# HIGH QUALITY COMPRESSED AIR

A GUIDE TO THE ISO 8573 SERIES
COMPRESSED AIR QUALITY STANDARD

domnick hunter

# PARTICULATE

THIS DOCUMENT PROVIDES AN INTRODUCTION TO THE ISO 8573 SERIES OF INTERNATIONAL STANDARDS WHICH COVER COMPRESSED AIR PURITY AND TEST METHODS, AS WELL AS THE PURIFICATION EQUIPMENT REQUIRED TO ACHIEVE THE STANDARDS.

**To understand the international standards for compressed air quality, we must first of all understand sources of contamination, the individual contaminants found within a compressed air system and the problems that contaminants can cause:**

## Sources of contamination in a compressed air system

Contaminants in a compressed air system can generally be attributed to the following:

**The quality of air being drawn into the compressor**
Air compressors draw in large volumes of air from the surrounding atmosphere containing large numbers of airborne contaminants.

**The type and operation of the air compressor**
The air compressor itself can also add contamination, from wear particles to coolants and lubricants.

**Compressed air storage devices and distribution systems**
The air receiver and system piping are designed to store and distribute the compressed air. As a consequence they will also store the large amounts of contamination drawn into the system. Additionally, piping and air recievers will also cool the moist compressed air forming condensate which causes damage and corrosion.

## Types of contamination found in a compressed air system

**Atmospheric Dirt**
Atmospheric air in an industrial environment typically contains 140 million dirt particles for every cubic metre of air. 80% of these particles are less than 2 microns in size and are too small to be captured by the compressor intake filter, therefore passing directly into the compressed air system.

**Water Vapour, Condensed Water and Water Aerosols**
Atmospheric air contains water vapour (water in a gaseous form). The ability of compressed air to hold water vapour is dependent upon it's temperature. The higher the temperature, the more water vapour that can be held by the air. During compression, the air temperature is increased significantly, which allows it to easily retain the incoming moisture. After the compression stage, air is normally cooled to a usable temperature. This reduces the air's ability to retain water vapour, resulting in a proportion of the water vapour being condensed into liquid water which is removed by a condensate drain fitted to the compressor after-cooler. The air leaving the after-cooler is now 100% saturated with water vapour and any further cooling of the air will result in more water vapour condensing into liquid water. Condensation occurs at various stages throughout the system as the air is cooled further by the air receiver, piping and the expansion of air in valves, cylinders, tools and machinery. The condensed water and water aerosols cause corrosion to the storage and distribution system, damage production equipment and the end product. It also reduces production efficiency and increases maintenance costs. Water in any form must be removed to enable the system to run correctly and efficiently.

**Rust and Pipescale**
Rust and pipescale can be found in air receivers and the piping of "wet systems" (systems without adequate purification equipment) or systems which were operated "wet" prior to purification equipment being installed. Over time, this contamination breaks away to cause damage or blockage in production equipment which can also contaminate final product and processes.

**Micro-organisms**
Bacteria and viruses will also be drawn into the compressed air system through the compressor intake and warm, moist air provides an ideal environment for the growth of micro-organisms. Ambient air can typically contain up to 3,850 micro-organisms per cubic metre. If only a few micro-organisms were to enter a clean environment, a sterile process or a production system, enormous damage could be caused that not only diminishes product quality, but may even render a product entirely unfit for use and subject to recall.

**Liquid Oil and Oil Aerosols**
Most air compressors use oil in the compression stage for sealing, lubrication and cooling. During operation, lubricating oil is carried over into the compressed air system as liquid oil and aerosols. This oil mixes with water vapour in the air and is often very acidic, causing damage to the compressed air storage and distribution system, production equipment and final product.

**Oil Vapour**
In addition to dirt and water vapour, atmospheric air also contains oil in the form of unburned hydrocarbons. The unburned hydrocarbons drawn into the compressor intake as well as vapourised oil from the compression stage of a lubricated compressor will carry over into a compressed air system where it can cool and condense, causing the same contamination issues as liquid oil. Typical oil vapour concentrations can vary between 0.05 and 0.5mg per cubic metre of ambient air.

# WATER

ASK MOST MAINTENANCE OR PRODUCTION ENGINEERS WHAT IS THE MAJOR CONTAMINANT FOUND IN ANY COMPRESSED AIR SYSTEM, AND THE ANSWER WOULD PROBABLY BE OIL. IN REALITY, OIL IS NOT THE MAJOR PROBLEM EVERYONE THINKS IT IS, AS THE MOST PROLIFIC CONTAMINANT IS IN FACT WATER.

Up to 99.9% of the total liquid contamination found in a compressed air system is water. Oil is perceived to cause the most problems as it is seen emanating from open drain points and exhausting valves, however, in the majority of instances, it is actually oily condensate (oil mixed with water) that is being observed.

## How much water can be found in a typical compressed air system?

The amount of water in a compressed air system is staggering. A small 2.8m³/min (100 cfm) compressor and refrigeration dryer combination, operating for 4000 hours in typical Northern European climatic conditions can produce approximately 10,000 litres or 2,200 gallons of liquid condensate per year.

If the compressor is oil lubricated with a typical 2 mg/m³ (2ppm) oil carryover, then although the resulting condensate would visually resemble oil, oil would in fact account for less than 0.1% of the overall volume and it is this resemblance to oil to which a false association is made.

