Fan Performance

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The International Authority on Air System Components
Fan Testing for Air Performance
AMCA Standards 500-D & -L

Test Damper

Piezometer Ring
Damper Pressure Drop

Nozzles
Damper Airflow

Auxiliary Fan

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**AMCA 506 Test Results**

![Graph showing AMCA 506 Test Results with an Operating Point at 600 pressure and 8 air flow.](image-url)
Speed Change

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Damper Opening

The graph shows the relationship between air flow, Q, and pressure, P, for different operating points. The black line represents the current operating point, while the red line represents the new system. The yellow arrow indicates the new operating point for the new system.
System Effect

1st Definition

Installed duct configuration does not match tested duct configuration
Installation Type D
Ducted Inlet / Ducted Outlet

Test Fan

Piezometer Ring
Fan Static Pressure

Nozzles
Fan Airflow

Auxiliary Fan

Plenum

Installed Fan

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AMCA Catalog Ratings

Performance certified is for installation type:

- UA: Free inlet, Free outlet
- UB: Free inlet, Ducted outlet
- UC: Ducted inlet, Free outlet
- UD: Ducted inlet, Ducted outlet
System Effect
2nd Definition

Even when the tested duct configuration matches the installed duct configuration, improper duct design can introduce adverse flow conditions.
Elbow Example
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AMCA Publication 201
Detailed Plenum Example

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Detailed Plenum Example

- **E-F**: Duct friction at 5000 CMH (Q) 747 Pa (duct design)
- **E**: Contraction loss-plenum to duct 50 Pa (part of duct system)
- **E**: $P_s$ energy required to create velocity at E 125 Pa (part of duct system)
- **D**: $P_v$ loss (also $P_T$ loss) at D as result of air velocity decrease 0 Pa
  - $P_s$ does not change from duct to plenum at D
- **C-D**: Outlet duct on fan as tested 0 Pa

**REQUIRED Fan $P_s$**
922 Pa

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Detailed Plenum Example

D-E duct friction at 5000CMH (Q) 747 Pa (duct design)

D contraction loss-plenum to duct 50 Pa (part of duct system)

D $P_s$ energy required to create velocity at D 125 Pa (part of duct system)

B-C SEF 149 Pa

B-C $P_v$ loss (also $P_T$ loss) at C as result of air velocity decrease 0 Pa
$P_s$ does not change from duct to plenum at C

REQUIRED Fan $P_s$ 1071 Pa

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Fan Laws for Speed Change

\[ Q_c = \left( \frac{N_c}{N} \right)^2 Q \]

\[ P_c = \left( \frac{N_c}{N} \right)^3 P \]

\[ H_c = \left( \frac{N_c}{N} \right)^3 H \]

Q, Fan Airflow Rate

P, Fan Pressure

H, Fan Power
8% Speed Change

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Plenum Example from AMCA 201

Assuming:

- Use of the same fan for both systems
- Can attain both operating points with a change in speed
- The increased in power consumption to overcome System Effect is about 25%

\[
\frac{\dot{U}(1071/922)^{0.5}}{\dot{U}} = 1.08 \quad \text{(Fan Law for pressure)}
\]
\[
\frac{\dot{U}1.08^3}{\dot{U}} = 1.25 \quad \text{(Fan Law for Power)}
\]
Ducted Fan
Fan as Tested

NO OBSTRUCTION AT FAN INLET

PV = 125Pa

FRICTION 750Pa
AT 5000 CMH

C-D duct friction
A free inlet
B-C outlet with straight duct attached for 2 or more diam.

REQUERIED Fan PS
750 Pa

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Ducted Fan

A Entrance loss-sharp edge duct 100 Pa (duct design)
A-B Duct friction at 5000CMH 750 Pa (duct design)
B SEF 1 (Elbow at Inlet) 150 Pa
C SEF 2 (Obstruction) 50 Pa
E SEF 3 (Abrupt Discharge) 150 Pa

REQUIRED Fan Ps 1200 Pa

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Inlet System Effect

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Outlet System Effect

- Actual System with System Effect
- Calculated System with No Allowance for System Effect
- System Effect Loss at Design Airflow
- Catalog Performance Curve
- Design Resistance
- Design Airflow
- Airflow Deficiency

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Speed Changes

Before Increasing Speed

- Check with the manufacturer for max safe operating speed
- Determine expected power increase
  - Motor size
  - Electric Service
- Expect more noise
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Rules of Thumb

- Minimum 2.5 duct diameters on Outlet
- Minimum 3 to 5 duct diameters on Inlet
- Avoid inlet swirl
Recommendations

- Allow enough space in the building design to allow for appropriate fan connections to the system
Recommendations

- Use allowances in the design calculations when space or other factors dictate less than optimum arrangement of the fan outlet and inlet connections.
Recommendations

Include adequate allowance for the effect of all accessories and appurtenances on the performance of the system and the fan.
Thank you