regulator difficult to adjust.	Adjusting screw or knob locking device in locked position.	Pull to unlock knob and adjust; push knob to lock  Threaded adjusting screws: loosen lock nut, remove adjusting screw, clean thread and lubricate.
	Contaminants in adjusting screw threads.	Place some lubricant on tip of screw.

# Filter/Regulators

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### 4.2 PERFORMANCE CHARACTERISTICS

### 4.3 SPECIALS

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Filter/Regulator?
- 4.3.2 Can we do special materials?

# Filter/Regulators

## QUESTIONS

### 4.1 GENERAL OVERVIEW

Filter/regulators combine the features of a filter and regulator with a single compact body.

Air passes through the filter section first removing water and particle contaminants, and is then regulated by the top regulator section.

See individual filter and regulator sections for details.

### 4.2 PERFORMANCE CHARACTERISTICS

The regulator section of the filter/regulator determines the flow and regulation characteristics of the unit.

Flow is therefore measured in terms of pressure droop from set pressure (see regulators) and not flow versus pressure drop as in a filter.

Regulation characteristics are determined in the same way as regulators.

### 4.3 SPECIALS

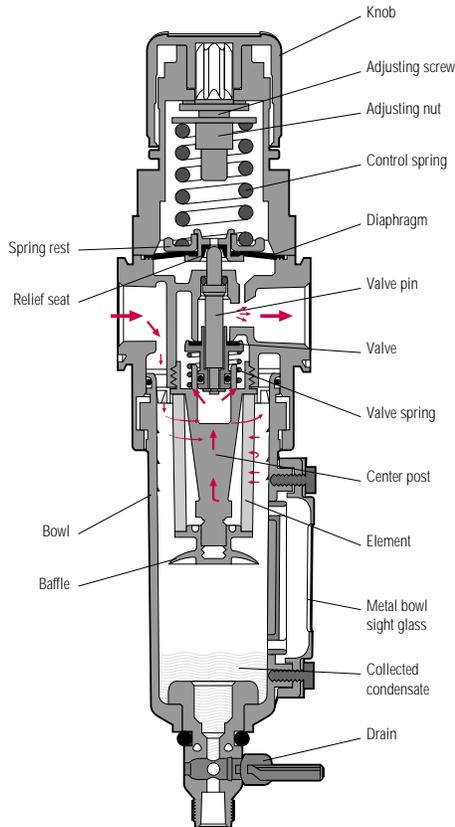
4.3.1 Can we do a Coalescing Filter/Regulator?

Yes. We have a B39 unit in the 07 Series. Other sizes could be considered for volume customers.

4.3.2 Can we do special materials?

Units are available in stainless steel (B05 and B38) for harsh environments and process applications.

GENERAL PURPOSE FILTER/REGULATOR



# Lubricators

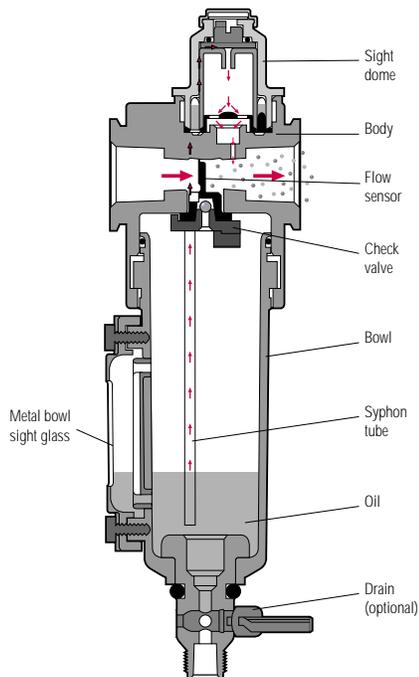
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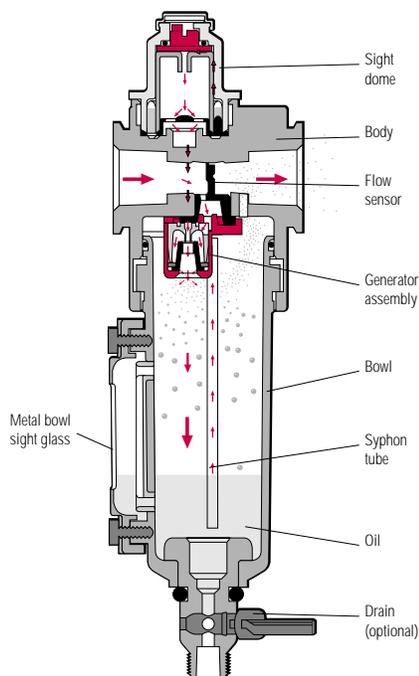
# Lubricators

