

ASET-EU

Air System Engineering and Technology Conference - Europe

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Understanding and Combating System Effects

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Learning Objectives

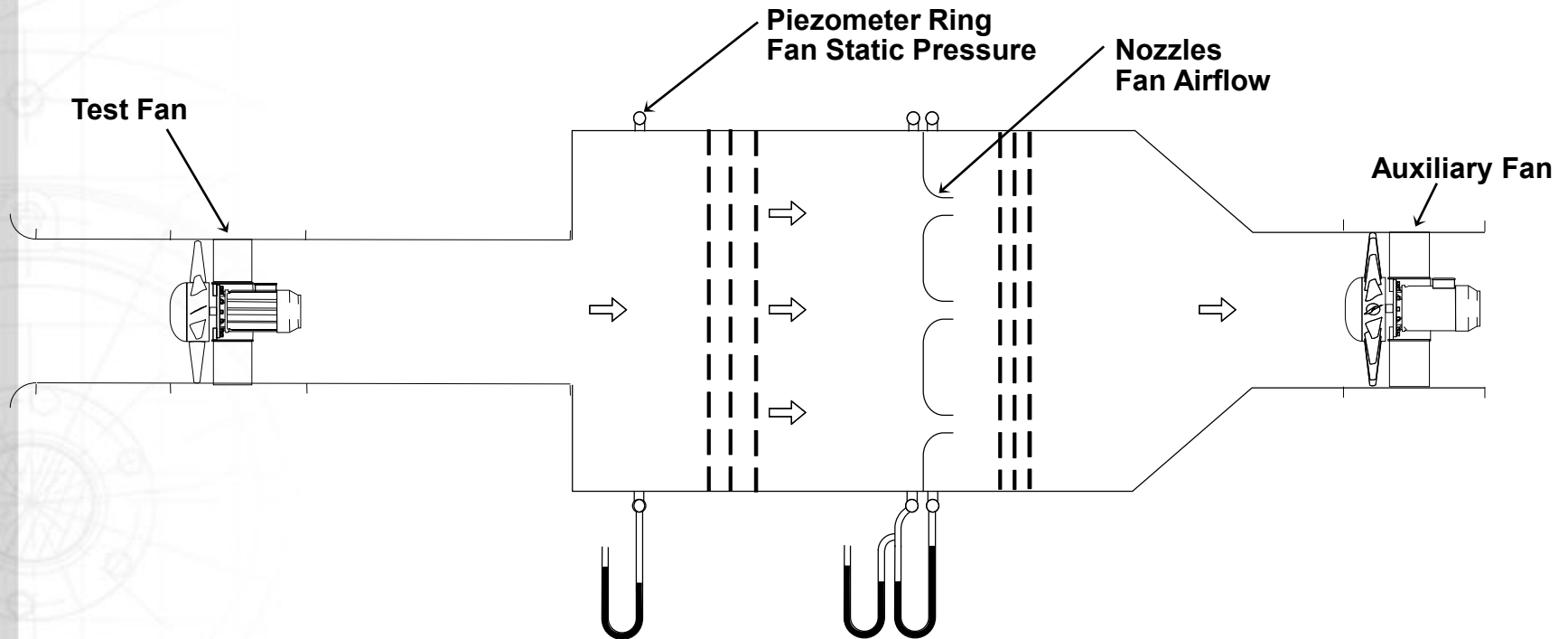
- Basic air systems
- What's System Effect?
- Inlet versus outlet System Effect
- System Effect's effect on power consumption
- Is System Effect a common occurrence?
- Rules of thumb

