WHITEPAPER

# ISO 29461-1:2021

## FIRST GT AIR FILTER EFFICIENCY STANDARD

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## ABSTRACT

Gas turbines and other turbomachinery are sensitive equipment that require protection against harmful particulates that could diminish life and performance. Without filtration, particles that reach the gas turbine lead to performance loss due to three main mechanisms: erosion due to large particles mechanically impacting turbine blades, fouling due to buildup of film on the turbine blades and corrosion due to chemical attack of the turbine blade itself.

Even relatively clean outside air can lead to large reductions in performance, because of the sheer quantity of air being consumed by gas turbines. For example, a 500 MW turbine would consume over 850 kg/s of air, and even in a clean rural area with a PM2.5 concentration of 10 µg/m³, this gas turbine would consume over 200 kilograms of dirt per year. This can lead to sizeable reductions in performance and cause up to 20% reduction in power output over the course of a year. This performance penalty can either be treated after the fact by cleaning and replacing turbine blades, or at the source with inlet air filtration. However, proper selection of turbomachinery filters is crucial to ensure the right level of protection is provided in the challenging environments they face.

Previously, filter specifications used for turbomachinery have been borrowed from either the comfort sector providing clean air to buildings and their occupants, or to the clean room sector providing clean air to industrial processes such as semiconductor and pharmaceutical fabrication. This led to several compromises, as the specific needs for the turbomachinery sector were not taken into account when writing these standards, or when designing filters to meet them. For the first time, the ISO 29461 family of specifications were written from the ground up with turbomachinery in mind. Following the initial release of ISO 29461-1 for filter efficiency, several additional sections will follow with test methods designed to rate the pulsability, burst strength, water resistance and salt resistance of filters.

This whitepaper will describe the ISO 29461-1 efficiency standard, highlighting the key differences compared with previous filter standards such as EN779 / ISO 16890 / ASHRAE 52.2 / EN1822, and why these differences can help you select the right filter products for any turbomachinery application.


**FIGURE 1: GAS TURBINE TEST RIG**




## TURBOMACHINERY-SPECIFIC STANDARD

The need for test standards to rate and compare air filters has been understood for several decades. The comfort industry recognized this and created standards such as ASHRAE 52.1, ASHRAE 52.2, EN779 and ISO 16890. Eventually, the clean room applications developed EN1822 and ISO 29463 to address their needs. For the turbomachinery industry, the result has been the use of one or more of these standards, largely depending upon what part of the world the application is in.

It will be shown that for turbomachinery air intake filters, none of the existing standards covers the entirety of the needs of the industry. Those needs clearly differ from the industries mentioned above in important ways – turbomachinery filters are typically subjected to higher dust concentrations, have a longer service life with less frequent opportunities for filter changeouts, and range in efficiency from very basic coarse grade filters to HEPA-class filters. ISO 29461-1 addresses each of those needs so that operators can be sure that they have the information they need to make the best decision for their application.