## QUESTIONS

### OIL-FOG LUBRICATOR



### MICRO-FOG LUBRICATOR



## 5.1 GENERAL OVERVIEW

Norgren manufactures two main types of lubricators: Oil-Fog and Micro-Fog. These units are mounted directly into the pipe and add small amounts of oil to the air flowing through them.

### *Oil Fog-Lubricators:*

All the oil droplets seen in the sight dome are added directly into the air flow. This results in relatively large oil droplets passing downstream, suitable for heavy lubrication applications eg single cylinders and tools. Most competitive in line lubricators are of the Oil-Fog type.

### *Micro-Fog Lubricators:*

The oil droplets seen in the sight dome are atomized and collected in the area above the oil in the bowl. The smaller lighter particles are drawn into the air flow and pass downstream.

As a result typically only 10% of the oil seen as drops in the sight dome is passed downstream. The remainder falls back into the oil reservoir. Consequently, drip rate settings are somewhat higher than their Oil-Fog equivalent. This makes setting much easier, particularly in low flow applications.

The fine Micro-Fog oil particles can travel long distances through complex pipe work making Micro-Fog lubricators suitable for multiple valve and cylinder circuits.

## 5.2 WHAT ARE THE DIFFERENCES BETWEEN MICRO-FOG AND OIL-FOG?

### 5.2.1 Oil-Fog:

- Large oil particles not as fine as micro-fog.
- All oil drips seen in sight domes are delivered downstream.
- For applications over short distances.
- Should be mounted at same level or higher than device being lubricated.
- Standard bowls can be filled under pressure. (Not on rapid cycle units).
- Suitable for heavy lubrication applications eg single large cylinders and tools.
- Has a flow sensor which provides constant oil output density for varying flows.

### 5.2.2 Micro-Fog:

- Small oil particles; less than 2 micron.
- Only 10% of 'drip rate' is delivered downstream as active lubricant (remainder is returned to main oil reservoir).
- High drip rates make drip setting easier in low flow applications.
- Can be mounted above or below the point of application.
- Cannot be filled without shutting off upstream air (unless a quick fill cap or remote fill device is used).
- For use with lengthy air lines, multiple valve and cylinder circuits.
- Has a flow sensor to provide an almost constant oil output density for varying flows.

### 5.2.3 Can Oil-Fog and Micro-Fog Units be Converted?

Generally not, simply changing a green (Oil-Fog) sight dome for a red (Micro-Fog) sight dome does not change the function.

Some lubricators are designed around a cartridge insert. In this case it may be possible to swap the cartridge and sight domes to change the function.

## 5.3 SETTING LUBRICATOR DRIP RATES

### 5.3.1 What is the Correct Drip Rate Setting?

The drip rate will depend on the application, the amount of lubrication required, the flow through the lubricator and the lubricator type.

In Micro-Fog lubricators only 10% of the droplets in the sight dome are carried downstream. The drip rate in Micro-Fog lubricators therefore tends to be much higher.

The following table can be used to estimate drip rate for required flow. This is very much a rule of thumb. In practice it is necessary to fine tune the oil drip rate in each application.