Basic Air Systems

Fan Air Performance Testing



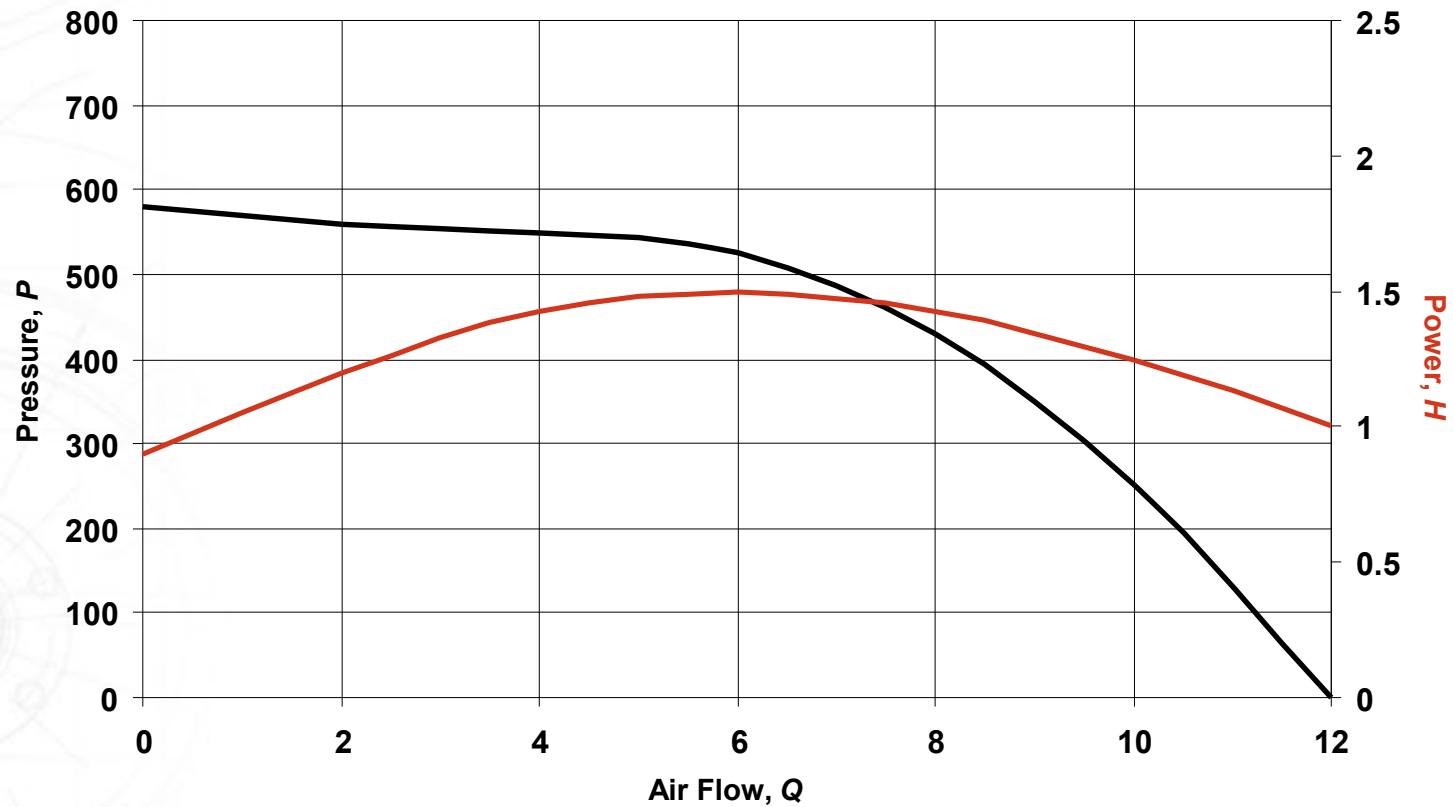
AMCA Standard 210



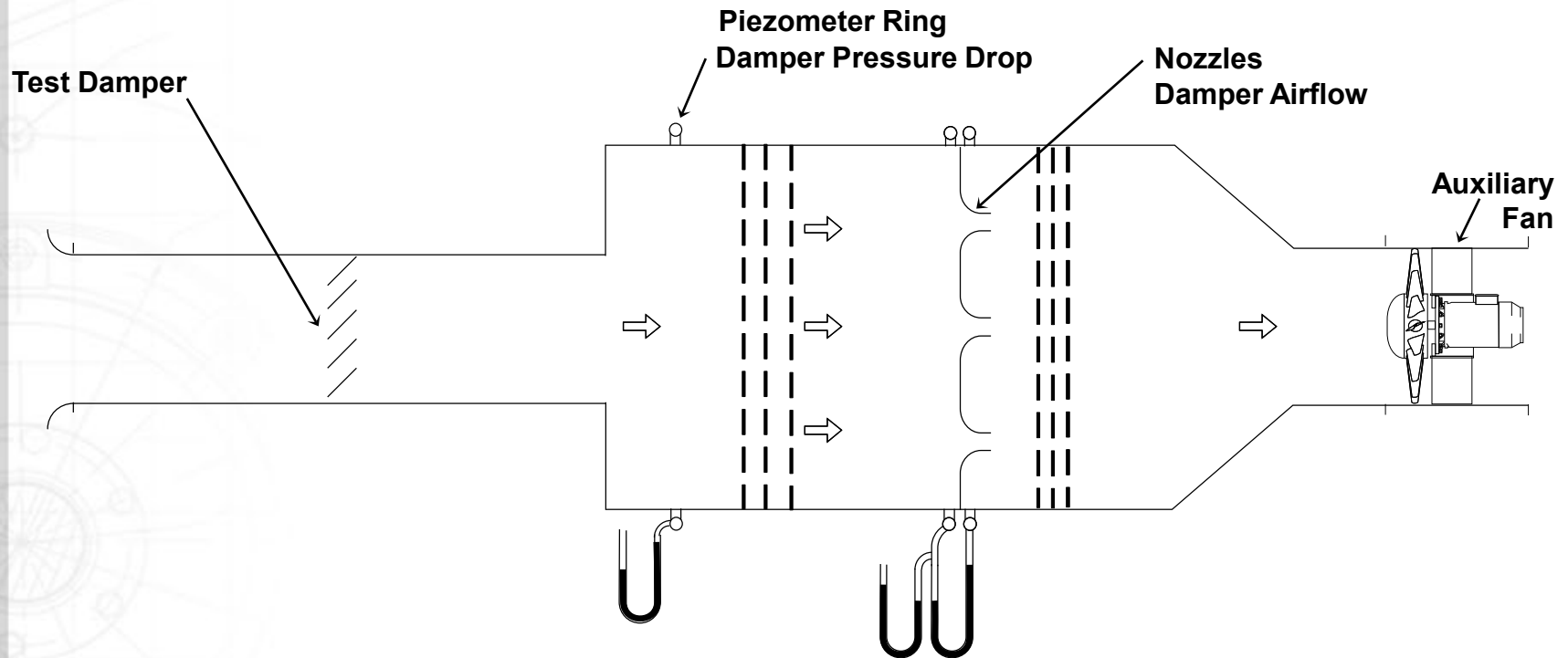
Nozzle Wall



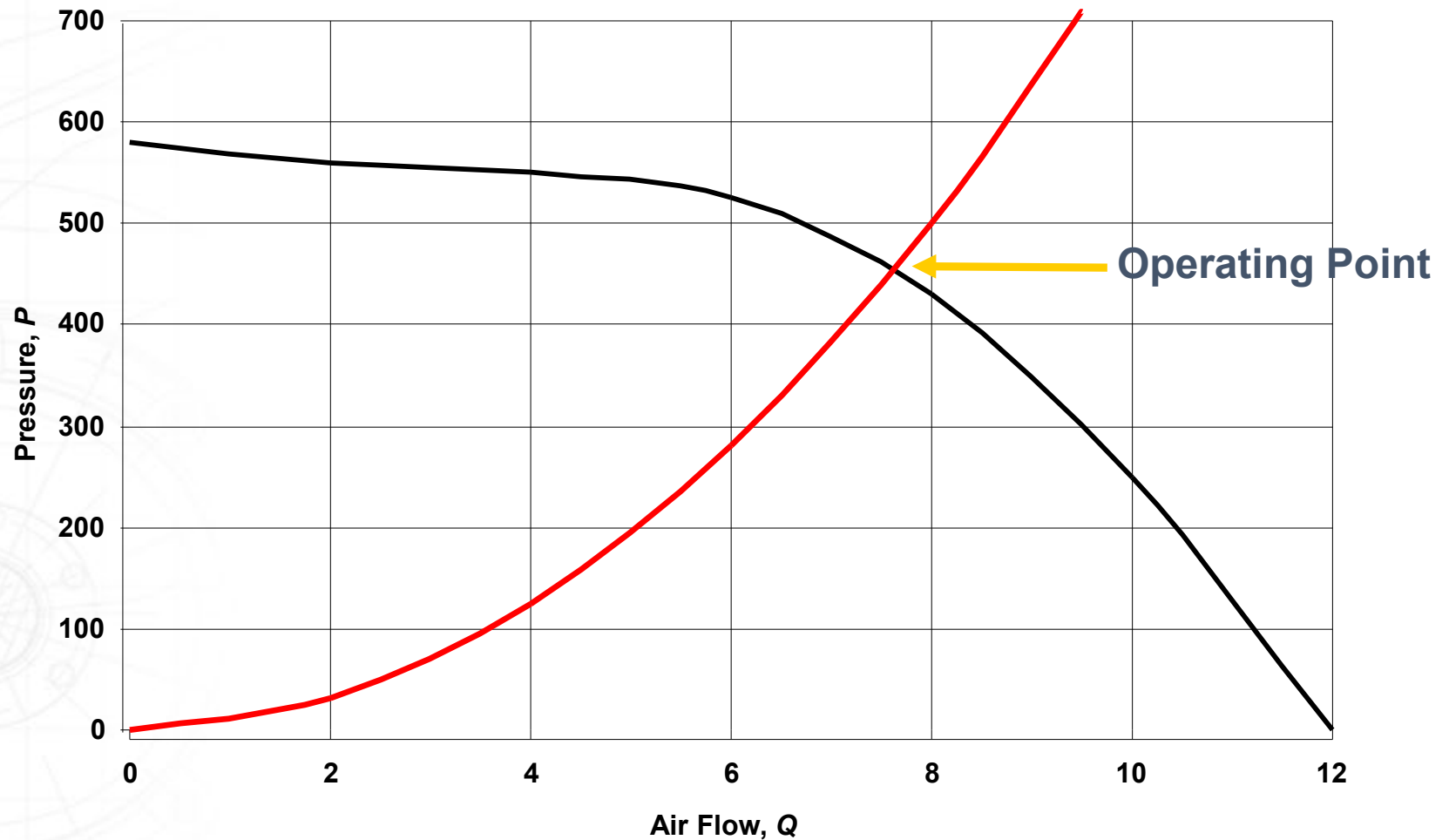
AMCA 210 Test Results