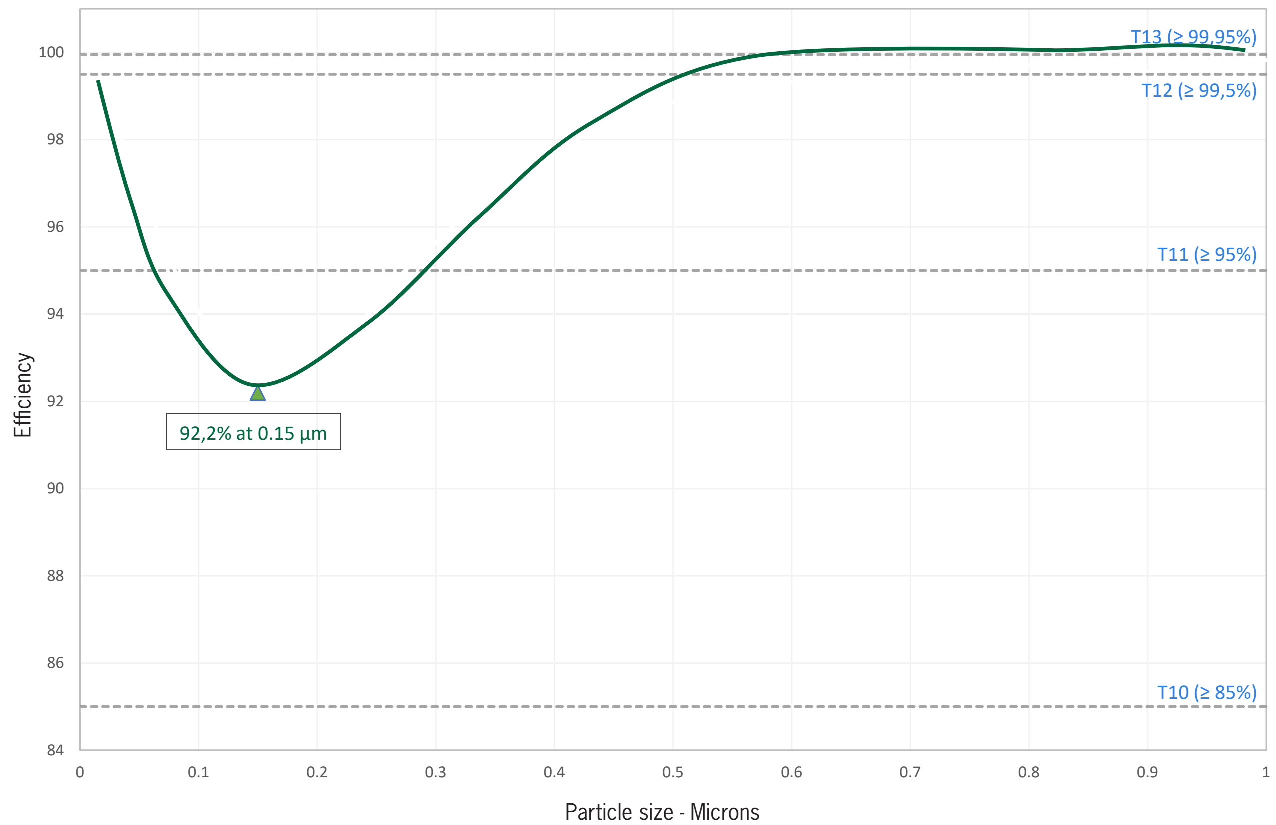
## TEST PROCEDURE

ISO 29461-1 utilizes long-established filter testing procedures from well-known standards such as ISO 16890 and ISO 29463. Filters that are in the low and medium efficiency grades are tested by the procedure listed in ISO 16890 and filters that are in the high efficiency grades are tested according to ISO 29463. Air filters that are to be tested under ISO 29461-1 are first installed in a test duct. A photograph of a representative test duct can be seen in Figure 1. Once installed, the filter is subjected to tests that will quantify relevant aspects of its performance such as particle capture efficiency, resistance to air flow, and dust holding capacity.

As in ISO 16890, the efficiency of the filter is converted into the metric “particulate matter efficiency”, or ePM. These ePM values form the basis by which the filter is classified by ISO 29461-1. Medium and high efficiency filters undergo an effective, non-destructive discharge method for the purpose of the minimum efficiency measurement.

Filters that exceed the efficiency limitations of the ISO 16890 standard are tested in accordance with ISO 29463. This standard determines the “most penetrating particle size”, or MPPS, of the filter. Once that particle size has been established, as shown in Figure 2, the efficiency of the filter at its MPPS is measured and the filter is classified according to that value. To note, low and medium filter classes estimate the percentage of mass that goes through the filter. A key distinction of the MPPS efficiency for H(EPA) filters is that it is measuring the percentage of individual particles that go through the filter, which allows for a clear differentiation between their filter classes that a mass efficiency would not provide since the mass would be insignificant. HEPA grade filters are also individually leak tested per ISO 29463.

**FIGURE 2: MPPS: PARTICLE SIZE REMOVAL EFFICIENCY**



The final step of the testing process is a measure of the dust holding capacity of the filter. All filters, regardless of efficiency class, are tested using a standardized procedure with the loading dust specified in ISO 15957 as L2. This dust is otherwise known as A2 Fine, or "ISO Fine" and is also used in ISO Standard 16890. The key difference is that ISO 29461-1 specifies a higher final resistance than ISO 16890 with regard to the dust holding portion of the test as filters in gas turbine applications typically are run longer and to higher pressure drop than in other applications.

## FILTER CLASSIFICATION

As can be seen in Table 1, the filter classification table for ISO 29461-1 has been designed to grade filters in a way that will maintain some familiarity for users with experience in previous test standards. There are thirteen filter classifications ranging from T1-T13. The classifications are grouped in such a way that the lowest efficiency "coarse" filters consider the overall gravimetric efficiency, which factors particles of all sizes. As the filter grade increases, the threshold for maximum particle size considered decreases, until we reach the EPA and HEPA groups which consider only the most penetrating particle size of the filter. While ISO 29461-1 has been designed to utilize many of the procedures of ISO 16890, a key difference between the two standards emerges upon examination of the new classification table. But first, a detour into ISO 16890.

ISO 16890 measures filter performance by calculating the percent of mass in typical urban areas that a filter would stop, either 1 micron in diameter and smaller, or 2.5 microns in diameter and smaller. This efficiency is calculated twice: first for a filter in its initial state including any electrostatic charge, and second after a discharging step when all electrostatic charge is removed. The initial and minimum efficiencies are then averaged, and are reported as the ePM1 rating (for up to 1 micron particles) and ePM2.5 rating (for up to 2.5 micron particles).

More coarse filters are rated based on the percent of mass in a typical rural area that a filter would stop, 10 microns and smaller. This time, the filter is only tested in its initial charged state, and reported as the ePM10 rating.

