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Critical Environment Solutions

Airflow Uniformity and Fan Filter Units

Airflow uniformity is critical for applications requiring adherence to ISO, FDA or cGMP cleanliness requirements. However, many Fan/Filter Units (FFUs) that appear to meet nominal cleanliness requirements fail to provide the uniform velocity and flow on which your processes depend.

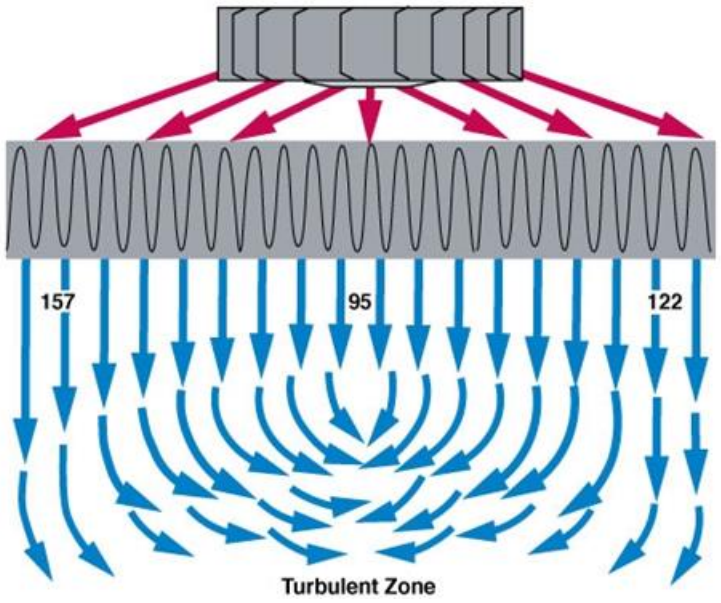
What is airflow uniformity?
Certifiers measure air velocity at multiple (typically six or eight) locations across a filter face. Ideally, air speed measurements taken at these locations vary by no more than 15% from mean values. For example, in an ISO 5 laminar flow system with a specified minimum average air velocity of 90 fpm (feet per minute), the minimum air speed measurements typically should be in the range of 80 – 100 fpm.

Discrepancies greater than this create turbulence as the faster air streams (lamina) are drawn into the localized areas of lower pressure created by the slower ones.

The greater the airspeed differential, the more likely and the more severe this turbulence becomes, resulting in swirling that can suspend minute particles rather than sweeping them downward and out of the laminar flow system. Worse, localized turbulence can create second-pass air that swirls up and re-enters the downward flow, drawing particles upward and redistributing them into other locations inside the classified work space. Under such conditions, a cleanroom or laminar flow cabinet fails to meet ISO laminar flow conditions – and ceases to be a clean!

How does airflow uniformity differ from airflow average?
Some FFU manufacturers specify an average airflow (or average velocity) that can mask serious performance deficiencies.

In the case below, a Fan/Filter Unit produces an average airflow of 1004 CFM (cubic feet per minute) and average air speed of 125 fpm on high speed, perfectly acceptable performance values. However, individual lamina measurements demonstrate substantially non-uniform filter face velocity and flow, with discrepancies of over 60% at various locations across the filter (30% from mean values). FFU performance will create areas of turbulence due to this lack of uniformity.



Turbulent zone created by non-uniform velocity

How does a Fan/Filter Unit achieve airflow uniformity?
Several design and construction features help to ensure uniform FFU performance in Terra-manufactured FFUs. Most importantly, these FFUs include an internal baffling system and plenum chamber that equalize the air pressure across the filter face as the air exits the motorized impeller. Uniform inlet pressure correlates to uniform exit velocity, assuming a high-quality filter medium of uniform density and flow resistance.

In addition, Terra FFUs include a perforated anodized aluminum exit plate that both protects the filter medium against damage and helps to reinforce even air distribution across the filter face.

Finally, sound-deadening foam contributes to the rigidity of the structure while dampening noise and vibration, resulting in whisper-quiet operation that won't interfere with operator health or productivity.

Although these measures add to the manufacturing cost of Terra FFUs, they contribute substantially to their performance (see comparative data below).

Turbulent Performance: Fan/Filter Unit with *non-uniform* airflow
Measurements of non-baffled 2' x 4' HEPA Fan/Filter Unit with AC impellerized motor, taken 6" from filter face

Speed Setting:	High
Noise:	73 dBA
Average Speed:	125.5 fpm
Average Flow:	1004 CFM
Max. Deviation from Mean:	27.5%

High Speed		
Top Right: **157 fpm**	Top Center: **95 fpm**	Top Right: **122 fpm**
Bottom Left: **160 fpm**	Bottom Center: **109 fpm**	Bottom Right: **110 fpm**

Medium Speed		
Top Right: **58 fpm**	Top Center: **47 fpm**	Top Right: **53 fpm**
Bottom Left: **61 fpm**	Bottom Center: **39 fpm**	Bottom Right: **34 fpm**

Speed Setting:	Medium
Noise:	60 dBA
Average Speed:	48.7 fpm
Average Flow:	389 CFM
Max. Deviation from Mean:	30%

Speed Setting:	Low
Noise:	55 dBA
Average Speed:	7.6 fpm
Average Flow:	61 CFM
Max. Deviation from Mean:	Out of Spec

Low Speed		
Top Right: **0 fpm**	Top Center: **0 fpm**	Top Right: **0 fpm**
Bottom Left: **46 fpm**	Bottom Center: **0 fpm**	Bottom Right: **0 fpm**

Laminar Performance: Terra Fan/Filter Unit with *uniform* airflow

Measurements Terra's 2' x 4' HEPA Fan/Filter Unit (No. 6601-24-H) with AC impellerized motor, taken 6" from filter face

Speed Setting:	High
Noise:	55 dBA
Average Speed:	139 fpm
Average Flow:	980 CFM
Max. Deviation from Mean:	13%

High Speed		
Top Right: **150 fpm**	Top Center: **125 fpm**	Top Right: **149 fpm**
Bottom Left: **137 fpm**	Bottom Center: **121 fpm**	Bottom Right: **154 fpm**

Medium Speed		
Top Right: **131 fpm**	Top Center: **120 fpm**	Top Right: **111 fpm**
Bottom Left: **121 fpm**	Bottom Center: **108 fpm**	Bottom Right: **112 fpm**

Speed Setting:	Medium
Noise:	54 dBA
Average Speed:	117 fpm
Average Flow:	823 CFM
Max. Deviation from Mean:	12%

Speed Setting:	Low
Noise:	53 dBA
Average Speed:	100 fpm
Average Flow:	703 CFM
Max. Deviation from Mean:	5%

Low Speed		
Top Right: **105 fpm**	Top Center: **96 fpm**	Top Right: **103 fpm**
Bottom Left: **98 fpm**	Bottom Center: **96 fpm**	Bottom Right: **105 fpm**

Revised 5-27-2015