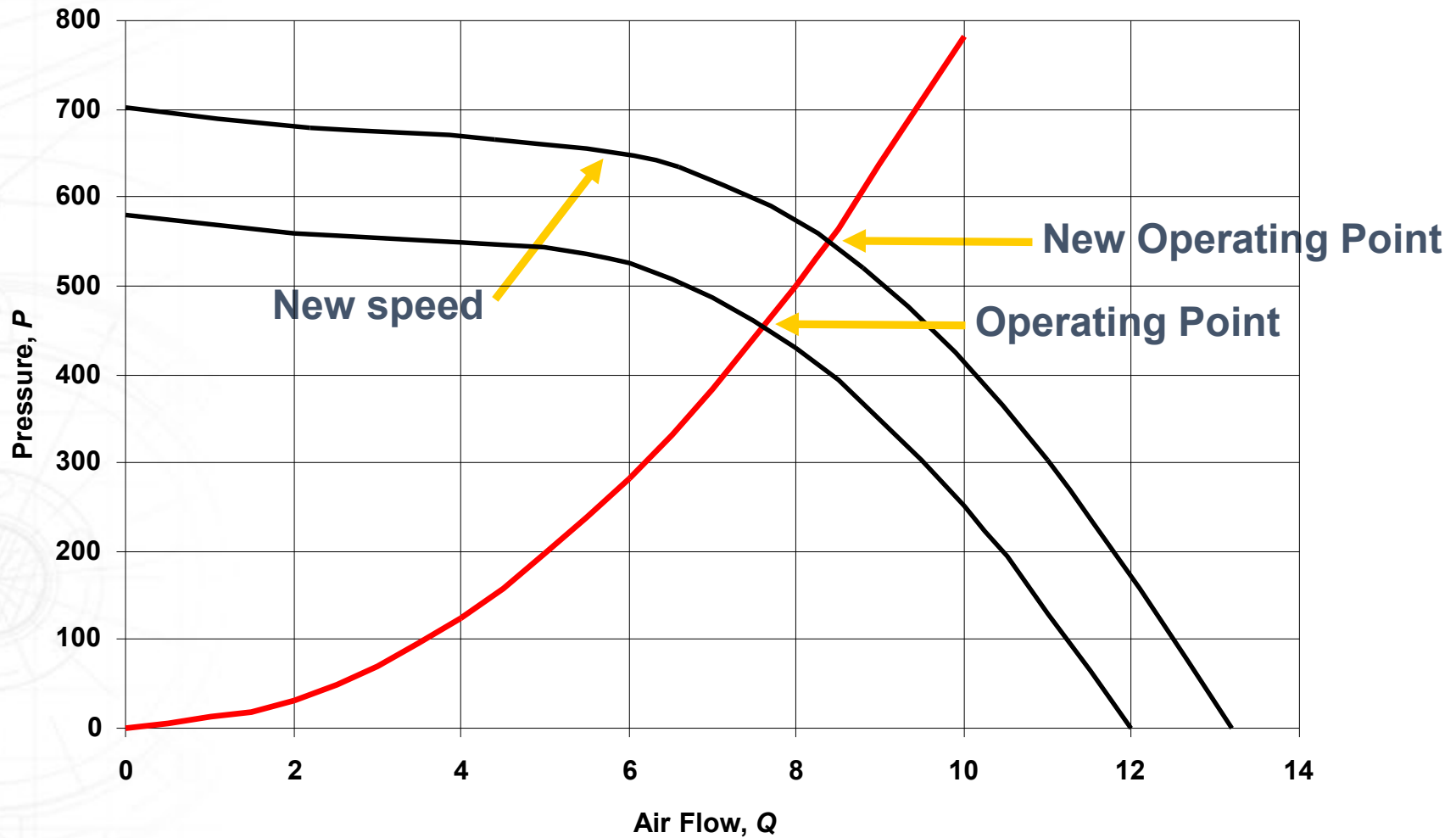
AMCA Standards 500-D & -L



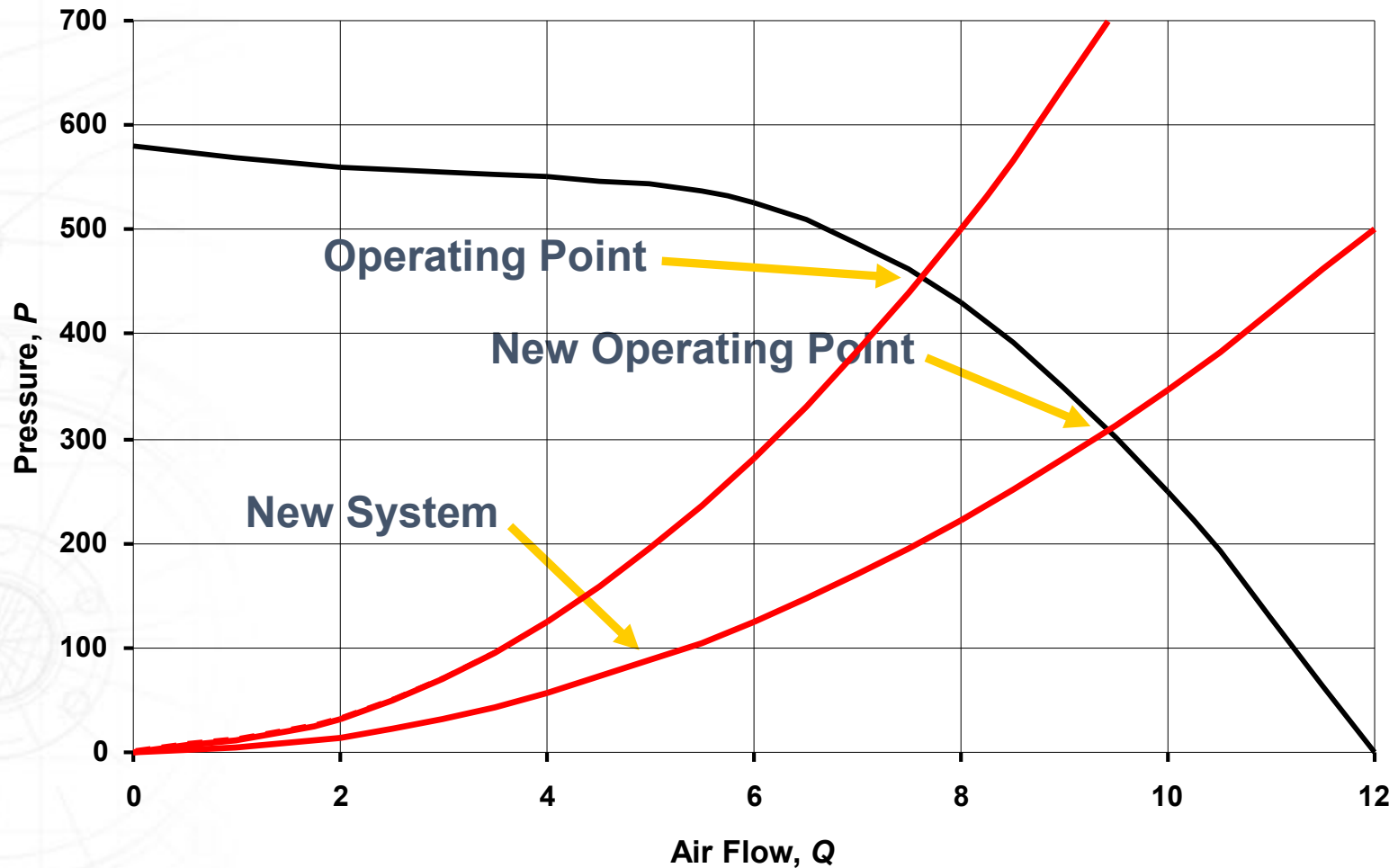
AmCA 500 Rating Test Results



Speed Change

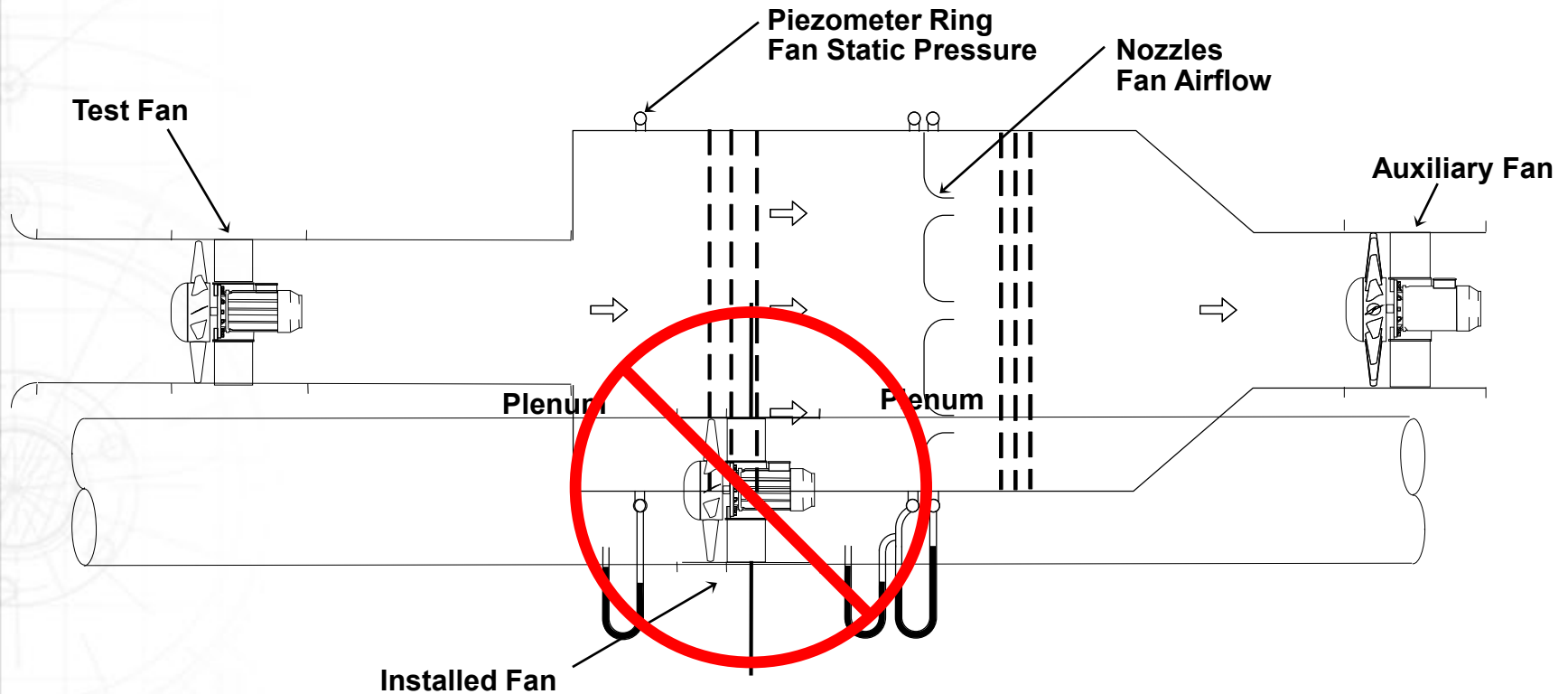


Damper Opening



What's System Effect?