Finally, even more coarse filters are rated on the percent of a standardized lab dust that is caught, based on the first few grams of loading.

Back to ISO 29461-1, for filters that are contained within the ePM1 and ePM2.5 groups, or T6-T13 classes, only the minimum efficiency of the filter is considered unlike in ISO 16890 when the initial charged and minimum discharged efficiency are given equal weight and the average of the two values is reported. This subtle difference has a large effect on filter classification, as medium and high efficiency filters rated T6 and above are now only rated based on their mechanical, long term efficiency. Meanwhile, both ISO 16890 and ISO 29461-1 consider only the initial charged efficiency for more coarse filters contained within the ePM10 groups or T5 class, since they are rated by their ability to capture much larger particulate that are too large and heavy to be significantly impacted by electrostatic charge.

To better illustrate the information that is presented on the ISO 29461-1 test report, a sample report can be found on Figure 3 on the next page. General information, including the filter dimensions, media area, test air flow rate, and ISO 16890 test report numbers, must be presented in the summary section. Note that the net effective media area must be measured and calculated by the testing organization as per a standardized method outlined in ISO 29461-1.

**TABLE 1: ISO 29461:1 FILTER CLASSIFICATION TABLE**

| Class | Group | MPPS efficiency | $ePM_1$, min | $ePM_{2,5}$, min | $ePM_{10}$ | Initial gravimetric arrestance $A_{100}$ |
|---|---|---|---|---|---|---|
| ISO T1 | Coarse | | | | | $20\% < A_{100} < 50\%$ |
| ISO T2 | | | | | | ≥ 50 % |
| ISO T3 | | | | | | ≥ 70 % |
| ISO T4 | | | | | | ≥ 85 % |
| ISO T5 | ePM10 | | | | ≥ 50 % | |
| ISO T6 | ePM2,5 | | | ≥ 50 % | | |
| ISO T7 | ePM1 | | ≥ 50 % | | | |
| ISO T8 | | | ≥ 70 % | | | |
| ISO T9 | | | ≥ 85 % | | | |
| ISO T10 | EPA | ≥ 85 % | | | | |
| ISO T11 | | ≥ 95 % | | | | |
| ISO T12 | | ≥ 99,5 % | | | | |
| ISO T13 | HEPA | ≥ 99,95 % | | | | |



Performance data that is required to be included in the report summary includes: Initial and final pressure differential, ePM values and minimum ePM values, MPPS efficiency if applicable, initial and average arrestance, test dust capacity, and ISO filter class according to Table 1. The aforementioned ISO 16890-2, 16890-3, and 16890-4 test reports for the filter can be referenced to obtain more detailed information such as resistance at different airflows and resistance at differing amounts of dust loading.

Referring back to the sample report, it can be seen that the filter achieved a rating of T8 per ISO 29461-1. This rating was arrived at by following the ePM ratings up the classification table to the highest class that the filter would achieve. The ePM10 rating of 96% achieves T5, and the ePM2.5min rating of 86% achieves T6. Therefore, the progression continues to the ePM1 group of filters. For this group, the ePM1 min rating of 80% in our sample filter report achieves T7 and T8, but does not satisfy the requirement of 85% for a T9 class filter. Therefore, this filter is classified as a T8 filter.

**FIGURE 3: THIRD PARTY FILTER TEST REPORT**

TEST NO. 00-246-7C

**SAMPLE TEST REPORT**

**ISO 29461-1 2021**
**Air Filter Test Result Summary**

Page 1 of 4

**Counter Information**

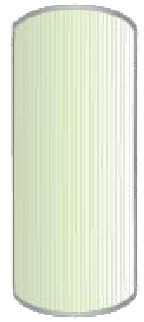
| | |
|---|---|
| Manufacturer | ABC, Inc. |
| Model No. | 2468 |

**Test Conditions**

| | |
|---|---|
| Test Flow Rate ($m^3/h$) | 1150 |
| Test Aerosol | Aerosolized KCl & DEHS |
| Temperature (Deg C) | 20.0 |
| Relative Humidity (%) | 45.0 |
| Barometer (kPa) | 97.90 |
| Dust Type | ISO Fine |

**Filter Description**

| | |
|---|---|
| Manufacturer | Global Filter Manufacurer |
| Filter Model | Air Filter Cylinder |
| Part Number | ACE135792468 |
| Dimensions | 660 x 325 mm |
| Type of Media | Synthetic |
| Media Area | $19m^2$ |
| Construction | Metal/Synthetic |
| Filter/Media Electrostatic Charge | N A |
| Media Color | White |
| Media Adhesive | N/A |
| Sample Procurement | New From Manufacturer |
| Initial Filter Weight (g) | 4881 |
| Final Device Weight (g) | 5701 |
| Initial Arrestance (%) | >95% |
| Initial Pressure Drop (Pa) | 149 |