*The example above assumes uses a small compressor to highlight the large volume of condensate produced. If a compressed air system was operated in warmer, more humid climates, or with larger compressors installed, running for longer periods, the volume of condensate would increase significantly.*

## Contamination and Types of Compressor

It is often believed that the level of compressed air purification equipment required in a system is dependent upon the type of compressor used. Contamination in a compressed air system originates from many sources and is not related solely to the compressor or it's lubricants. No matter what compressor type is selected, adequate filtration and separation products will be required to remove the large volume of dirty contaminated water as well as the dirt, rust, pipescale and microbiological contamination in the system.

## Compressed Air and It's Purification

Having identified the different types of contamination that can be found within a compressed air system, we can now examine the purification technologies available for it's removal.

### Coalescing Filters

Coalescing filters are probably the most important items of purification equipment in any compressed air system. They are designed to remove oil and water aerosols using mechanical filtration techniques and have the additional benefit of removing solid particulate to very low levels (as small as 0.01micron in size). Installed in pairs, most users believe one to be an oil removal filter and the other to be a particulate filter, when in fact, the pair of filters both perform the same function. The first filter, a general purpose filter is used to protect the high efficiency filter against bulk contamination. This 'dual filter' installation ensures a continuous supply of high quality compressed air with low operational costs and minimal maintenance time.

### Water Separators

Used to protect coalescing filters in systems where excessive cooling takes place in distribution piping. Water Separators will remove in excess of 90% of bulk liquid contamination.

### Adsorption (Desiccant) Dryers

Water vapour is water in a gaseous form and is removed from compressed air using a dryer, with dryer performance being measured as pressure dewpoint. Adsorption or desiccant dryers remove moisture by passing air over a regenerative adsorbent material which strips the moisture from the air. This type of dryer is extremely efficient and typical pressure dewpoint ratings are -40°C or -70°C pdp. This means that for water vapour to condense into a liquid, the air temperature would have to drop below -40°C or -70°C respectively (the actual air temperature after an adsorption dryer is not the same as it's dewpoint).

Beneficially, a pressure dewpoint of -26°C or better will not only prevent corrosion, but will also inhibit the growth of micro-organisms within the compressed air system.

### Refrigeration Dryers

Refrigeration dryers work by cooling the air, so are limited to positive pressure dewpoint ratings to prevent freezing of the condensed liquid. Ideal for general purpose applications, they typically provide pressure dewpoints of +3°C, +7°C or +10°C pdp. Refrigeration dryers are not suitable for installations where piping is installed in ambient temperatures below the dryer dewpoint i.e. systems with external piping.

### Important Note Regarding Compressed Air Dryers

As adsorption and refrigeration dryers are designed to remove only water vapour and not water in a liquid form, they require the use of coalescing filters to work efficiently.

### Adsorption (Activated Carbon) Filters

Oil vapour is simply oil in a gaseous form and as with water vapour will pass through a coalescing filter just as easily as the compressed air itself. Therefore, oil vapour removal filters must be employed as these provide a large bed of activated carbon adsorbent for the effective removal of oil vapour, providing the ultimate protection against oil contamination.

### Dust Removal Filters

Dust removal filters are used for the retention of particulates when no liquid is present. They usually provide identical particulate removal performance to the equivalent coalescing filter and use the same mechanical filtration techniques to provide up to 99.9999% particle removal efficiency. For absolute particulate retention (100% at a given size), a sieve retention membrane filter must be used.

### Micro-biological (Sterile) Filters

Absolute removal of solid particulates and micro-organisms is performed by a sieve retention or membrane filter. They are often referred to as sterile air filters as they also provide sterilised compressed air. Housings are manufactured from stainless steel to allow steam sterilisation of the filter and element. It is important to note that the piping between the sterile filter and the application must also be cleaned and sterilised on a regular basis.

# OIL

# ISO 8573 – COMPRESSED AIR QUALITY STANDARDS

ISO 8573 IS THE GROUP OF INTERNATIONAL STANDARDS RELATING TO THE QUALITY OF COMPRESSED AIR AND CONSISTS OF NINE SEPARATE PARTS. PART 1 SPECIFIES THE QUALITY REQUIREMENTS OF THE COMPRESSED AIR AND PARTS 2 – 9 SPECIFY THE METHODS OF TESTING FOR A RANGE OF CONTAMINANTS.

ISO 8573.1 : 2001 is the primary document used from the ISO 8573 series as it is this document which specifies the amount of contamination allowed in each cubic metre of compressed air.