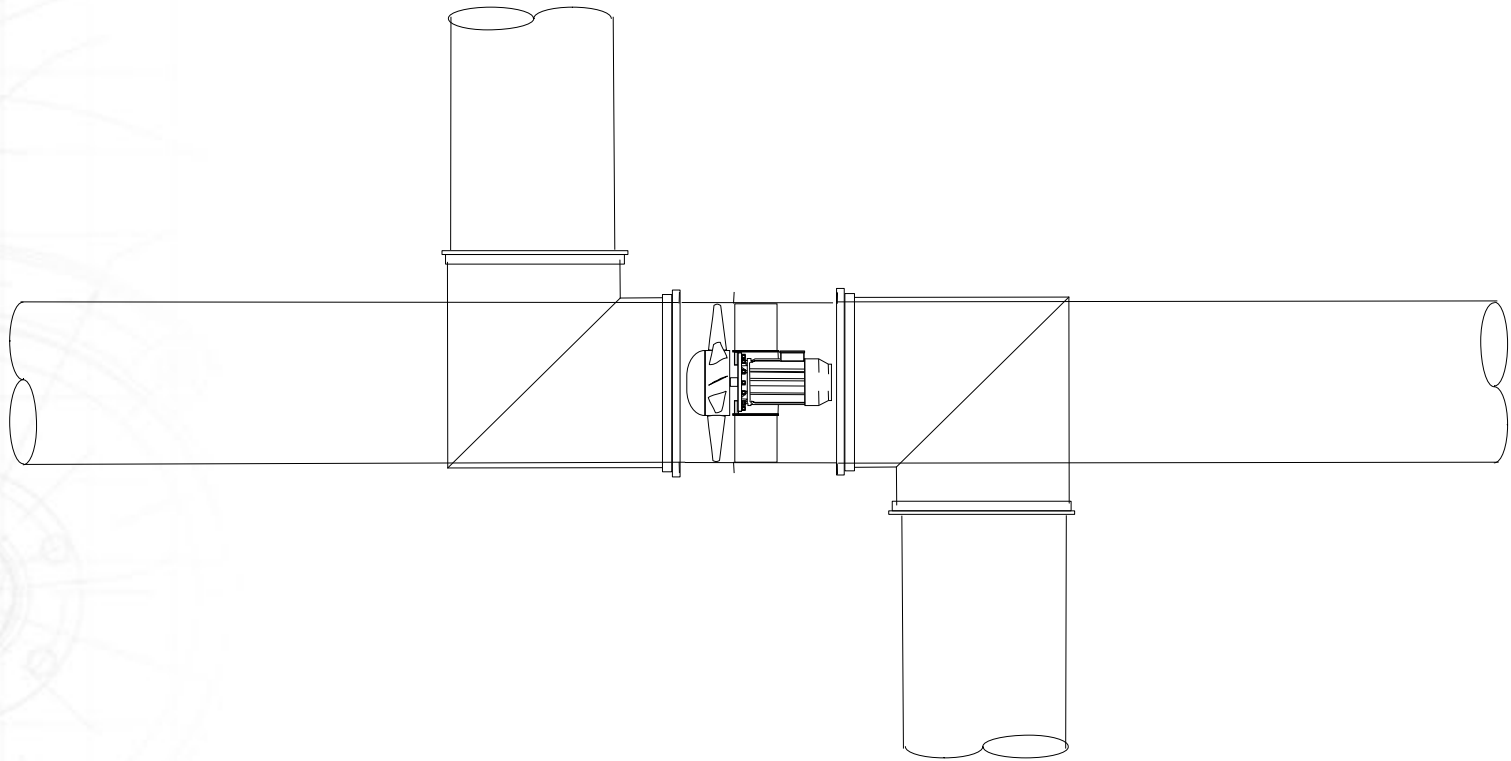
Installation \neq Test Setup

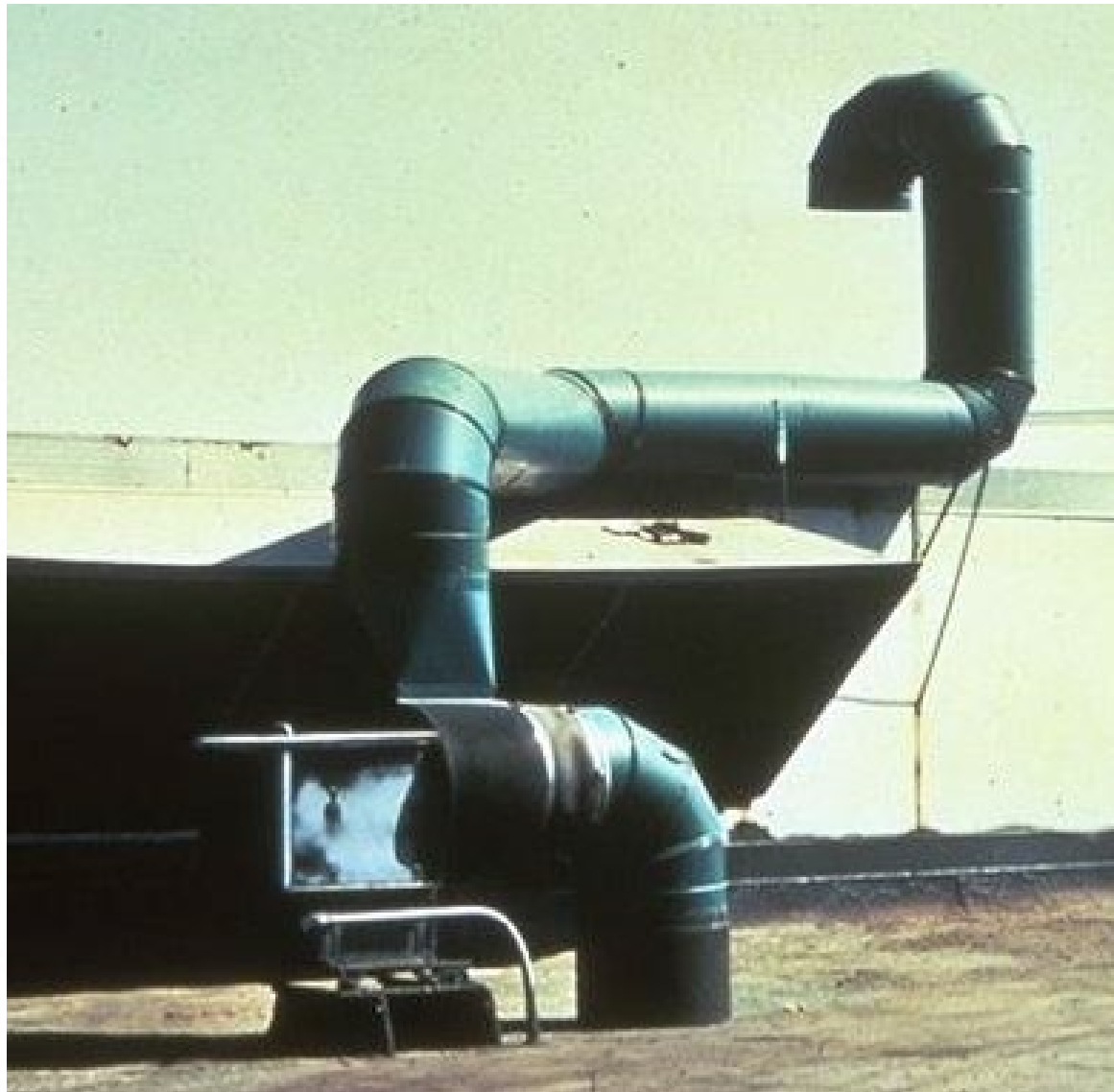


AMCA Catalog Ratings

- “Performance certified is for installation type:
 - A: Free inlet, Free outlet”
 - B: Free inlet, Ducted outlet”
 - C: Ducted inlet, Free outlet”
 - D: Ducted inlet, Ducted outlet”

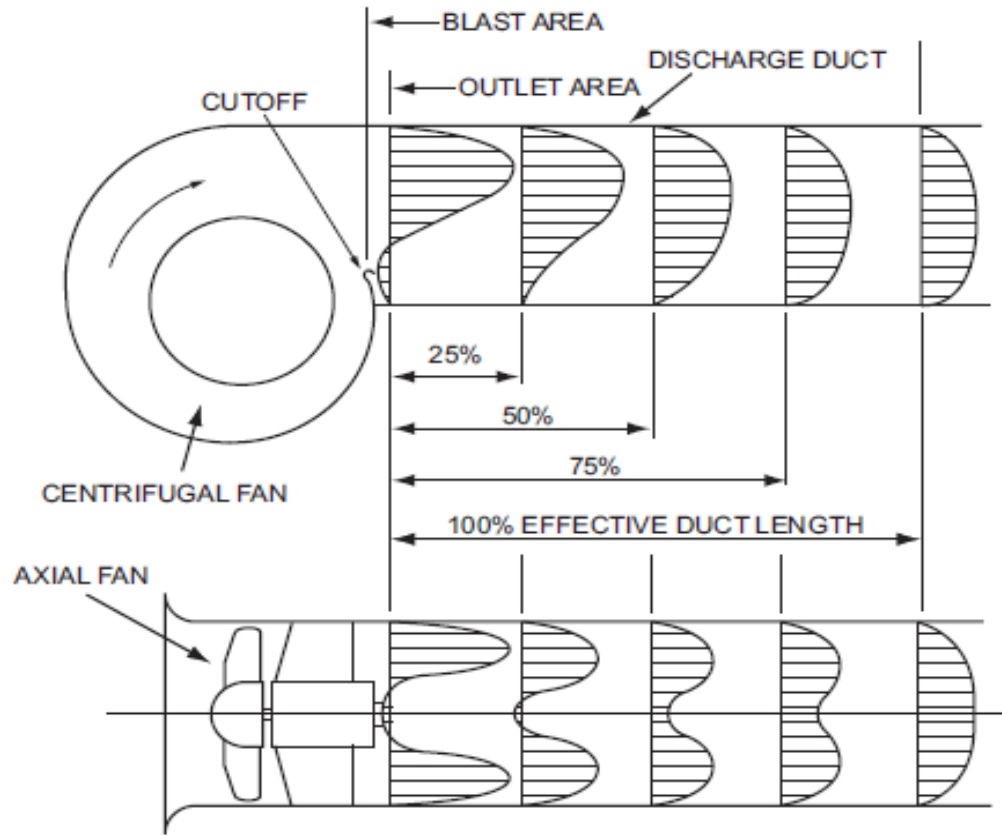
Duct Setups Match, But...