**DEHS Size .03 - 1.0 and KCL Size 1.0 - 10.0**

| Range (μm) | Geo. Mean | Initial Efficiency (%) | Discharged Efficiency (%) | Upstream Number of Particles | |
|---|---|---|---|---|---|
| | | | | Pre | Post |
| 0.3-0.4 | 0.35 | 72 | 71 | 690895 | 787431 |
| 0.4-0.55 | 0.47 | 80 | 79 | 555845 | 628354 |
| 0.55-0.7 | 0.62 | 86 | 85 | 320193 | 362057 |
| 0.7-1.0 | 0.84 | 92 | 91 | 324917 | 374980 |
| 1.0-1.3 | 1.14 | 96 | 95 | 10070 | 66060 |
| 1.3-1.6 | 1.44 | 98 | 97 | 4873 | 33653 |
| 1.6-2.0 | 1.88 | 98 | 98 | 8307 | 69210 |
| 2.0-3.0 | 2.57 | 99 | 99 | 3015 | 33949 |
| 3.0-4.0 | 3.46 | 100 | 100 | 1090 | 13120 |
| 4.0-5.5 | 4.69 | 100 | 100 | 647 | 7334 |
| 5.5-7.0 | 6.2 | 100 | 100 | 305 | 2396 |
| 7.0-10.0 | 8.37 | 100 | 100 | 288 | 1996 |

***Reporting Data***

| | $ePM_1$ | $ePM_{2,5}$ | $ePM_{10}$ |
|---|---|---|---|
| ***Minimum*** | ***80%*** | ***86%*** | ***--*** |
| ***Average*** | ***81%*** | ***86%*** | ***96%*** |
| ***Reported*** | ***80%*** | ***85%*** | ***>95%*** |

** Any Reporting value of N/A shows the minimum efficiency is below 50% for that ePM value*

| | |
|---|---|
| **ISO 29461-1 Classification** | **ISO T8** |

**Comments** **Tested For:** **Global Filter Manufacturer**

**Device Condition:** **New**

**Final Pressure Drop (Pa)** **625 Pa**
**Total Dust Captured (gms)** **2030**
**Average Arrestance (%)** **>95%**

The results of this test relate only to the test device in the condition stated herein. The performance results cannot by themselves be quantitatively applied to predict filtration performance in all "real life" environments.

Test Operator Information | Test Performed by: TB | Approved By: | Completion Date: 3-Mar-22

ISO 29461-1 2021 3-3-22

## WHAT MAKES ISO 29461-1 DIFFERENT?

In order to understand what differentiates ISO standard 29461-1 from the myriad of other tests that are currently in use, it is important to view the ways in which turbomachinery filters differ from the filters that those other test standards are designed for. Then, one can realize how ISO 29461-1 truly addresses the needs of the turbomachinery industry as a standalone test.

First, the dust loading that turbomachinery filters typically experience is significantly higher than filters in the comfort or cleanroom industries. Filters in the turbomachinery industry may often be located in heavy industrial areas with large concentrations of fine particulate or in regions that experience periodic dust and sand storms that subject the filters to dust loading that is higher than that of a clean room by several orders of magnitude. It is for this reason that the dust holding capacity of all filters, regardless of efficiency, is measured and reported within an ISO 29461-1 test report. Furthermore, the final resistance for dust loading has been increased from ISO 16890, which better reflects real world use in the turbomachinery industry. ISO 29461-1 requires filters to be loaded to a final resistance of 375 Pa for coarse grade filters (T1-T4) and 625 Pa for all other filter grades (T5-T13). Additionally, to improve the accuracy of results the initial gravimetric arrestance of coarse grade filters is based on the first 100 grams of dust loading in ISO 29461-1, compared to the first 30 grams of loading in ISO 16890.

The second key difference for the new standard is that it considers only the minimum efficiency of the filter when classifying the medium and high efficiency filters in classes T6-T13. The typical service life of a filter in the turbomachinery industry is quite long relative to the period in which an electrostatically charged filter maintains its initial efficiency. As will soon be shown in this document, factoring charged efficiency in these filters' ratings can drastically overestimate the performance of the filter over its entire life. With ISO 29461-1, the user can be confident that the filter will achieve the rated efficiency throughout its service life.

Another aspect of ISO 29461-1 that differs from existing test standards is a simple characteristic that no other standard offers: classification of filters across the entire spectrum of efficiencies, from coarse grade filters up to HEPA grade filters. One of the key points of emphasis that should become apparent is that ISO 29461-1 is not intended to be another test that is simply added to all of the others. Instead, it is designed to consolidate the relevant aspects of the existing tests to create a new standard that can replace the other tests for the turbomachinery industry. A single standard that encompasses the entirety of filter efficiencies used by the industry is thus critical to accomplishing that objective.

Within the turbomachinery industry, there is a need to objectively rate filters that have already been in use in the field for a period of time. ISO 29461-1 is well-suited for such testing, as the filter is able to be classified as it is received. Therefore, used filters can be tested and given an official T rating per the standard unlike in many previous standards where a dust loading phase would be needed in order to determine the filter efficiency.