ISO 8573.1 : 2001 lists the main contaminants as Solid Particulate, Water and Oil. The purity levels for each contaminant are shown separately in tabular form, however for ease of use, this document combines all three contaminants into one easy to understand table as shown below.

| Purity Class | Solid Particulate | | | | | Water | | Oil |
|---|---|---|---|---|---|---|---|---|
| | Maximum number of particles per m$^3$ | | | Particle Size | Concentration | Vapour | Liquid | Total oil (aerosol, liquid and vapour) |
| | 0.1 - 0.5 micron | 0.5 - 1 micron | 1 - 5 micron | micron | mg/m$^3$ | Pressure Dewpoint | g/m$^3$ | mg/m$^3$ |
| 0 | As specified by the equipment user or supplier | | | | | As specified by the equipment user or supplier | | As specified by the equipment user or supplier |
| 1 | 100 | 1 | 0 | - | - | -70°C | - | 0.01 |
| 2 | 100,000 | 1,000 | 10 | - | - | -40°C | - | 0.1 |
| 3 | - | 10,000 | 500 | - | - | -20°C | - | 1 |
| 4 | - | - | 1,000 | - | - | +3°C | - | 5 |
| 5 | - | - | 20,000 | - | - | +7°C | - | - |
| 6 | - | - | - | 5 | 5 | +10°C | - | - |
| 7 | - | - | - | 40 | 10 | - | 0.5 | - |
| 8 | - | - | - | - | - | - | 5 | - |
| 9 | - | - | - | - | - | - | 10 | - |

## Specifying Air Purity In Accordance With ISO 8573.1 : 2001

Compressed air purity levels are shown within ISO 8573.1 in tabular form. The horizontal headings show the three major contaminants of solid particulate, water and oil. The vertical headings show "purity classes" identified by a number.

Alongside each purity class, is a maximum permissible amount of contamination per cubic metre. When specifying purity classes, a different purity class should be selected for each contaminant and is written as shown in the following example :

**ISO 8573.1 : 2001 Class 1.2.1**
The first number refers to purity level class 1 for solid particulate, the second number refers to purity level class 2 for water and the last number refers to purity level class 1 for oil.

Selecting an air purity class of 1.2.1 would specify the following air quality.

**Class 1 Particulate**
No more than 100 particles in the 0.1 - 0.5 micron size range allowed in each cubic metre of compressed air.
No more than 1 particle in the 0.5 - 1 micron size range allowed in each cubic metre of compressed air.
No particles in the 1 - 5 micron size range allowed in each cubic metre of compressed air.

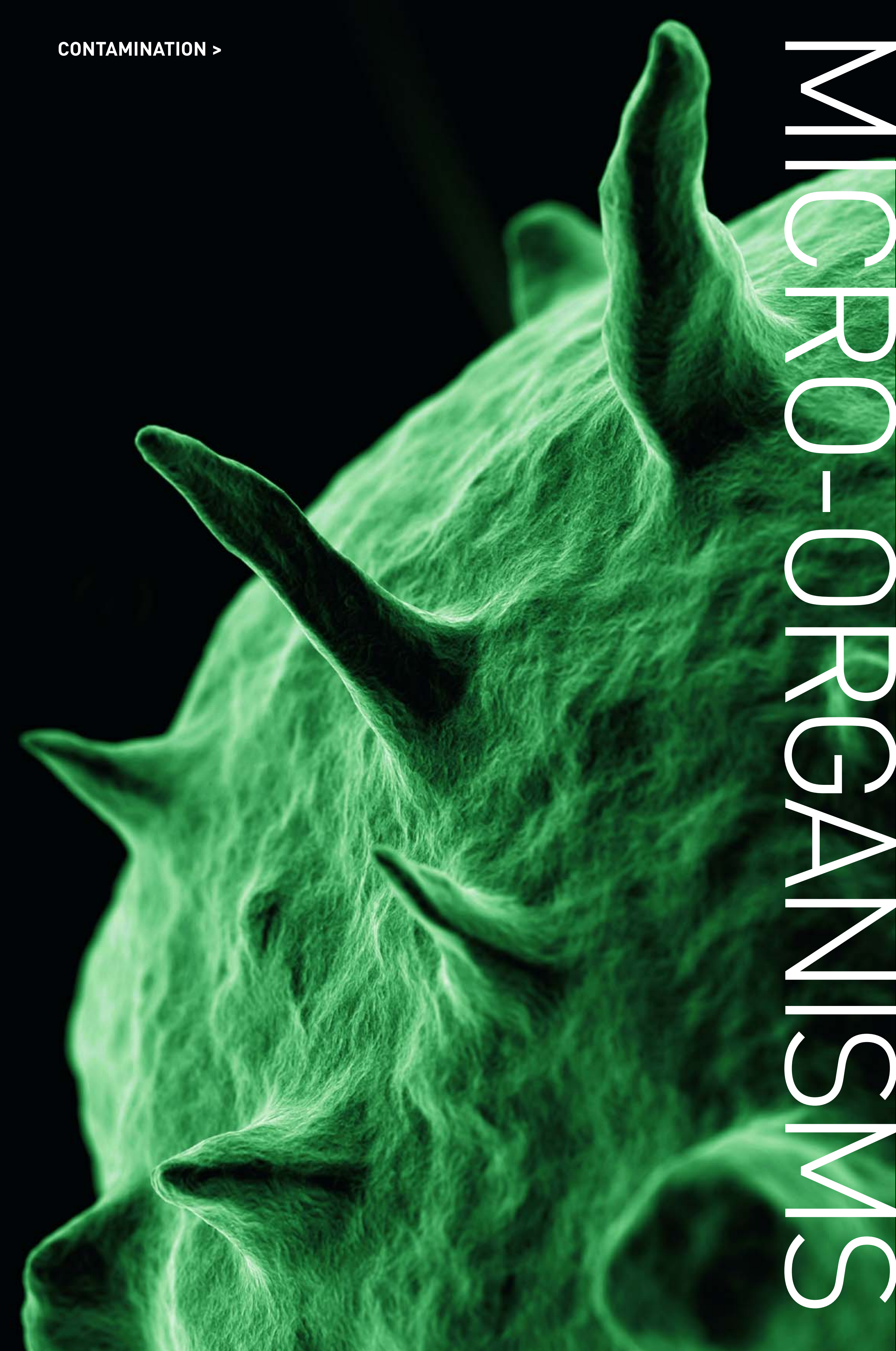
**Class 2 Water**
No liquid water allowed. Pressure dewpoint of -40°C or better.