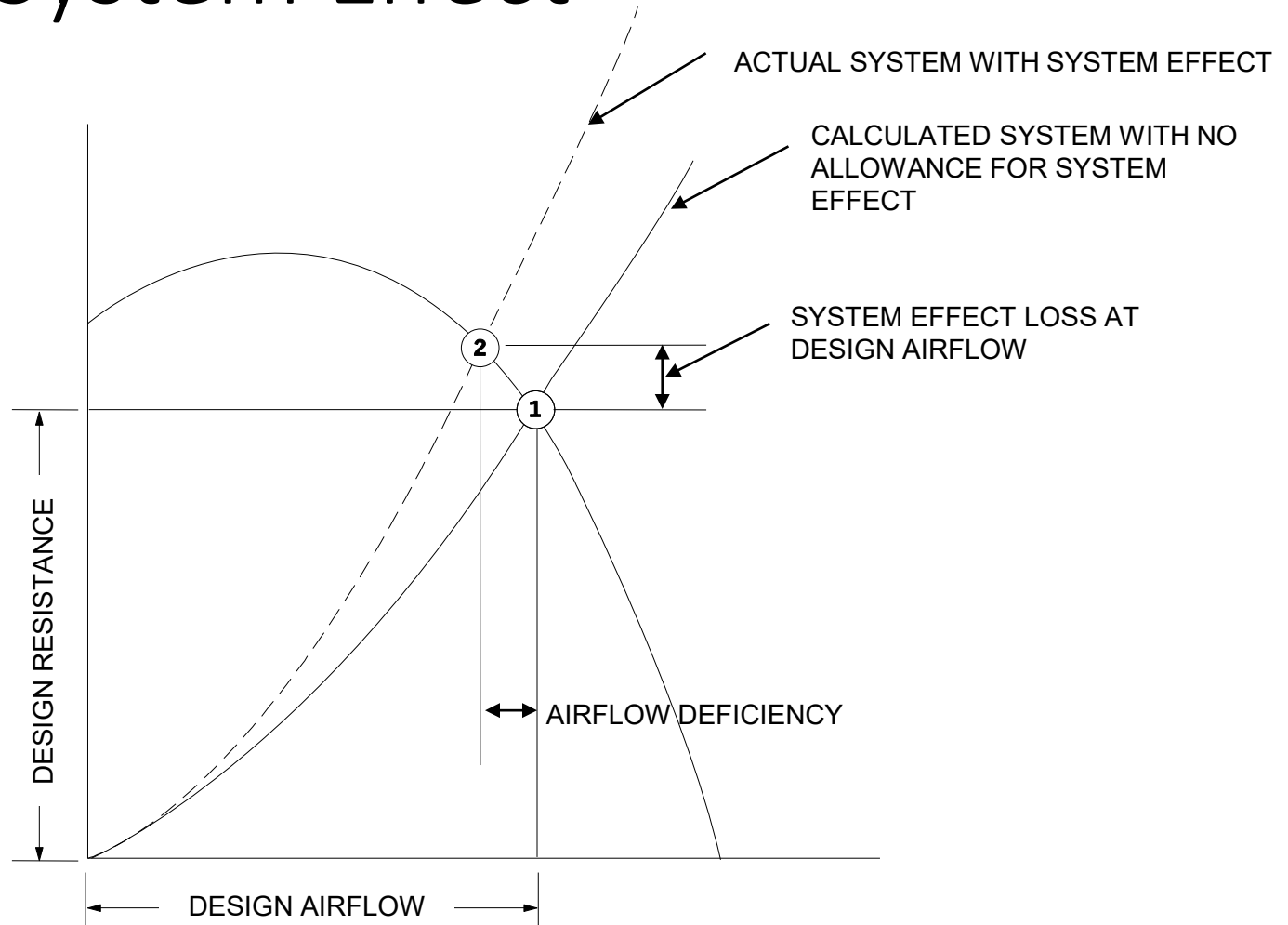


Inlet Versus Outlet System Effect

Outlet System Effect



Outlet System Effect



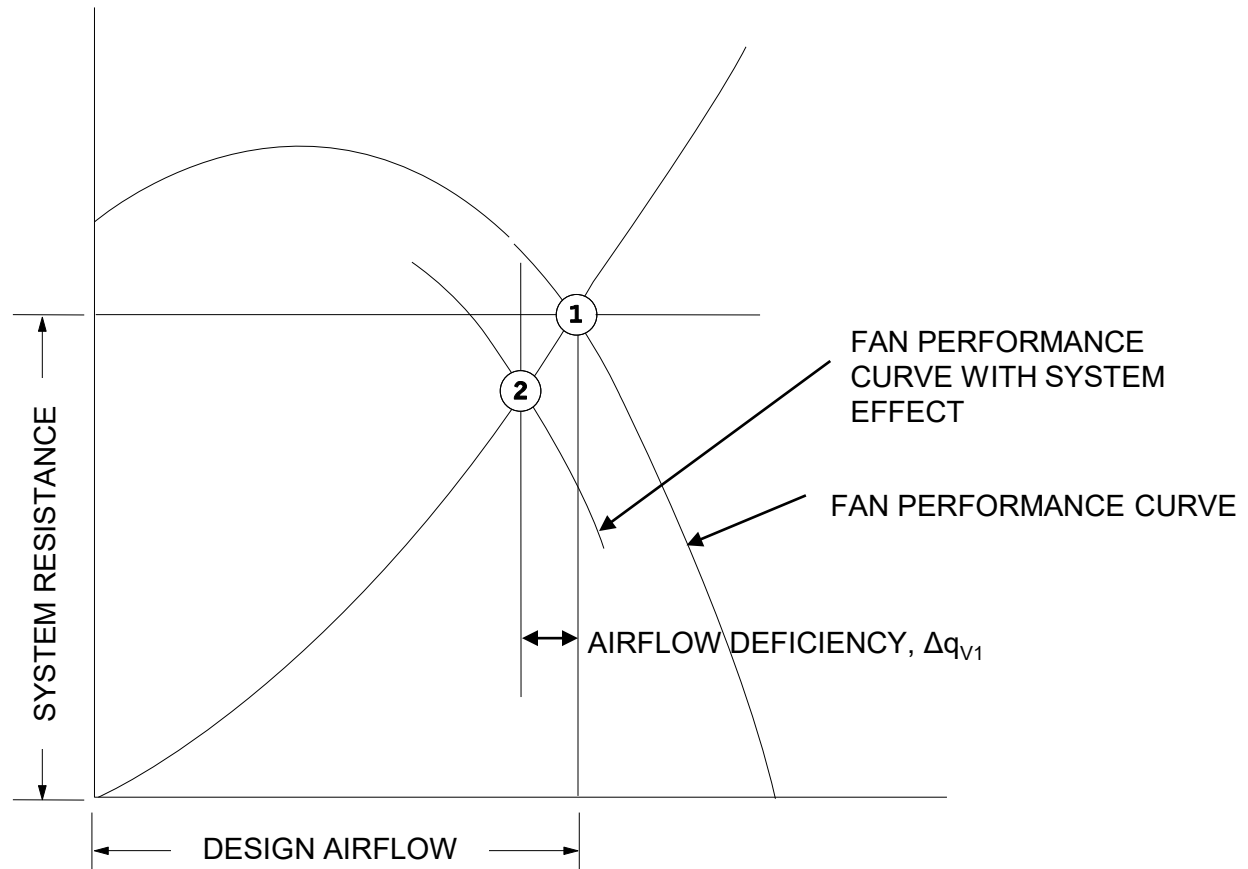
Outlet System Effect

$$SE = p_c + SE_o$$

Where:

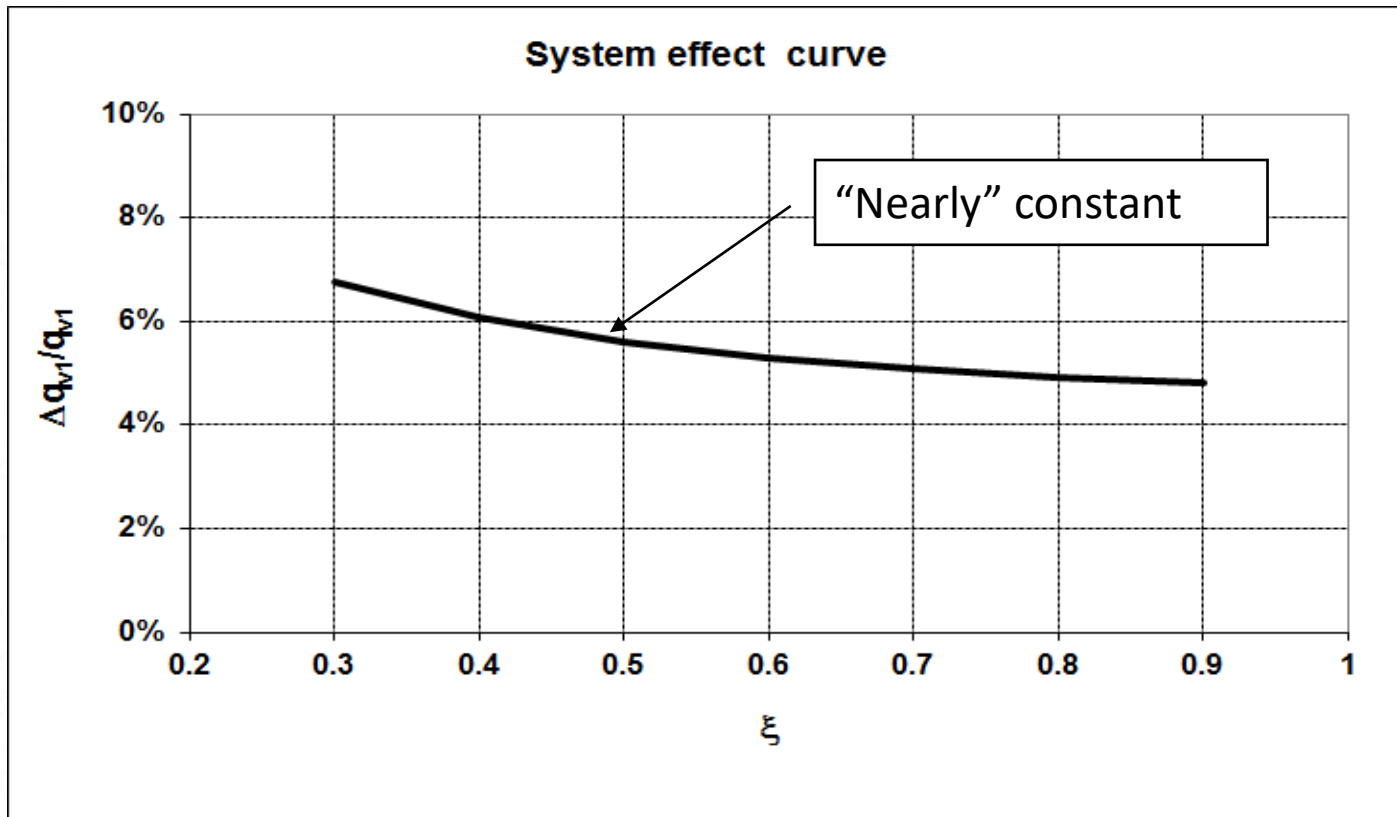
- p_c = Conventional pressure loss
- SE_o = Additional pressure loss due to non-uniform flow
- $SE_o = C \times p_{fd2}$