Finally, ISO 29461-1 addresses the need to test filters at a higher volumetric flow rate than is specified in existing standards such as ISO 16890. The upper limit of volumetric flow for a ISO 29461-1 test is 8500 m3/h, compared with 5400 m3/h for ISO 16890. The higher value allows users to compare filters for applications that require higher velocities such as those that can be found on offshore rigs.

## EXAMPLES OF ISO 29461-1 IN USE

How do the differences mentioned in the previous section combine to help turbomachinery operators make the most informed decision on how to best protect their equipment? A couple of scenarios that make this very clear.

In the first example shown in Figure 4, the choice between two filters is to be made. Each filter has similar resistance and efficiency. In fact, each of these filters would be rated as an E10 filter per EN1822 or ISO 29463. Thus, the information provided from the existing standards would leave an end user with a difficult decision, and filter price may become the determining factor.

ISO 29461 adds a critical piece of information needed to judge the relative performance of these two filters – the dust holding capacity. For the first time, EPA and HEPA class filters are required to have dust holding capacity tested in ISO 29461-1. The additional information gives us a key metric to differentiate the relative performance between these two filters.

The second example will consider the differences in real-world performance that users may experience if they are basing their filter choice on the efficiency rating of the current standards. The example in Figure 5 shows the efficiency of two filters over time. These filters were installed in a mobile laboratory at a gas turbine site. Therefore, they were subjected to the same environmental effects and particulate concentration as a filter in that housing. Two things become quite obvious when viewing this chart: the efficiency of one of the filters experiences a rapid decrease over the first two months of the test, and this same filter does not experience an appreciable increase in efficiency over the subsequent three months.

This example shows the dramatic effect that allowing initial efficiency to factor into an electrostatically charged filter's rating has in misrepresenting what kind of protection it will provide to the turbomachinery equipment over the filter's expected life. ASHRAE 52.2 may have rated this filter as a MERV 16, but it