Typical Drip Rate per Minute Micro-Fog	Typical Drip Rate per Minute Oil-Fog	Approx Flow scfm (dm <sup>3</sup> /s)
20	2	10 (5)
40	4	20 (10)
60	6	30 (15)
80	8	40 (20)
100	10	50 (25)
120	12	60 (30)

### 5.3.2 Can the Drip Rate be Shut Off?

In lubricators with needle valve type sight dome, yes.

Some Norgren sight domes use a felt pad which is soaked in oil at the point where the drops are formed. With this type of sight dome the oil droplets cease once the felt pad dries out.

With the new style dome (L72/73/74 and L07) complete shut off is not possible. Minimum adjustment for the drip rate is around 1 drop per minute.

## 5.4 FILLING METHODS

### 5.4.1 Oil-Fog and Micro-Fog Lubricators:

The standard Oil-Fog lubricators can be filled under pressure ie without switching off the upstream air. When a fill plug is removed a check valve in the lubricator body isolates the inlet pressure from the bowl and the reservoir will depressurize. The lubricator can then be filled with oil. When the fill plug is replaced, the reservoir will re-pressurize.

The standard Micro-Fog unit can only be filled without isolating the upstream pressure if a remote fill or quick fill nipple accessory is fitted. To remove the fill plug of a Micro-Fog lubricator whilst under pressure can be dangerous. If in doubt shut off the upstream air!

### 5.4.2 Remote Fill Devices:

The remote oil fill system provides a means of filling from a remote fill point, a single lubricator or a bank of lubricators manifolded together. The remote fill point may be connected to a portable reservoir or to a centralized, permanent

reservoir. A portable reservoir permits the use of different lubricants in different groups of lubricators to suit the requirements of the machinery being lubricated. The lubrication oil must be fed in at a higher pressure than exists in the bowl.

The devices are NOT intended for connection to an oil feed line which is under constant pressure from a pump or pressurized reservoir. The device cannot reset until the pressure is removed. Such lines are a potential safety hazard if they should leak or become broken.

#### 5.4.3 Quick Fill Nipples:

The quick fill system is an alternative which allows ease of filling a single Micro-Fog or Oil-Fog lubricator without switching off the mains air (on some units the quick fill nipple replaces the filler plug).

To fill the lubricator, a quick fill connector piped to a portable oil reservoir is snapped in place over the quick fill nipple. The main oil reservoir can now be pumped (or pressurized) to a pressure greater than the lubricator bowl and the lubricator filled.

## 5.5 OPTIONS AND ACCESSORIES

### 5.5.1 Where can Liquid Level Switches be Fitted?

Liquid level detection methods can be attached to the 1 quart bowl and 2 & 5 gallon tanks.

### 5.5.2 Where can Remote Fill and Liquid Level Switches be Fitted?

The smaller bowls, L73 and up, are all capable of either remote fill or liquid level detection (but not both at the same time!). The 2 quart and 2 & 5 gallon tanks only can have the liquid level switches fitted.

### 5.5.3 How do Liquid Level Switches Work?

Liquid level switches are bipolar reed switches which change state when the float rises and falls.

Liquid level switches are normally connected to give an electrical signal when the float falls (ie when the liquid level is too low). In critical applications the logic could be reversed. Maximum and minimum settings are possible too.

## 5.6 LARGE TANKS/RESERVOIRS

### 5.6.1 Which Units have Large Tanks/Reservoirs?

All units in basic 1/2" and above have optional larger bowls/tanks.

Olympian Plus and Excelon 74 are limited to 1 quart as standard. For 2 and 5 gallon capacity use 15/17 Series, or the 10-028/-076 (2") lubricators.

## 5.7 APPLICATION SPECIFIC UNITS

### 5.7.1 Do we Make Bearing Lubricators?

These are aerosol type lubricators. These lubricators use air to get the oil to the point of lubrication, however the tool or application is not powered by the air. Although produced by Norgren, systems for their application are designed and sold by Engineering and General Lubrication Systems.

### 5.7.2 What is a Fixed Venturi (Bi-Directional) Lubricator?

Standard Norgren lubricators use a flow sensor to achieve constant oil density with varying flows. In some applications high flow is more important than constant density and a fixed venturi can be used instead of a flow sensor. It may also be useful in systems with rapid cycling. Consult Air Line for more details.