Inlet System Effect



Inlet System Effect

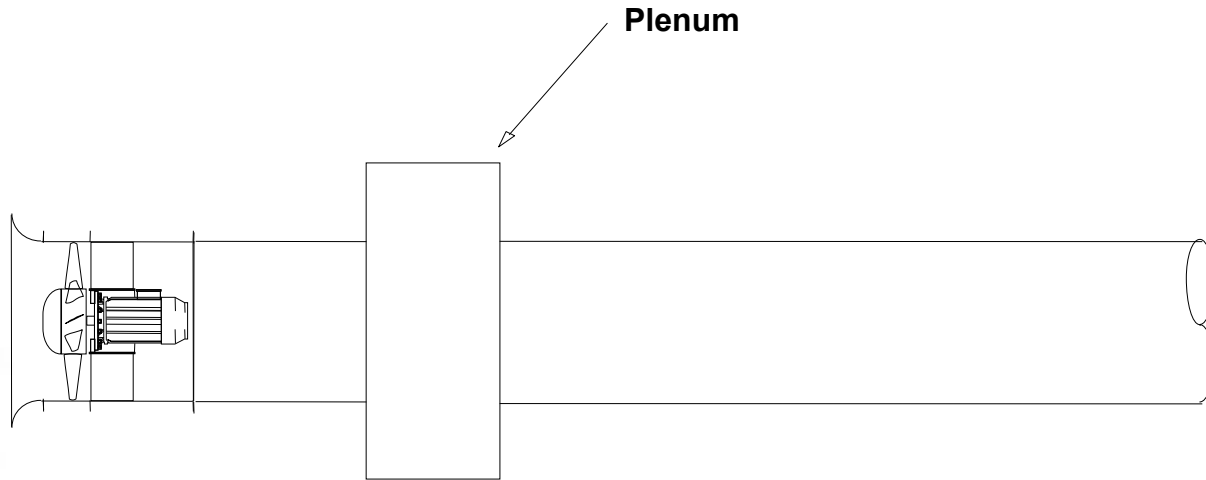
$$\xi = q_{V1} / \sqrt{p_{fs}}$$

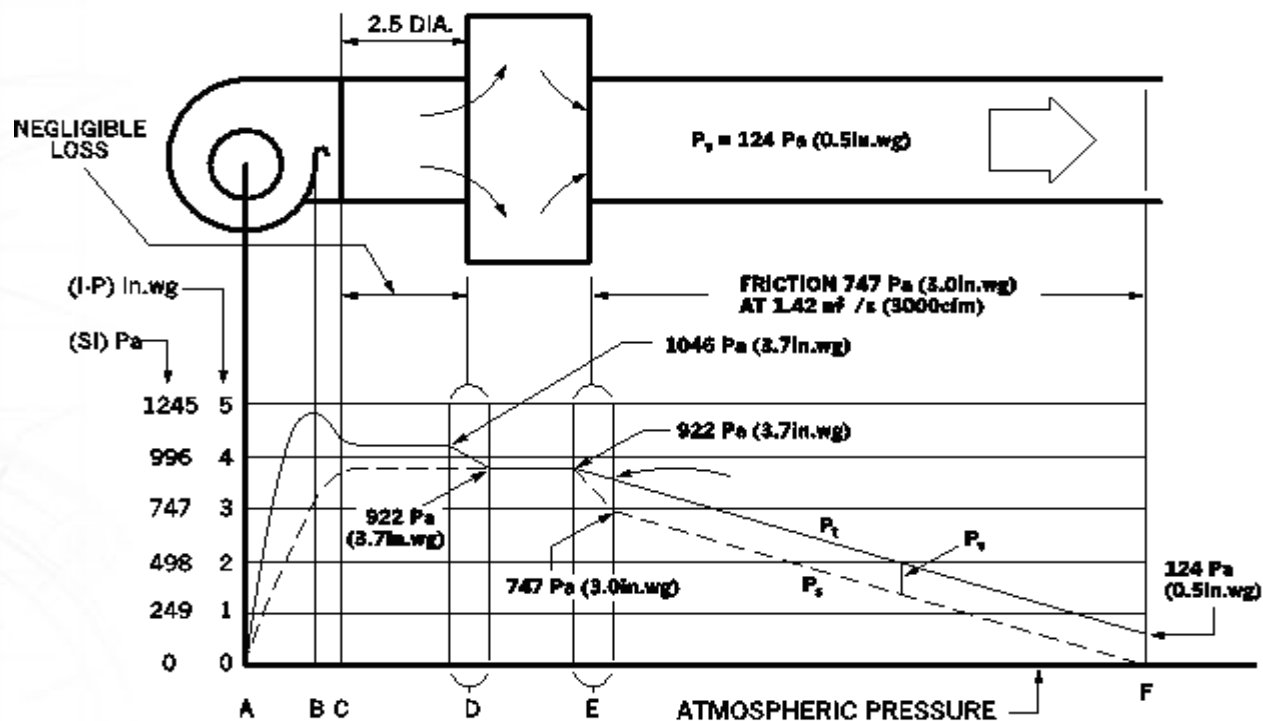


System Effect Calculation AMCA Publication 201

AMCA Publication 201

Plenum Example

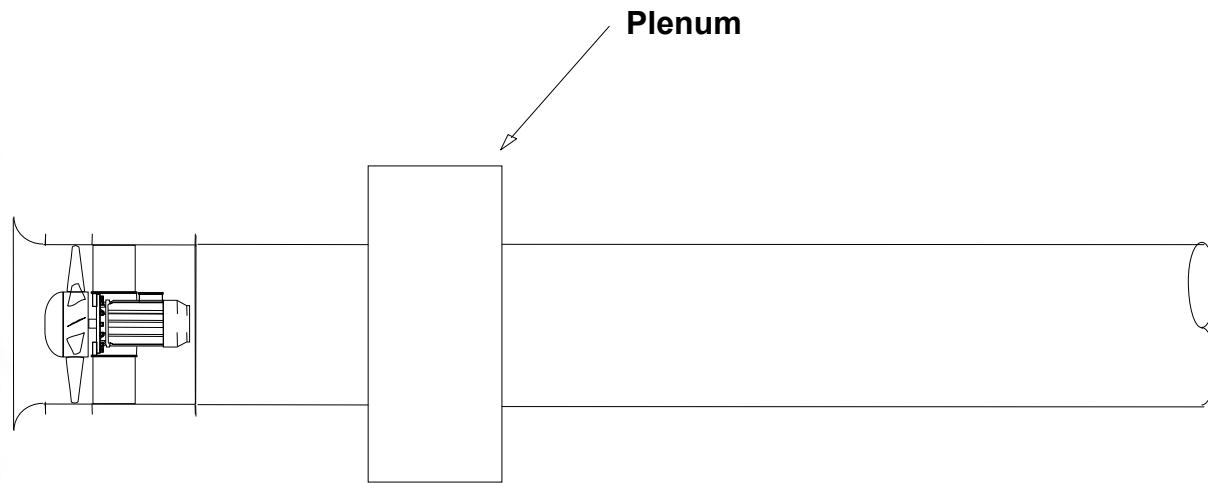


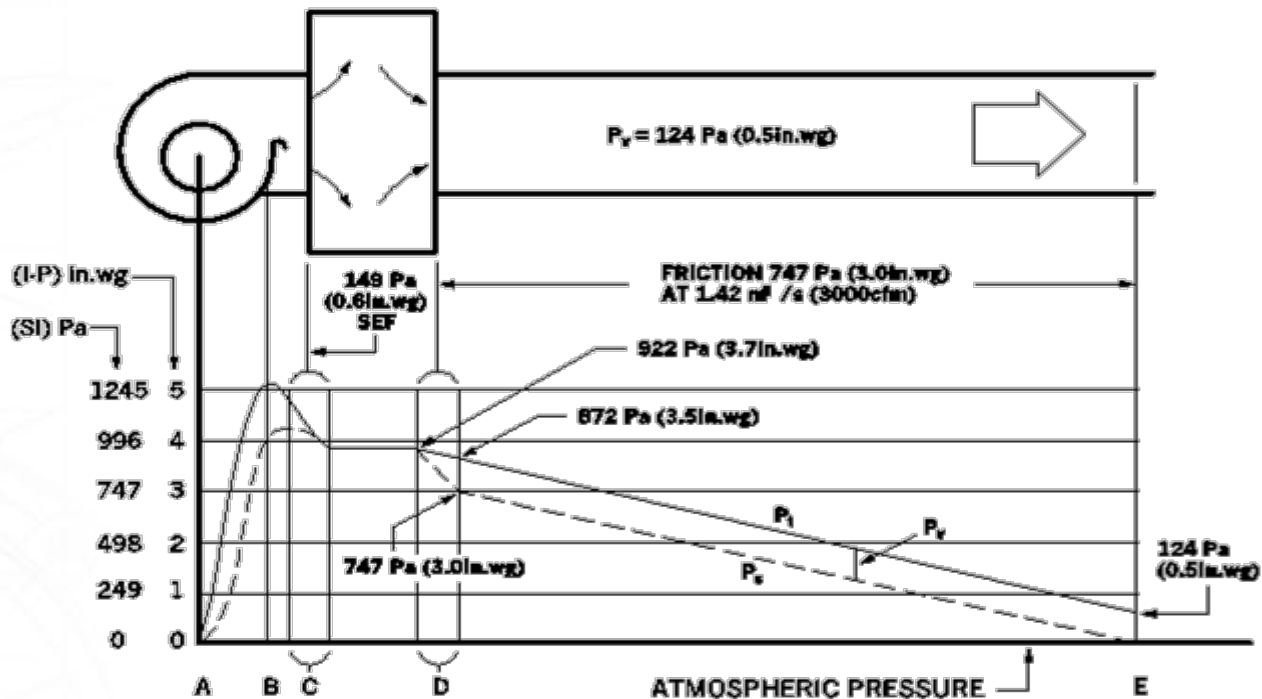


E-F	duct friction at 5000CMH (Q)	747 Pa (duct design)
E	contraction loss-plenum to duct	50 Pa (part of duct system)
E	P_S energy required to create velocity at E	125 Pa (part of duct system)
D	P_V loss (also P_T loss) at D as result of air velocity decrease	0 Pa
	P_S does not change from duct to plenum at D	