**FIGURE 4: FILTER PERFORMANCE COMPARISON FOR PRESSURE DROP, EFFICIENCY AND DUST HOLDING CAPACITY**

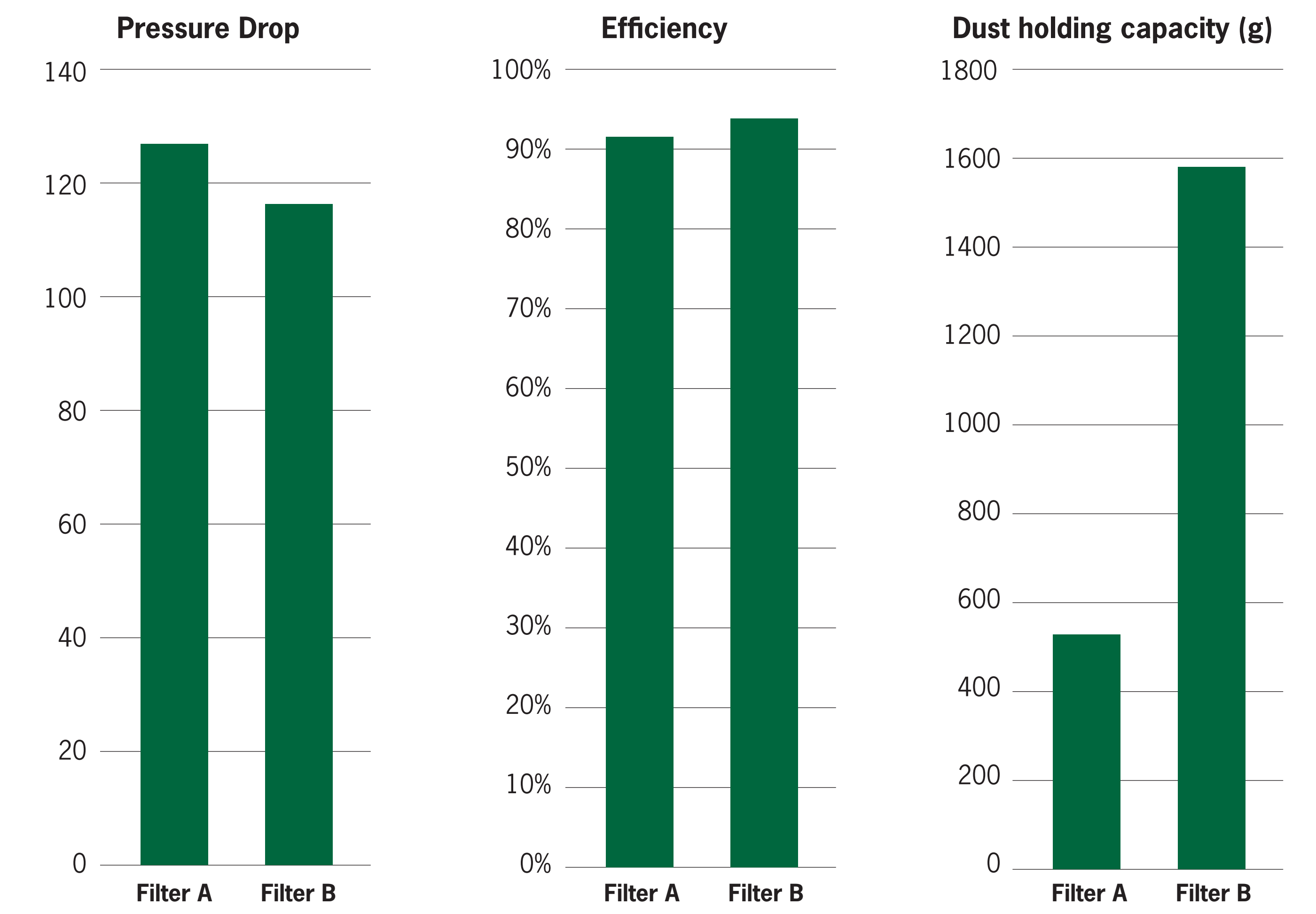
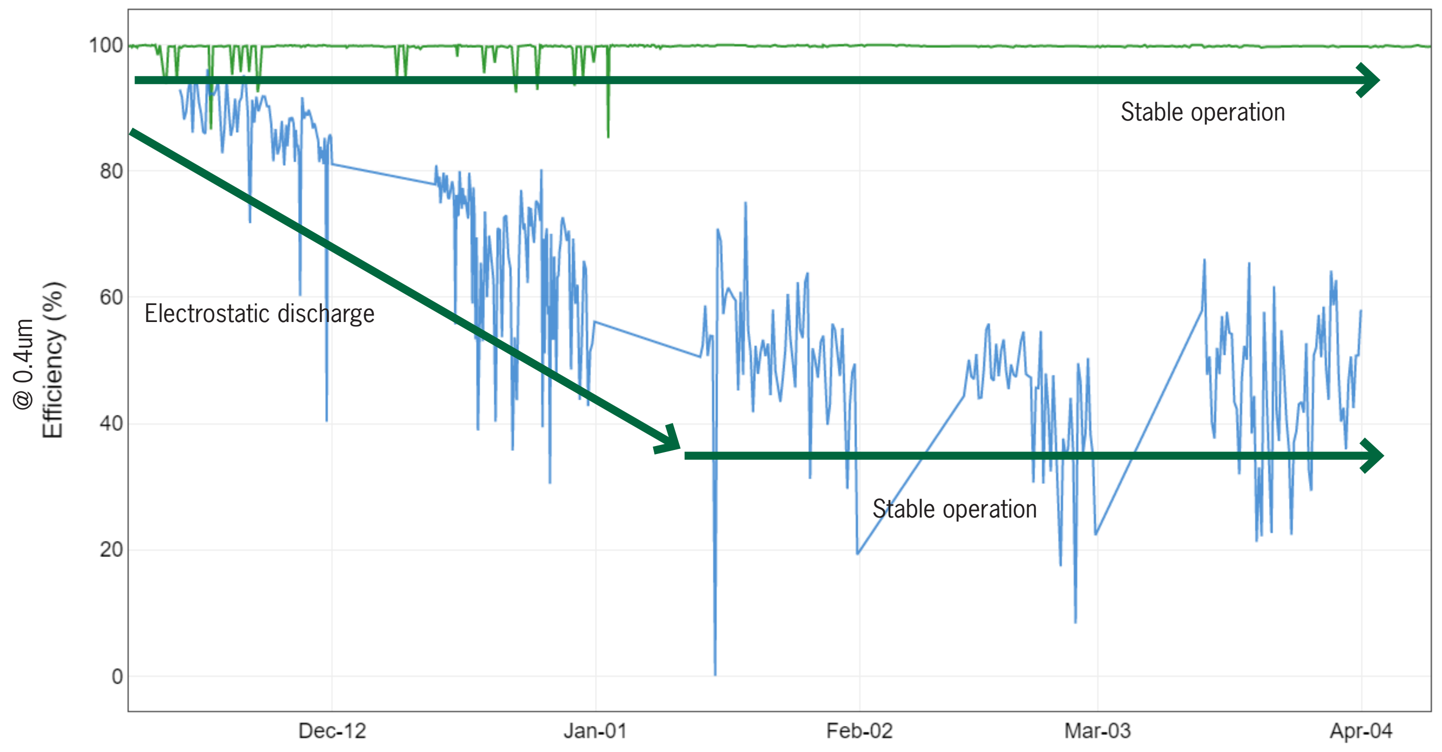



**FIGURE 5: FILTER COMPARISON FOR AN ELECTORSTATICALLY CHARGED FILTER VS**



can be seen that it hardly performs at that level for the majority of its useful time in service.