**Class 1 Oil**
Not more than 0.01mg of oil allowed in each cubic metre of compressed air. This is a combined level for both oil aerosol and oil vapour.

### ISO 8573.1 : 2001 CLASS 0

THE ISO 8573.1 : 2001 TABLE ALSO INCLUDES A CLASS 0 FOR EACH TYPE OF CONTAMINANT. CLASS 0 ALLOWS THE USER AND AN EQUIPMENT MANUFACTURER TO SPECIFY AND AGREE AN AIR QUALITY WHICH IS MORE STRINGENT THAN CLASS 1 SHOULD IT BE REQUIRED. CLASS 0 DOES NOT MEAN ZERO CONTAMINATION ALLOWED AS CONTAMINATION REMOVAL TO A ZERO LEVEL IS NOT DETECTABLE DUE TO THE ACCURACY OF CURRENTLY AVAILABLE MEASURING EQUIPMENT.

# MICRO-ORGANISMS



## TESTING AND VALIDATION

ISO 8573.2 TO ISO 8573.9 SPECIFY THE TEST METHODS FOR THE DIFFERENT CONTAMINANTS. ON-SITE TESTING IS OFTEN DIFFICULT DUE TO THE COMPLEXITY OF THE TEST METHOD AND THE EXPENSE OF TEST EQUIPMENT REQUIRED AND FOR THIS REASON, ALL DOMNICK HUNTER FILTRATION PRODUCTS HAVE BEEN TESTED IN ACCORDANCE WITH THE RELEVANT INTERNATIONAL STANDARDS AND PERFORMANCE VERIFIED BY LLOYDS REGISTER.

### OIL-X EVOLUTION Performance Validation

OIL-X EVOLUTION filters have been designed to provide compressed air quality that meets or exceeds the levels shown in the latest ISO 8573.1:2001 international air quality standard.

**OIL-X EVOLUTION** filters are not only validated by domnick hunter, filtration performance has also been independently verified by Lloyds Register.

### Coalescing Filters

Coalescing filter performance has been tested in accordance with ISO 8573.2 and ISO 8573.4.

### Dry Particulate Filters

Dry particulate filter performance has been tested in accordance with ISO 8573.4.

### Oil Vapour Removal Filters

Oil vapour removal filter performance has been tested in accordance with ISO 8573.5.

Performance Verified
Lloyd's Register
ISO 8573.2 / ISO 8573.4 / ISO 8573.5

### Materials of Construction

**OIL-X EVOLUTION** materials of construction have been independently verified to comply with FDA Code of Federal Regulations, Title 21 'Food and Drug'.

### Guaranteed Air Quality

All products are supplied with a one year compressed air quality guarantee, when sized, installed and maintained in accordance with domnick hunter recommendations. The air quality guarantee is automatically extended by replacing the filter element and consumable parts annually.

### Maintaining System Efficiency

Regular servicing of your purification equipment in accordance with domnick hunter recommendations is essential to maintain system performance and to guarantee air quality. Failure to maintain your purification equipment will invalidate performance guarantees and could result in reduced production performance, degrading air quality and increased running costs.

**Annual maintenance provides you with the following benefits:**

- **Lowest running costs**
- **Guaranteed compressed air quality**
- **Continued protection of downstream equipment and processes**
- **Peace of mind**

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INTERNATIONAL APPROVALS

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# SELECTION

## DO ALL COMPRESSED AIR FILTERS AND DRYERS PERFORM THE SAME?

TODAY, MANY MANUFACTURERS OFFER PRODUCTS FOR THE FILTRATION AND PURIFICATION OF CONTAMINATED COMPRESSED AIR, WITH MANY BEING SELECTED BASED ONLY ON THEIR INITIAL PURCHASE COST, WITH LITTLE OR NO REGARD FOR THE AIR QUALITY THEY PROVIDE OR THE COST OF OPERATION THROUGHOUT THEIR LIFE. COMPRESSED AIR PURIFICATION EQUIPMENT IS VITAL FOR THE REMOVAL OF SYSTEM CONTAMINATION, THEREFORE WHEN PURCHASING THIS TYPE OF EQUIPMENT, AIR QUALITY, ENERGY EFFICIENCY AND LIFETIME COSTS MUST ALWAYS BE CONSIDERED.

## The domnick hunter Design Philosophy

**All domnick hunter filtration and purification products are designed with the philosophy of air quality, energy efficiency and life time costs.**

**Air Quality**

This is the primary reason for installing purification equipment in the first place. All domnick hunter purification equipment has been designed to provide compressed air quality in accordance with the recommendations shown in ISO 8573.1 : 2001, the latest edition of the international air quality standard. Additionally, domnick hunter product performance has been independently verified by Lloyds Register and is backed up by a 12 month performance guarantee. The performance guarantee can be extended simply by carrying out annual maintenance in accordance with domnick hunter recommendations.