C-D	outlet duct on fan as tested	0 Pa

REQUIRED Fan P_s

922 Pa





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

AMCA 201 Example

Assuming:

- Use of the same fan for both systems
- Can attain both operating points with a change in speed

$$P_C = \left(\frac{N_C}{N} \right)^2 P$$

- Speed change ratio; $(1071/922)^{0.5} = \mathbf{1.08}$

AMCA 201 Example

$$H_C = \left(\frac{N_C}{N} \right)^3 H$$

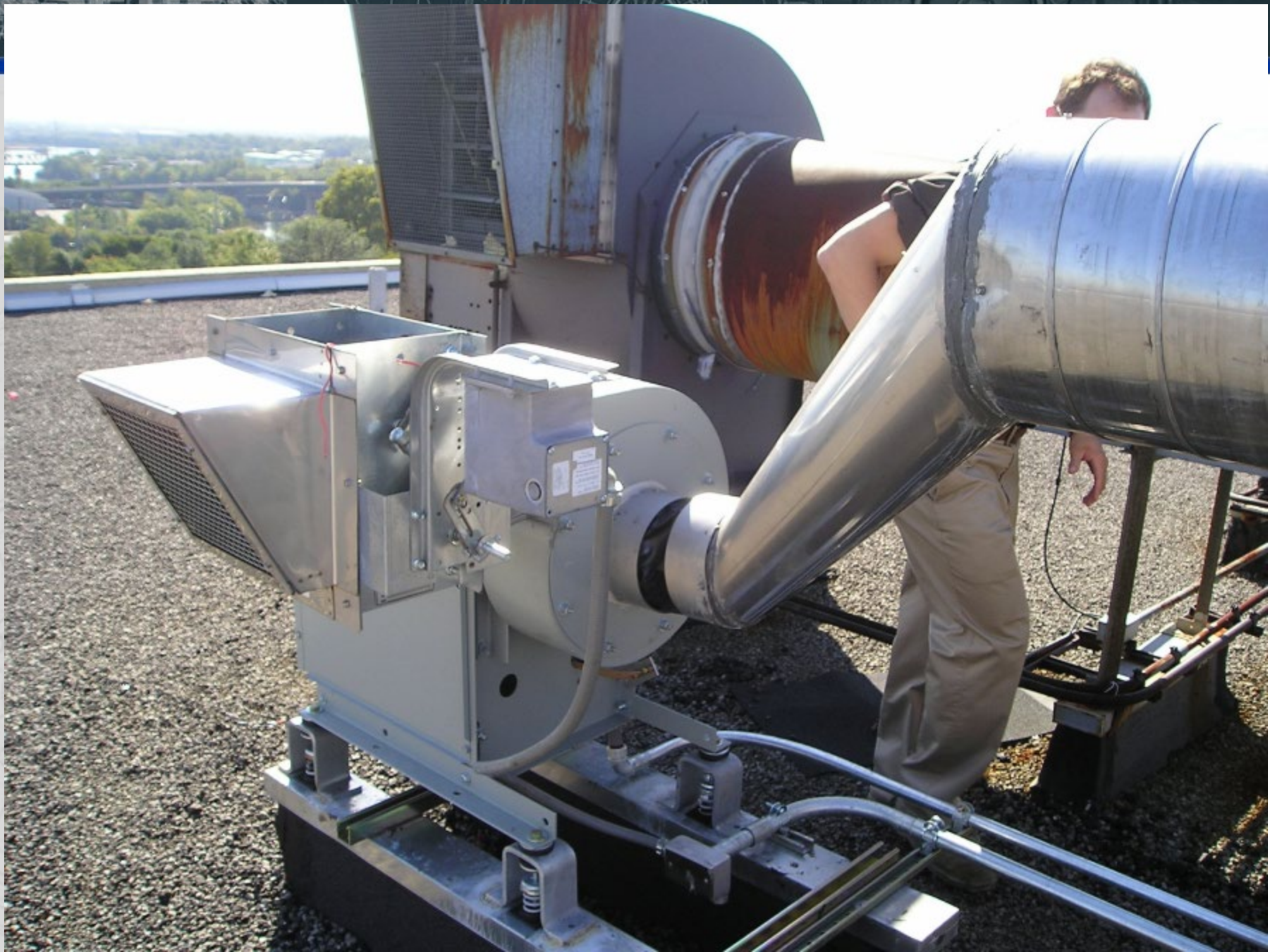
- **$1.08^3 = 1.25$**
- The increased in power consumption to overcome System Effect is about **25%**

Is System Effect a Common Occurrence?

