## 5.8 OILS

### 5.8.1 What Oils are Recommended?

Recommended oils fall into 2 categories:-

- 1 Oils recommended for use with all Norgren units (valves, cylinders, fittings and FRLs).
- 2 Oils which can be used with Norgren lubricators but not necessarily with other Norgren equipment.

Refer to Norgren technical literature for recommended lubricants.

### 5.8.2 Can Non-Recommended Oils be Used?

Some oils can be tested for suitability, but Norgren cannot be responsible for use of non-recommended lubricants.

## 5.9 SIMPLE LUBRICATOR TROUBLESHOOTING

Problem	Possible Cause	Remedy
No Drip Rate	Oil adjustment knob fully clockwise.	Readjust knob.
	Low oil level.	Check oil level.
	Airflow through lubricator too low.	Use smaller size lubricator.  Remove bowl and sight feed adjustment dome and clear syphon tube.
	Blocked oil filter screen.	Remove sight feed adjustment dome and clean or replace screen located in dome assembly.
	Air leaks.	Check bowl, filler plug and sight dome seals. Tighten if necessary.
Oil Foaming	Over aeration.	Check bowl seals for slight leaks.
Oil Emulsified	Water in lubricator.	Fit filter immediately upstream.
Drip Rate changes after setting	Fade.	Readjust drip rate.

# Control Valves

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- 6.1.2 What Operators are Available?
- 6.1.3 Do we have an Emergency Dump?
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### 6.2 EXCELON VALVES

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- 6.3.7 Can I Use an Upstream Shut Off Downstream?

# Control Valves

## QUESTIONS

OLYMPIAN PLUS P64F SOFT START/DUMP VALVE



EXCELRON P72F SOFT START/DUMP VALVE



## 6.1 SOFT START/DUMP VALVES

### 6.1.1 What Sizes are Available?

We can do units in 1/4" through 1 1/2" actual port size, based on Excelon 72 (1/4 - 3/8), Olympian Plus 64 (1/4 - 3/4), Excelon 74 (3/8 - 3/4) or the new P68F (3/4 - 1 1/2").

### 6.1.2 What Operators are Available?

All valves have air pilot, 22mm solenoid and CNOMO solenoid options. In addition the P68F can use the Webber Excel 32mm solenoid.

### 6.1.3 Do we have an Emergency Dump?

Yes. The P64F/P74F have an optional dump slide with a yellow handle, used to break the pilot signal and dump the downstream system. The slide can be locked out using a standard 8mm padlock or lockout hasp. The P68F has a dump handle as standard (optional without). Again this can be locked out.

### 6.1.4 How Fast/Slow can it go?

The snap point where full pressure kicks in is fixed for a given line pressure. You can control the time between signalling the valve and the snap by using the needle valve adjuster. Refer to catalogue sheet for minimum/maximum times, which will depend on the downstream system volume.

### 6.1.5 What is the Minimum Operating Pressure?

The snap action requires a minimum line pressure of 44 psig (3 bar).

### 6.1.6 Will the Unit Soft Start Only?

The combined function valves are not intended for use as soft start only. If you need such a valve use the Excelon 74 individual valves, or the AOY poppet valves for Olympian.

### 6.1.7 Will the Unit Dump Only?

The combined function valves are not intended for use as dump only. If you need such a valve use the Excelon 74 individual valves, or the DYO poppet valves for Olympian.

## 6.2 EXCELON VALVES

### 6.2.1 What Versions are Available?

The individual valves for use in Excelon 74 are 2/2 and 3/2 poppet valves P74A and P74B. There is a 2/2 soft start (P74E) and 3/2 on-off valves with solenoid or pilot operator (P74C). The 3/2 valves have optional lockout slides.

### 6.2.2 Are the Excelon Valves Direct Ported?

The valves in the Excelon 74 range are intended for modular installation only. If you need a threaded inlet/outlet use a Quikclamp and pipe adapter.