**Energy Efficiency**

During the design of domnick hunter filtration and drying products, our engineers strive to provide the lowest operating costs whilst achieving the air quality required by the international standards. Pressure loss is the major contributor to operational costs of filtration products. domnick hunter OIL-X EVOLUTION filters have been designed using aerospace technology to ensure pressure loss and thus energy consumption is kept to an absolute minimum. By considering pressure losses after 12 months of operation and not just at start-up, energy savings in excess of 60% compared to an ordinary filter are not uncommon. domnick hunter adsorption dryers are also optimised to ensure regeneration costs are minimised and energy management systems are available to further reduce operational costs during periods where the water vapour entering the dryer is reduced whether it is due to ambient conditions, shift patterns or a variable air demand.

**Low Lifetime Costs**

Equipment with a low purchase cost may turn out to be a very costly investment in the longer term. Always consider the initial purchase cost, plus the cost of operating and maintaining the purification equipment. In addition, consider the cost to your business of poor air quality?

By guaranteeing air quality and ensuring energy consumption is kept to a minimum, domnick hunter purification equipment can reduce the total cost of ownership and improve your bottom line through improved manufacturing efficiencies.

***OIL-X EVOLUTION***
*Coalescing and dust removal filters*

***High Flow TETPOR II***
*Sterile air filters*

***PNEUDRI***
*Modular adsorption dryers*

***CRD²***
*Refrigeration dryers*

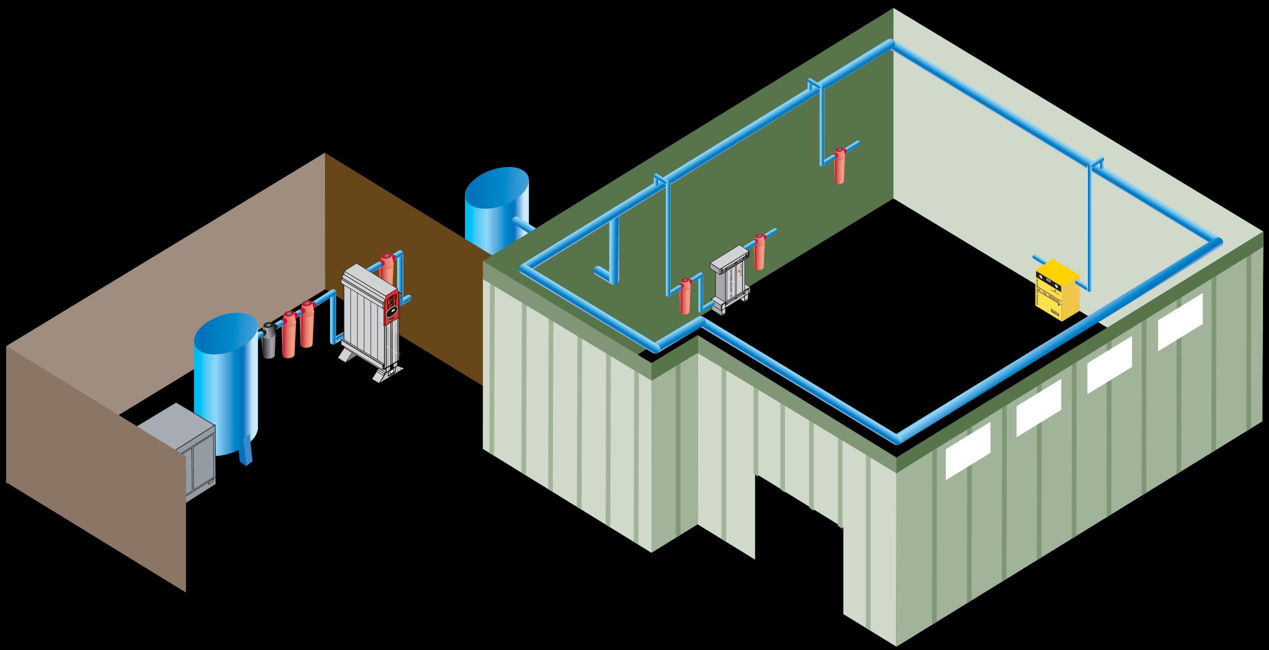

***OVR***
*Oil vapour removal filters*

# SYSTEM DESIGN

## OPTIMISED SYSTEM DESIGN FOR TYPICAL APPLICATIONS

THE QUALITY OF AIR REQUIRED THROUGHOUT A TYPICAL COMPRESSED AIR SYSTEM CAN VARY. THE EXTENSIVE RANGE OF PURIFICATION EQUIPMENT AVAILABLE FROM DOMNICK HUNTER IS IDEAL FOR BOTH CENTRALISED AND DECENTRALISED COMPRESSED AIR SYSTEMS. THIS ALLOWS THE USER TO SPECIFY THE QUALITY OF AIR FOR EVERY APPLICATION, FROM GENERAL PURPOSE RING MAIN PROTECTION, THROUGH TO CRITICAL CLEAN DRY AIR (CDA) POINT OF USE SYSTEMS.

DOMNICK HUNTER HAS COMPREHENSIVE RANGES OF PURIFICATION EQUIPMENT AVAILABLE TO EXACTLY MATCH SYSTEM REQUIREMENTS, ENSURING BOTH CAPITAL AND OPERATIONAL COSTS ARE KEPT TO A MINIMUM.