The second thing that this example illustrates is the outsized effect that factoring dust loaded efficiency, as is done in EN779, can have on the filter's expected performance in the real world. For example, an F9 filter rated per EN779:2012 is required to have a minimum efficiency of only 70% and an average efficiency with dust loading of 95%. In many turbomachinery applications, a significant efficiency increase over time is not observed until many months have passed. Therefore, factoring the filter's dust loaded efficiency can again give an inflated measure of performance that will not be seen in the real world.

## UPCOMING DEVELOPMENTS IN ISO 29461

In addition the ISO 29461-1:2021, which is designed to measure and rate the efficiency of turbomachinery filters, the ISO 29461 family of standards is designed to rate several important aspects of filter performance. Of particular note are:

- ISO 29461-1:2021, efficiency measurement
- Upcoming ISO 29461-3, mechanical integrity of filter elements
- Upcoming ISO 29461-7, filter element endurance test in fog and mist

ISO 29461-3 and ISO 29461-7 both aim to bring standardization to very challenging aspects of filtration where no current standards exist: mechanical integrity of filters and performance in wet conditions. Currently a patchwork of standards exist from turbine manufacturers and operators, but no international standard is in use to define mechanical integrity or water handling despite their importance.

Turbomachinery differ from most air filter applications in that an enormous amount of power is available to provide flow at extremely high pressure drop values, adding importance to maintaining the mechanical integrity of filter elements. While a blower in comfort air applications may only be able to produce a few hundred pascal of static pressure across a filter element, turbomachinery operators and manufacturer typically require air filters to be tested to thousands of pascal of static pressure without structural failure. While most filters would ideally be replaced long before these values are reached, upset conditions can occur rapidly increasing the static pressure drop of filters, requiring accurate measurement of static pressure and quick reduction of turbine rotating speed to limit static pressure on filters. In case of failure in either of these systems, it is important that the filters can withstand extremely high static pressures without collapsing and shedding of components that can be carried downstream to the turbine blades, potentially causing catastrophic failure of the engine itself. ISO 29461-3 defines a test method for measuring the integrity of filter elements and determining the maximum pressure filters can withstand, to easily compare various filter elements.

Many turbomachinery also operate in wet conditions exposed to rain, fog and mist. This becomes important to operators to ensure that filters remain both hydrophobic to prevent the bypass of dissolved contaminants, as well as ensure pressure drop remains stable when exposed to precipitation so that the turbomachine can remain operating at full load no matter the ambient conditions. ISO 29461-7 aims to answer both questions, defining a method of spraying a fine fog on filters over a three hour period to determine both the pressure rise, in addition to measuring both the amount of water downstream with enough precision to determine the presence of even a single drop of water penetrating through the filter element to ensure the selected filters are completely hydrophobic.

## ADDITIONAL TOOLS TO USE WITH ISO 29461-1

Filtration standards today revolve around how efficiently a filter can stop air particulates from reaching the turbine. For gas turbines, while filter efficiency is important, it does not show the whole picture. While a T10 may be better at stopping particles than a T9, how does it affect turbine performance? Meanwhile the pressure drop caused by an air filter limits a turbine's ability to do useful work, but by how much? The Value Rating converts an air filter's performance into real-world impact, so you can decide what's best for your operation.

Air filters will impact gas turbine performance by two main mechanisms: fouling and pressure drop.

Fouling is the accumulation of fine particles (<2µm) on air compressor blades. The buildup of dirt changes the air profile of the blades, resulting in an overall lower compressor efficiency. High efficiency filters using fine fibres are required to stop the large amounts of particulates in order to minimize fouling.

Any grade of filtration adds resistance to the inlet airflow and makes the turbomachinery work harder to pull air through them, quantified as pressure drop. The more particulates that get collected over time, the higher the pressure drop rises. This affects both the available power output and the heat rate of the gas turbine. Therefore, while the air might be cleaner, a higher efficiency filter has the adverse effect of limiting the useful work a turbine can perform.

The Value Rating aims to compute information useful to real-world gas turbine operation. Fouling and pressure drop impact the fuel consumption and power output of a gas turbine. Combining them allows us to predict how a gas turbine will perform. At the same time, the amount of fuel consumed directly impacts how much $CO_2$ is emitted by the engine. In a time where carbon footprint is a major concern also this is a valuable metric to predict and minimize.

The Value Rating aims at facilitating the selection of final filter based on the relative impact a filters' efficiency, dust loading behaviour, and pressure drop have on the gas turbine.

Calculating the impact of pressure drop on power output is relatively straightforward, as each kPa of reduced inlet pressure drop due to changes in barometric pressure or increased resistance across the filter affect turbine performance in a similar way. As power output versus barometric pressure tables are widely available, the impact on both power output and heat rate can be calculated.

Note that while the initial pressure drop of the filters are important, it is also critical to take into account the way the filters will load and the expected rise in filter pressure drop over time. The Value Rating takes this into account by evaluating both the pressure drop across the filter new and clean, as well as after 250 grams of accumulated dust to give a factor to the rate of pressure drop rise during use.