## 6.3 SHUT OFF VALVES

### 6.3.1 What Options are Available?

The Olympian 1" product line has a ball valve (T15), but recent products have moved to the slide type. They are generally available in 2/2 (non-exhausting) and 3/2 types, for use upstream or optionally downstream of FRL units.

### 6.3.2 Can they be Locked?

All the slide valves in Excelon and Olympian Plus can be locked closed using the padlock hole provided in the blade. For certain applications where it is vital that the air is not turned off, a lock open and closed option is possible (eg T64A or T64C). The T15 can be locked by dropping in the lock ring and fitting a padlock.

### 6.3.3 What is Patented about the T64/T74?

The design of a slide valve where the exhaust air is captured rather than venting to atmosphere past the slide is the patented feature.

### 6.3.4 Why are the Blades Different Colors?

The colour of the slide depends on the valve function and the market in which it is sold.

Yellow = 3/2 exhaust not tapped OSHA (USA)

Black = 2/2 Excelon 74

Red = 3/2 exhaust tapped (Europe)

### 6.3.5 Do we have Downstream Shut Off Valves?

Yes. The Excelon valves can be used either upstream or downstream, and will always vent the downstream system. In Olympian Plus you need to use a special downstream version.

### 6.3.6 Is there a Shut Off which Fits Between Yokes in Olympian Plus?

Yes. This can be used within a build, or in Duplex assemblies.

### 6.3.7 Can I Use an Upstream Shut Off Downstream?

The Excelon family valves can be used either upstream or downstream. If used downstream, remember that the FRL units remain pressurized - the valve vents the downstream system.

There are special versions of the Olympian Plus and 15 Series valves for downstream use.

# Relief Valves

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7.2.3 What is Failure Flow?

# Relief Valves

## QUESTIONS

### 7.1 GENERAL OVERVIEW

#### 7.1.1 What Types are Available?

Family	Type	Repeatability	Pipe Size	Advantages
16-004 Series	Pop	± 20%	1/8" & 1/4"	Compact, Low Capacity
V06	Diaphragm	± 10%	1/8" & 1/4"	Brass Bodied, Liquid Service
V07	Diaphragm	± 10%	1/8" & 1/4"	Miniature Series
V72	Diaphragm	± 10%	1/4" & 3/8"	Excelon Modular & In Line Mounting
V74	Diaphragm	± 10%	3/8-3/4"	"
V64	Integral Pilot	± 5%	1/4-3/4"	Extremely Good Performance Yoke Mounted, Fail Safe
16-001	Diaphragm	± 10%	3/4" & 1"	High Relief Rates
16-002	External Pilot	± 5%	1/2" - 1"	Good Performance High Relief Rates

#### 7.1.2 How do they Work?

The inlet port is connected to the system and the valve limits the downstream pressure by exhausting when the system pressure exceeds the preset pressure of the valve. The valve is normally closed, only opening when unusual system conditions prevail.

#### 7.1.3 Are they Safety Valves?

No. Safety valves are covered by a variety of national standards eg BS 1123. Norgren relief valves are not designed to these standards.

### 7.2 SIZING

#### 7.2.1 How do I Size a Relief Valve?

If the relief valve is to be fitted to prevent excess pressure then it needs to be sized to cope with the maximum flow that the system can see - often the output flow capacity of the compressor.

The relief valve needs to be able to cope with this flow within acceptable pressure limits. See catalogue data sheets for relief flow characteristics.

#### 7.2.2 Should the Relief Valve be the same Size as the Regulator?

Not necessarily. In general the failure flow of a regulator will require use of a relief valve of larger basic size. Detailed graphs are available for sizing - please call Application Engineering.

#### 7.2.3 What is Failure Flow?

This is the maximum flow that will pass through a regulator in the event of its total failure.

It varies with system pressure and the test results on all Norgren regulators are available from Application Engineering.

The failure flow is used for sizing relief valves downstream of regulators.