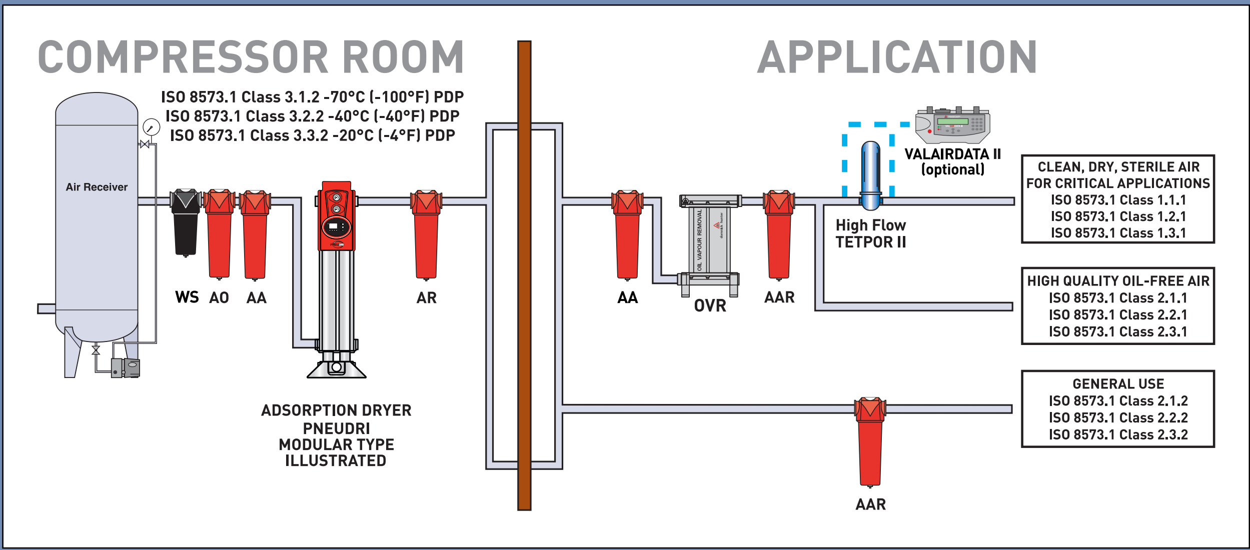
### Cost Effective System Design

To achieve the stringent air quality levels required for today's modern production facilities, a careful approach to system design, commissioning and operation must be employed. Treatment at one point alone is not enough and it is highly recommended that the compressed air is treated prior to entry into the distribution system to a quality level suitable for protecting air receivers and distribution piping. Point of use purification should also be employed, with specific attention being focussed on the application and the level of air quality required. This approach to system design ensures that air is not "over treated" and provides the most cost effective solution to high quality compressed air.

**The following table highlights the domnick hunter filtration and drying products required to achieve each air purity classification shown in ISO 8573.1 : 2001. If a Class 0 purity level is required, contact domnick hunter for recommendations regarding product requirements.**

| ISO 8573.1:2001 | SOLID PARTICULATE | | WATER | OIL |
|---|---|---|---|---|
| CLASS | WET PARTICULATE | DRY PARTICULATE | VAPOUR | TOTAL OIL (AEROSOL LIQUID and VAPOUR) |
| 1 | OIL-X EVOLUTION Grade AO + AA + TETPOR II | OIL-X EVOLUTION Grade AR + AAR + TETPOR II | PNEUDRI -70°C PDP<br>DTV -70°C PDP | OIL-X EVOLUTION Grade AO + AA + OVR<br>OIL-X EVOLUTION Grade AO + AA +ACS<br>OIL-X EVOLUTION Grade AO + AC |
| 2 | OIL-X EVOLUTION Grade AO + AA | OIL-X EVOLUTION Grade AR + AAR | PNEUDRI -40°C PDP<br>DTV -40°C PDP | OIL-X EVOLUTION Grade AO + AA |
| 3 | OIL-X EVOLUTION Grade AO | OIL-X EVOLUTION Grade AR | PNEUDRI -20°C PDP<br>DTV -20°C PDP | OIL-X EVOLUTION Grade AO |
| 4 | OIL-X EVOLUTION Grade AO | OIL-X EVOLUTION Grade AR | CRD +3°C PDP | OIL-X EVOLUTION Grade AO |
| 5 | OIL-X EVOLUTION Grade AO | OIL-X EVOLUTION Grade AR | CRD +7°C PDP | - |
| 6 | - | - | CRD +10°C PDP | - |

