

# ENGINEERING REPORT

## TOPIC: Velocity Ratings for Fire/Smoke Dampers

Report No. 495:1

By Richard L. Cravy

Confusion exists in the HVAC industry regarding velocity ratings of fire/smoke dampers. This report will clarify the maximum velocity ratings of these dampers.

Underwriter's Laboratories writes the test standards to which manufacturers *qualify* combination fire/smoke dampers and their actuators for performance at extended static pressures and velocities. However, system designers should not use this performance data as the only guideline when selecting and specifying fire/smoke dampers.

Some manufacturer's specifications may read like the following:

***Model FSDXYZ is a combination fire/smoke damper with 3 vee style blades. While this model has been qualified to 3000 fpm and 4" w.g. for operation and dynamic closure in emergency fire/smoke situations, its recommended application is in HVAC duct systems with velocities to 2000 fpm and 4" w.g.***

The obvious question is, what's the difference between the manufacturer's ***qualified*** rating and the ***recommended*** application? The answer has four parts:

1. **UL555/UL555S<sup>1</sup>**
2. **Turbulence**
3. **Noise**
4. **Pressure Drop**

Let's look at these 4 parts in detail.

### 1. **UL555/UL555S**

The manufacturer's qualified rating applies to UL555/UL555S which require "under conditions of maximum recommended air flow, the dampers shall function as intended, and without damage to the dampers or their components and shall completely close, during each of three opening and closing cycles."

The 3000 feet per minute and the 4" w.g. are the velocity and pressure at which the damper *and its actuator* fulfilled the UL555/UL555S requirements.

---

<sup>1</sup> ULSSS is the Standard for Safety for Fire Dampers  
UL555S is the Standard for Safety for Leakage Rated Dampers for use in Smoke Control Systems

**RUSKIN**®

3900 Dr. Greaves Rd.  
Kansas City, MO 64030  
(816) 761-7476  
FAX (816) 765-8955  
www.ruskin.com

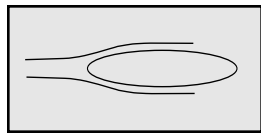
UL does not require an extended life cycle test at these velocities and pressures. Additionally, noise or pressure drop are not measured at the time of the UL test.

Ruskin has qualified both airfoil and triple V blade fire/smoke dampers to 4359 fpm at 4" w.g. with electric actuators and 4290 fpm at 4" w.g. with pneumatic actuators. The UL test is performed in ideal laminar flow conditions. It is an indication of the damper and actuator under these conditions without respect to total system performance. How a damper performs in the total system is the key consideration.

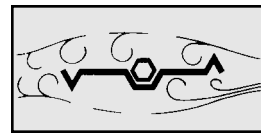
There are more important issues for the system designer to consider. These issues (parts 2 - 4 below) are the essence of the manufacturer's recommended application.

## 2. Turbulence

Turbulent flow is defined as a "fluid flow in which the velocity at a given point varies erratically in magnitude and direction."<sup>2</sup> Triple V blades are shaped so the formed grooves add strength to the single skin design. This shape, however, promotes turbulent air flow, a problem compounded at take-off branches and fan discharges. High velocities result in more turbulent air flow.



AIRFOIL



TRIPLE-V-GROOVE

## 3. Noise

Noise is a by-product of the turbulent flow created by air passage over the blade. The Air Movement and Control Association (AMCA)<sup>3</sup> recommends using triple V blade dampers in systems with velocities less than 2,000 fpm. The following chart shows the noise produced by the two main blade shapes at various velocities through the dampers. The airfoil blade results in significantly less noise than a triple V-blade.

### NOISE CRITERIA

Velocity	Blade Type	
	Airfoil	Triple V-Groove
<b>1000 FPM</b>	<b>19 NC</b>	<b>30 NC</b>
<b>2000 FPM</b>	<b>35 NC</b>	<b>46 NC</b>
<b>3000 FPM</b>	<b>45 NC</b>	<b>55 NC</b>
<b>4000 FPM</b>	<b>51 NC</b>	<b>60 NC</b>

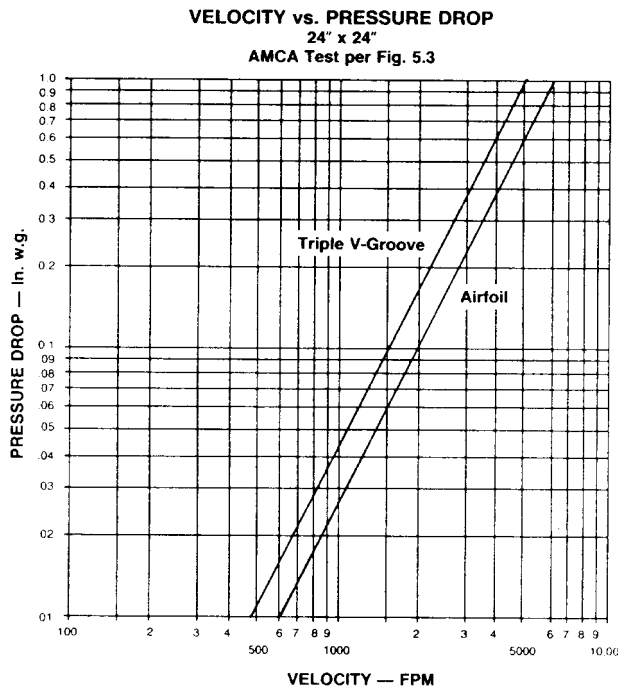
1. NC based on noise generated in third octave band with 10 db room attenuation.
2. Test conducted in accordance with ASTM Standard E477-80.

<sup>2</sup> Merriam-Webster Ninth New Collegiate Dictionary 1985

<sup>3</sup> AMCA Publication 502-89 Damper Application Manual.

#### 4. Pressure Drop

Pressure drop is the resistance to airflow across an open damper and increases as turbulent flow increases. AMCA publication 502-89 also recommends using the triple V blade in systems with velocities less than 2000 feet per minute in order to lessen the affect of pressure drop. The figure below shows pressure drop velocity for 24" x 24" dampers. Testing was performed to AMCA Standard 500.<sup>4</sup> Many systems have multiple dampers in series so static pressure drop becomes even more critical when velocities exceed 2000 fpm.



#### Conclusion

While it is true that triple V blade dampers and modified single skin type have been qualified to 3000 - 4000 fpm or more at 4" w.g., Ruskin does not recommend using these designs in systems with velocities greater than 2000 fpm. Ruskin triple V blade fire/smoke dampers do meet the 3000 fpm, 4" w.g. specification but their recommended application is 2000 feet per minute at 4" w.g. because of the reasons outlined above.

It is the responsibility of the design engineer to take into account turbulence, noise and pressure drop when designing the HVAC system. Be careful when relying on "qualified" velocity and pressure ratings for fire/smoke dampers because these ratings pertain to individual manufacturer's specific damper and actuator assemblies and have been rated without any respect to system conditions.

*For more information on this subject matter,  
please contact your local Ruskin  
representative today.*

<sup>4</sup> AMCA Publications 500-89 Test Methods for Louvers, Dampers and Shutters

***RUSKIN***®

3900 Dr. Greaves Rd.  
Kansas City, MO 64030  
(816) 761-7476  
FAX (816) 765-8955  
[www.ruskin.com](http://www.ruskin.com)