The impact of efficiency is slightly harder to calculate, since the impact of dust buildup and fouling on different filters can be quite variable. Camfil has been tracking engine output degradation through the PowerEye condition monitoring program worldwide since 2016, and the value rating uses the typical fouling data we have been collecting .

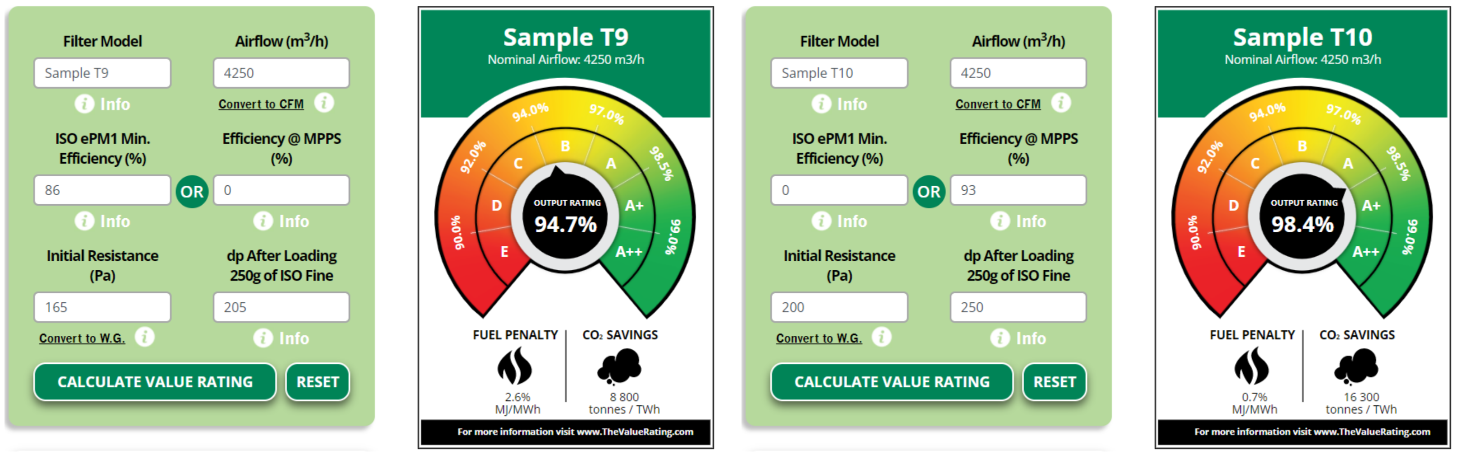
Overall, The Value Rating makes comparing filter performance easy. Figure 6 shows that comparing a T9 filter with a pressure drop of 165 Pa to a T10 filter with a pressure drop of 200 Pa is as simple as using the online calculator, which shows the turbine output rating increasing from 94.7% to 98.4%. In this particular case, the increased protection offered by the higher efficiency filter more than makes up for the increased pressure drop, and the engine is able to generate 3.7% more power while producing 7 500 fewer tonnes of CO2 per TWh.

## SUMMARY

For the first time, a single standard has been developed to address the technical needs of turbomachinery operators, allowing for easy comparison of performance among filters of a wide range of efficiencies based on the performance characteristics that matter most. Specifying filters rated to this standard ensures that you are one step closer to selecting the right filter for your turbomachinery application. If you are comparing filters, make sure they are tested according to ISO 29461-1, then use third party tools such as The Value Rating to calculate the impact that the filters will have on your gas turbine.

- Visit www.TheValueRating.com to use the calculator.
- Learn more about PowerEye, the first predictive analytics service for gas turbines and air filters, and how it can help improve the power output of your turbines.
- For more information on this whitepaper, please contact your nearest local Camfil representative.

**FIGURE 6: THE VALUE RATING T9 VERSUS T10 FILTER**



## Camfil – a global leader in air filters and clean air solutions

For more than half a century, Camfil has been helping people breathe cleaner air. As a leading manufacturer of premium clean air solutions, we provide commercial and industrial systems for air filtration and air pollution control that improve worker and equipment productivity, minimize energy use, and benefit human health and the environment. We firmly believe that the best solutions for our customers are the best solutions for our planet, too. That's why every step of the way – from design to delivery and across the product life cycle – we consider the impact of what we do on people and on the world around us. Through a fresh approach to problem-solving, innovative design, precise process control and a strong customer focus we aim to conserve more, use less and find better ways – so we can all breathe easier.

The Camfil Group is headquartered in Stockholm, Sweden, and has 31 manufacturing sites, 6 R&D centres, local sales offices in over 35 countries, and about 5200 employees and growing. We proudly serve and support customers in a wide variety of industries and in communities across the world. To discover how Camfil can help you to protect people, processes and the environment, visit us at www.camfil.com.