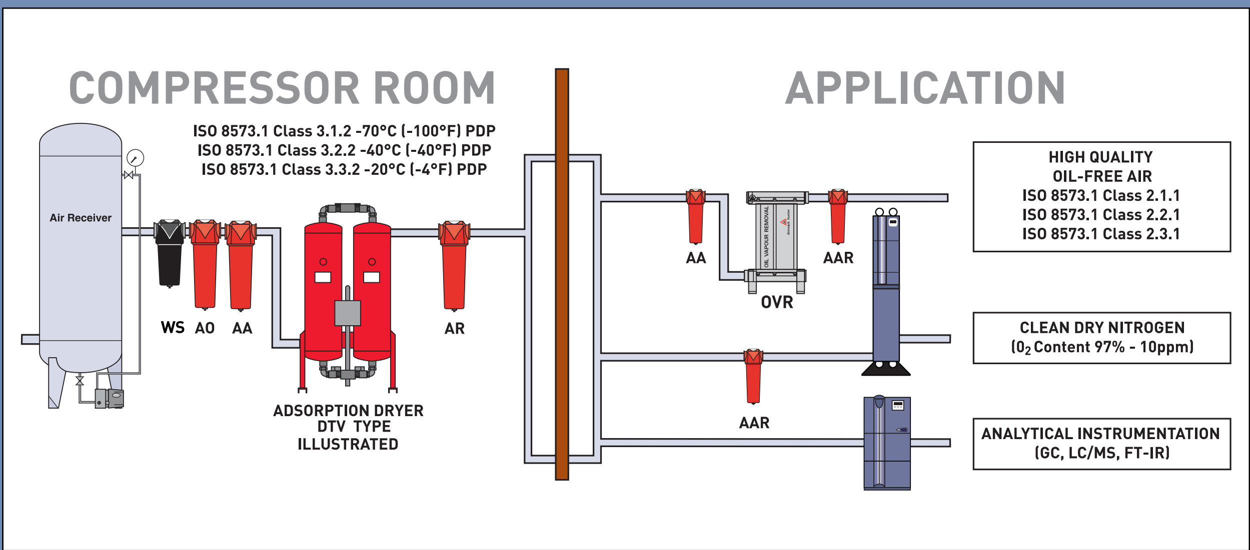
## CRITICAL APPLICATIONS




### Typical Applications

Pharmaceutical products
Silicon wafer manufacturing
TFT / LCD Screen manufacturing
Memory device manufacturing
Optical storage devices (CD, CD/RW, DVD, DVD/RW)
Optical disk manufacturing (CD's/DVD's):
Hard disk manufacturing
Foodstuffs
Dairies
Breweries
CDA systems for electronics manufacturing

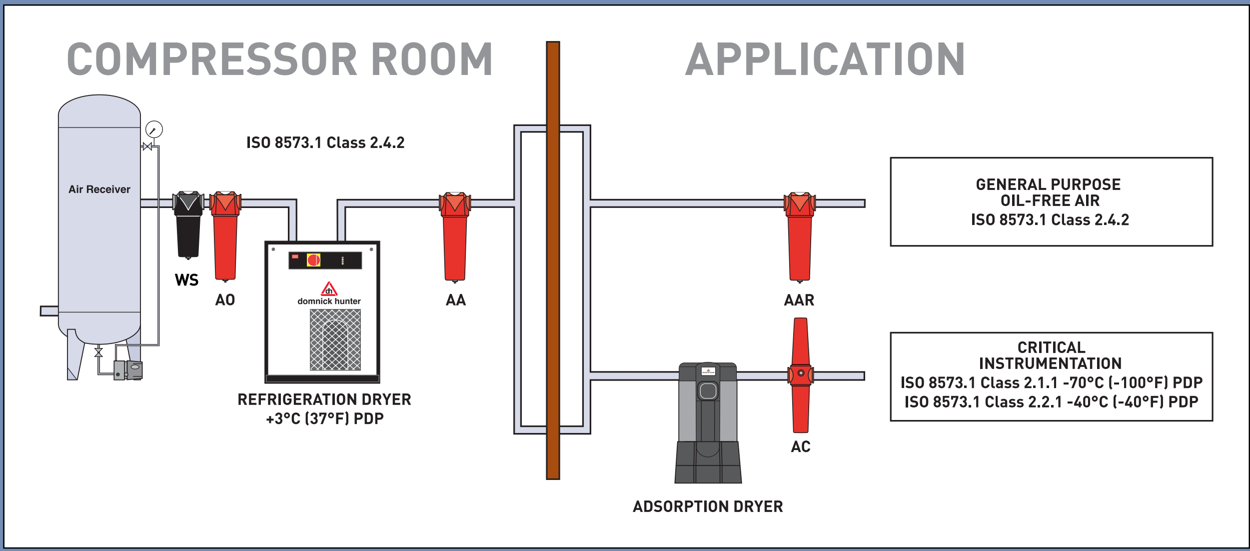
## HIGH QUALITY OIL-FREE AIR




### Typical Applications

Blow Moulding of Plastics e.g. P.E.T. Bottles
Film processing
Critical instrumentation
Advanced pneumatics
Air blast circuit breakers
Decompression chambers
Cosmetic production
Medical air
Dental air
Lasers and optics
Robotics
Spray Painting
Air bearings
Pipeline purging
Measuring equipment
Blanketing
Modified Atmosphere Packaging
Pre-treatment for on-site gas generation

