

## 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.

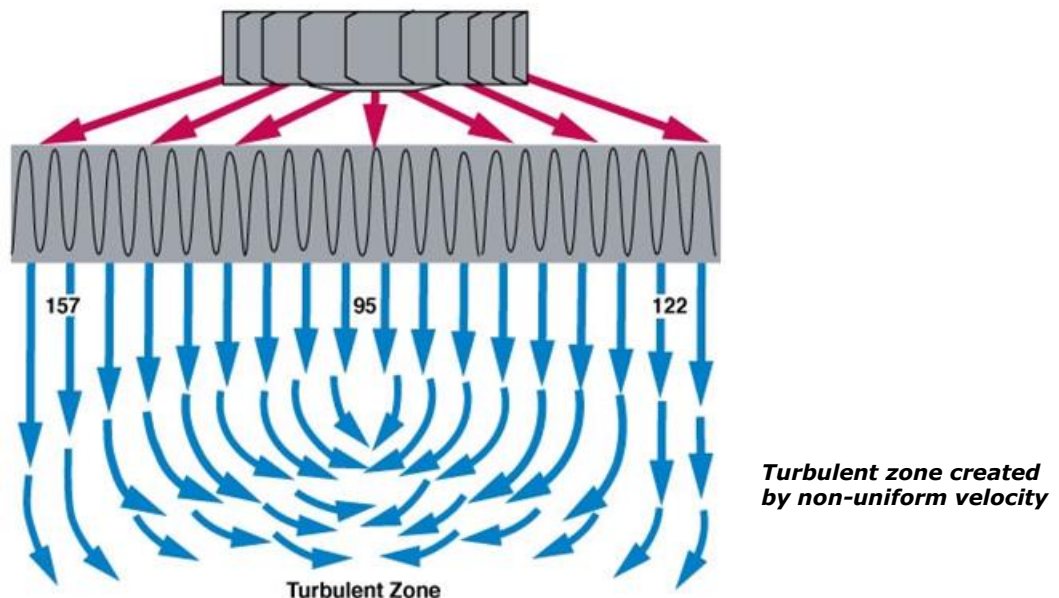
Discrepancies greater than this create turbulence as the faster air streams (lamina) are drawn into the localized areas of lower pressure created by the slower ones.

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.





**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	<b>High Speed</b>		
Noise:	73 dBA	Top Right:	Top Center:	Top Right:
Average Speed:	125.5 fpm	<b>157 fpm</b>	<b>95 fpm</b>	<b>122 fpm</b>
Average Flow:	1004 CFM	Bottom	Bottom	Bottom
Max. Deviation from Mean:	27.5%	Left:	Center:	Right:
		<b>160 fpm</b>	<b>109 fpm</b>	<b>110 fpm</b>

<b>Medium Speed</b>			Speed Setting:	Medium
Top Right:	Top Center:	Top Right:	Noise:	60 dBA
<b>58 fpm</b>	<b>47 fpm</b>	<b>53 fpm</b>	Average Speed:	48.7 fpm
Bottom	Bottom	Bottom	Average Flow:	389 CFM
Left:	Center:	Right:	Max. Deviation from Mean:	30%
<b>61 fpm</b>	<b>39 fpm</b>	<b>34 fpm</b>		

Speed Setting:	Low	<b>Low Speed</b>		
Noise:	55 dBA	Top Right:	Top Center:	Top Right:
Average Speed:	7.6 fpm	<b>0 fpm</b>	<b>0 fpm</b>	<b>0 fpm</b>
Average Flow:	61 CFM	Bottom	Bottom	Bottom
Max. Deviation from Mean:	Out of Spec	Left:	Center:	Right:
		<b>46 fpm</b>	<b>0 fpm</b>	<b>0 fpm</b>

**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%

<b>High Speed</b>		
Top Right: <b>150 fpm</b>	Top Center: <b>125 fpm</b>	Top Right: <b>149 fpm</b>
Bottom Left: <b>137 fpm</b>	Bottom Center: <b>121 fpm</b>	Bottom Right: <b>154 fpm</b>

<b>Medium Speed</b>		
Top Right: <b>131 fpm</b>	Top Center: <b>120 fpm</b>	Top Right: <b>111 fpm</b>
Bottom Left: <b>121 fpm</b>	Bottom Center: <b>108 fpm</b>	Bottom Right: <b>112 fpm</b>

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%

<b>Low Speed</b>		
Top Right: <b>105 fpm</b>	Top Center: <b>96 fpm</b>	Top Right: <b>103 fpm</b>
Bottom Left: <b>98 fpm</b>	Bottom Center: <b>96 fpm</b>	Bottom Right: <b>105 fpm</b>