# Accessories

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# Accessories

## QUESTIONS

### 8.1 OLYMPIAN PLUS (64 SERIES)

8.1.1 Can we do Duplex Units?

Yes. The Olympian Plus rear entry bracket has been designed to fit the existing Duplex blocks. A basic single yoke assembly, and double yoke assembly are available. (Don't forget to order the FRL units too!)

8.1.2 Is there a Rear Entry Bracket?

Yes. Part number 18-026-981. This simplifies plumbing allowing direct connection to bulkheads.

8.1.3 What Special Brackets can we do?

We have a growing range of brackets. Basic types are:-

Standard	74504-50
13 Series Spacing	74504-51
1 litre Bowl	74504-52

Many specials exist - contact Air Line with your requirements.

8.1.4 Can My Customer Make His Own Accessories?

Yes. We have a yoke adapter block 74616-89 which screws onto a customer's own block allowing it to be connected to a yoke.

8.1.5 Is there a Non-Return Valve?

Yes. We can offer a non-return valve built into the Olympian Plus porting block. This isolates the downstream pressure when the upstream pressure is removed. Beware the fact that unless a downstream shut off valve is used the system remains under pressure.

### 8.2 EXCELON FAMILY

8.2.1 Can I Connect Excelon 72 to 73/74?

There are transition connectors to incorporate 72 Series products in the same assembly as 73 and/or 74 Series components.

8.2.2 Can I Connect Excelon to Olympian?

There is no special connector for this. You can nipple an Excelon unit onto an Olympian yoke.

8.2.3 Can we do Special Brackets?

It may be possible to do special brackets, for example if you need to match the mounting holes of a competitor's unit. Contact Application Engineering with your enquiry.

8.2.4 Is there a Non-Return Valve?

Not at present. If it is feasible to produce non-return versions of both the Excelon 74 and 72 manifold blocks. If you have enquires from customers please contact Application Engineering.

8.2.5 Why isn't a Porting Block the Same Width as a Unit?

Most customers want a compact porting block. However some like a full modular approach where accessories are the same port to port dimension as units. For such applications use the manifold block.

### 8.3 PRESSURE SWITCHES

8.3.1 Are they Explosion Proof?

No.

8.3.2 How Accurate are they?

12% at mid range and repeatability to 3% full range.

8.3.3 What Type of Plugs are Available?

DIN connectors or 1 metre flying leads.

8.3.4 What Protection Rating do they have?

To IP65.

## 8.4 COALESCING SILENCERS

### 8.4.1 What is the Oil Level in Exhausting Air?

For average duty typically 2ppm.

### 8.4.2 Can I Use Two Silencers at Once?

Yes. To provide enough flow capacity, two silencers can be connected in series with inlets from either/both sides. The Olympian yoke system provides a neat installation.

### 8.4.3 How do I Connect Multiple Exhaust Lines to a Coalescing Silencer?

Using the Olympian system you can mount a porting block on the inlet and/or outlet of a yoke to provide multiple connections.

## 8.5 FLOW METERS

### 8.5.1 Does the Flowmeter Read Free Air Flow?

No. There are correction factors for applied pressure and temperature shown on the element to allow free air to be determined.

## 8.6 LIQUID LEVEL CONTROLS

### 8.6.1 Do we have Electrical Liquid Level Switches for all Lubricators?

Generally they are available for larger capacity bowls 2 quart tanks and larger.

### 8.6.2 Can I Retrofit?

Yes. May require change of bowl.

### 8.6.3 What Connections are Available?

Clang plug and socket or 3 wire outlet connections (earth, neutral and live) rated to 10VA, maximum 0.25 amps inductive.

## 8.7 PRESSURE GAUGES

### 8.7.1 Can we do Non-Standard Gauges?

Yes. Through our Global purchasing arrangement we have access to an extensive range of gauges. If there is significant volume these can be supplied with Norgren or "no-name" faces. Contact Application Engineering with your enquiry.