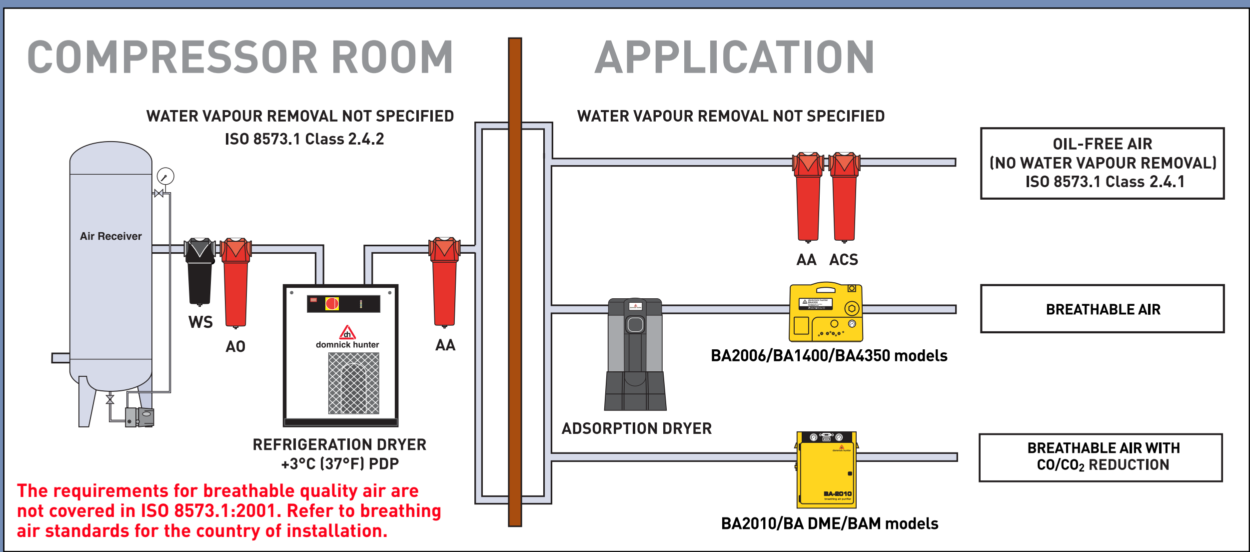
# GENERAL PURPOSE OIL-FREE AIR



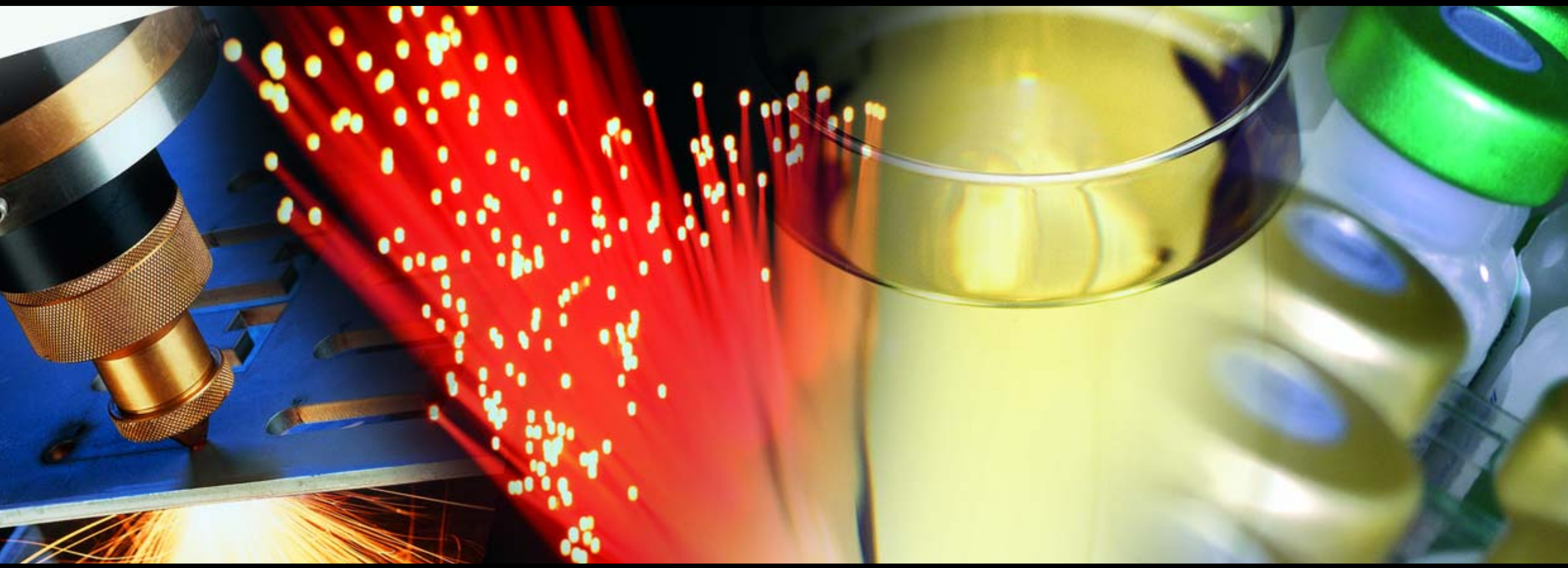

## Typical Applications

General ring main protection
Pre-filtration to point of use adsorption air dryers
Plant automation
Air Logistics
Pneumatic tools
General instrumentation
Metal stamping
Forging
General industrial assembly (no external pipework)
Air conveying
Air motors
Workshop (Tools)
Garage (Tyre filling)
Temperature control systems
Blow guns
Gauging equipment
Raw material mixing
Sand / bead blasting

# GENERAL PURPOSE OIL-FREE AIR (PRE-FILTRATION TO BREATHING AIR)




Pre-filtration to point of use breathing air systems



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