# General

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# General

## QUESTIONS

### 9.1 REPAIR KITS

#### 9.1.1 What Repair Kits are Available?

In general, it is Norgren's intention to only sell repair kits to the market (as opposed to individual replacement components). Details of spares kits can be found in the international data sheets.

However Norgren also recognizes that a number of other items are generally considered as replaceable parts, and you can expect the following items to be available to market companies:

- Filter Elements
- Filter and Filter/Regulator centre posts
- Regulator and Filter/Regulator knobs
- Regulator and Filter/Regulator Control springs
- Bowls
- Sight Glass Repair Kits
- Sight Domes
- Drains

As a rule all other parts are not considered to be saleable items and exceptions are only made at the discretion of Product Marketing.

Illustrated parts list are available for all the newest product ranges. These give a breakdown of all parts and their part numbers. This does not mean that they are all saleable items! Please use these documents with care, they are for internal reference only.

### 9.2 OXYGEN CLEANING

#### 9.2.1 Can Norgren Supply Oxygen Clean Units?

Units can be cleaned for oxygen at an additional cost. Units are fully degreased and assembled in a clean environment (without grease or using lubricants compatible with oxygen service). They are tested on specially cleaned test rigs and then sealed in a bag before shipping.

When asked for oxygen cleaned units it is important to understand the customer's application.

In some cases oxygen clean units may not be necessary. The user may simply require degreased components which could significantly reduce the cost. Check the application!

### 9.3 NON COMPRESSED AIR APPLICATIONS

#### 9.3.1 Will Units Work with other Gases?

In general Norgren units will work on other gases but there are limitations. Having evaluated the application thoroughly and made the user aware of the limitations of the unit it may be acceptable to use a standard product.

In other cases, where safety or material compatibility problems exist Norgren may choose to decline to offer any product.

#### 9.3.2 What are the Problems Associated with other Gases?

In assessing an application the following should be considered.

- Is there a safety risk? Is the fluid potentially dangerous or explosive? If so we may decline to quote.
- Is there a material compatibility problem? (eg oxygen can cause ignitions with some greases - hydrogen sulphide can cause stress fractures in metals)?
- All units (including the competition) have a very small leak rate. This is not a problem with units used on compressed air but could be on other gases (hydrogen, for example).
- Is the fluid likely to leak into an enclosed environment (eg a cellar)? This could cause oxygen depletion in the environment potentially resulting in suffocation.
- Refer to the warning in the catalogue sheets. Norgren units are design and tested for use with compressed air unless otherwise specified.

#### 9.3.3 Can Units be Offered for use with other Gases?

If asked to offer an Air Line product for use with a gas other than compressed air please adopt the following approach.

- Assess the application fully.
- For inert gases such as argon, nitrogen, carbon dioxide users should be made fully aware of the implications outlined above (keep a record in writing that this has been done).
- Products for use with oxygen should only be offered with the approval of Norgren.
- Never use products in applications with combustible or flammable fluids (gaseous or liquid).

## 9.4 SUPPORT DOCUMENTATION

### 9.4.1 What are FMEAs?

An FMEA is a formal method of evaluating the likelihood of a unit failing in a particular way. As a part of the new product development process, Air Line Division conducts an FMEA on all the units to be produced and reduces the risk of failure to a minimum. These details can be made available to customers on request.

### 9.4.2 What are Certificates of Conformity?

Certificates of conformity are Norgren documents which state that the product supplied conforms to the specifications laid down.

Certificates of conformity do not declare that units are suitable for a specific application.

Certificates can be provided to confirm the accuracy of the catalogue data.

## 9.5 CUSTOMIZING PRODUCT

### 9.5.1 Are Different Colored Units Possible?

Norgren can produce products in a variety of colors.

Additional costs and lead times will depend on quantities required and the colour.

To support such special colors, typically private label customers, Norgren can also offer special labels and packaging.

### 9.5.2 Can we do Special Labels?

Products can be produced with no Norgren Identification (no name), or with the customer's own logo on the labels. Similarly, packaging can be branded if required.