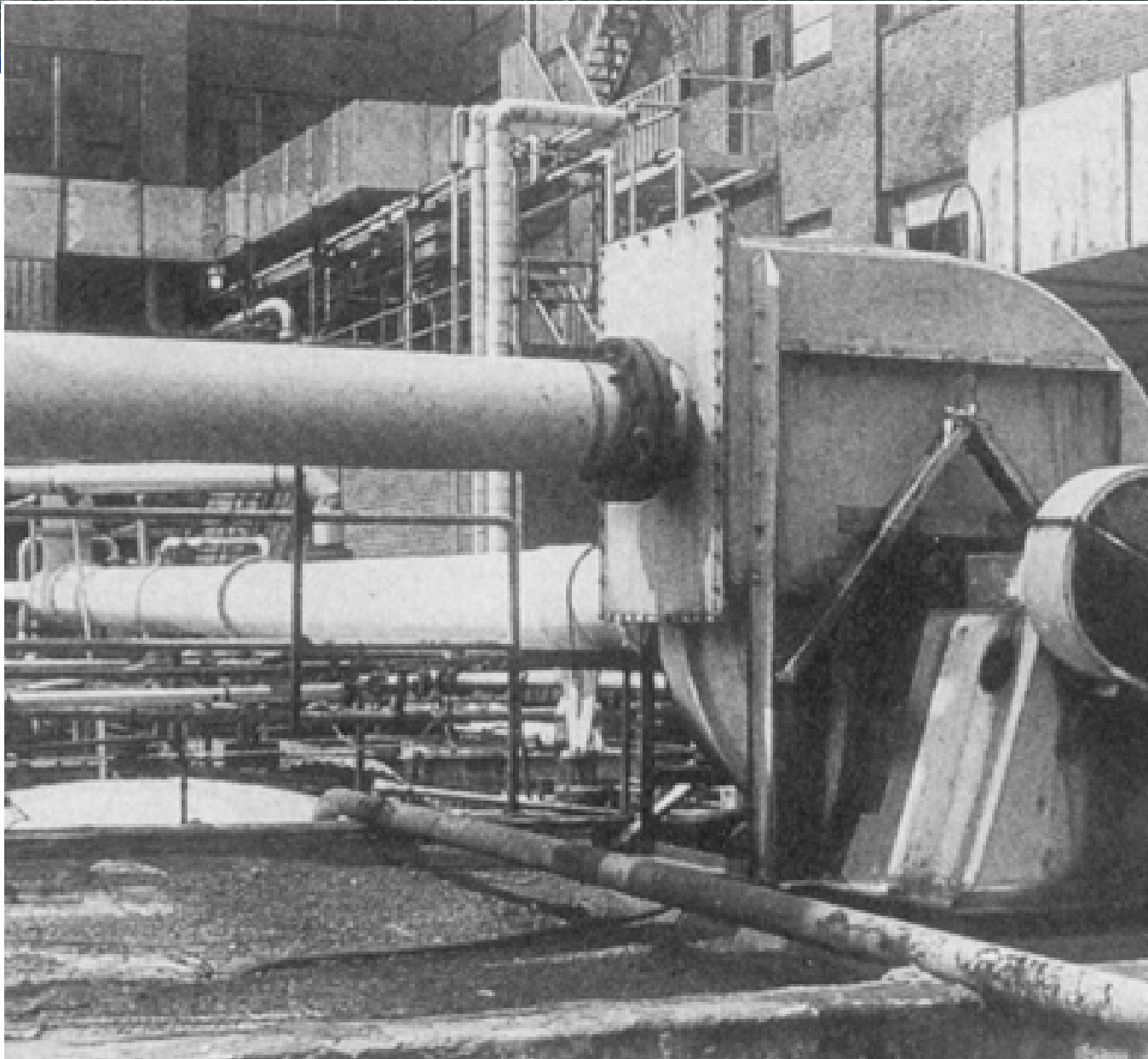


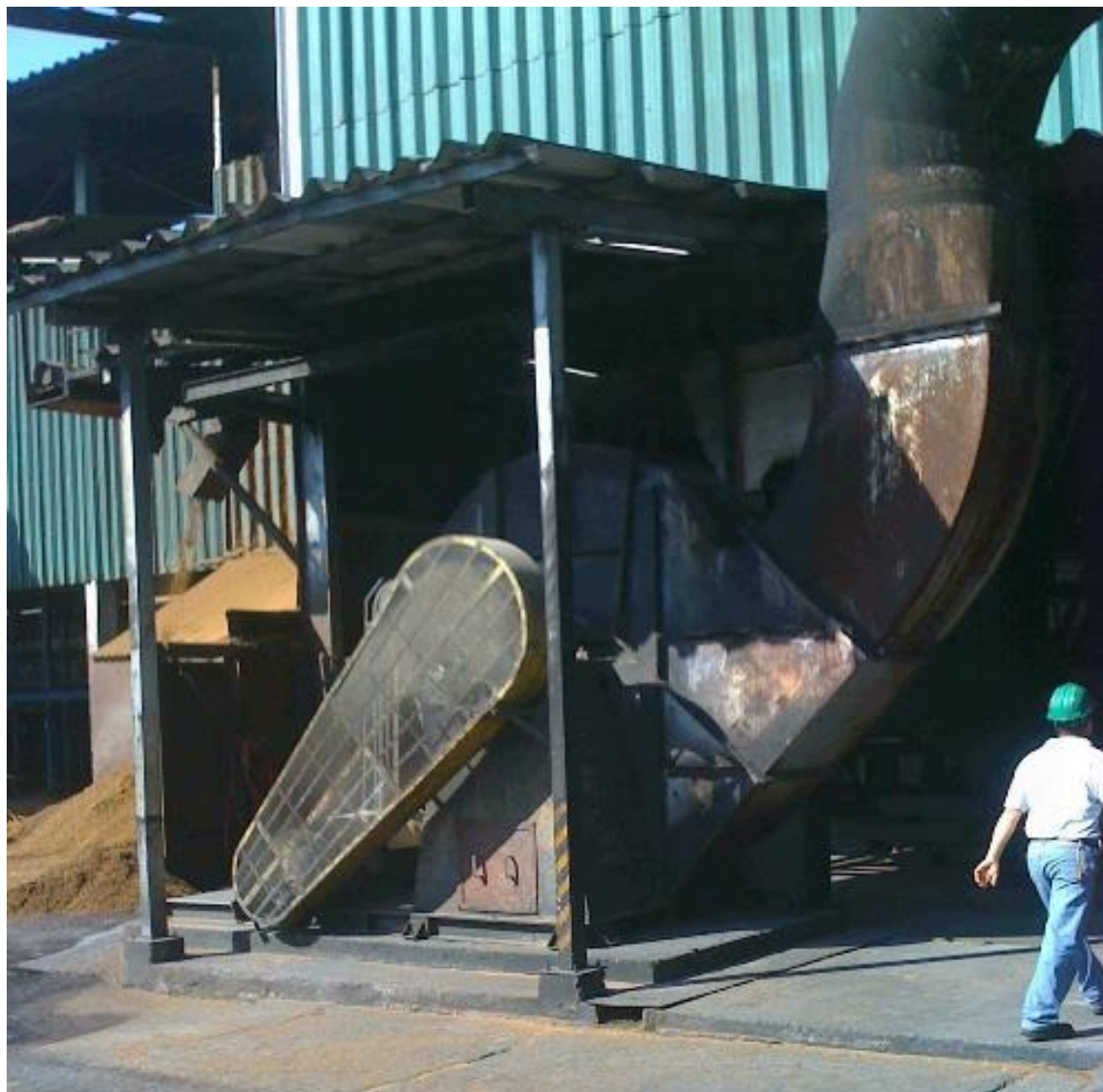




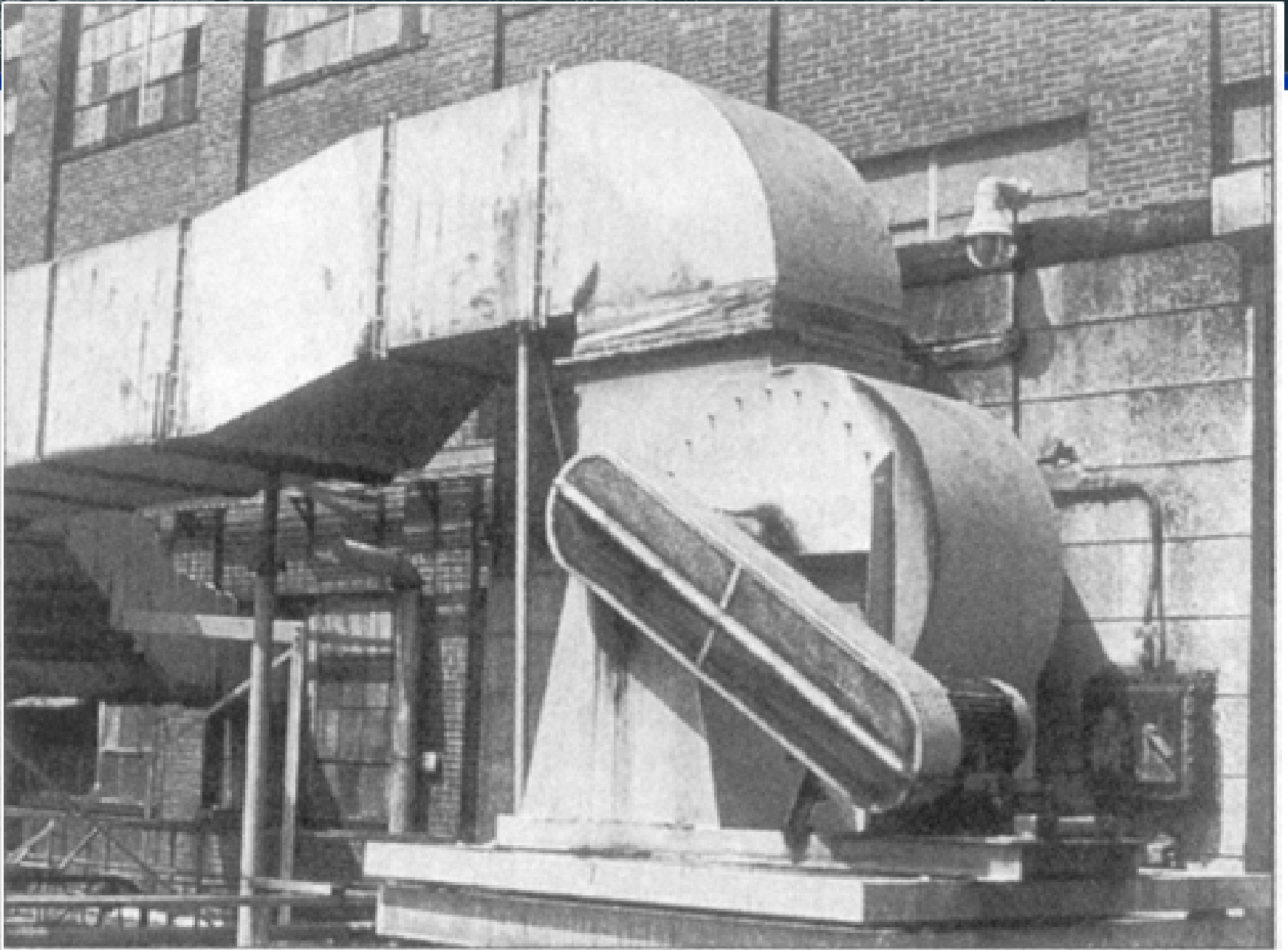




































Rules of Thumb

- 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
- Use allowances in the design calculations when space or other factors dictate less than optimum arrangement of the fan outlet and inlet connections
- Include adequate allowance for the effect of all accessories and appurtenances on the performance of the system and the fan

Recommendations

- Be aware of ISO TR 16219
- Make liberal use of AMCA's Fan Application Manual
 - AMCA 201 (under review)
 - AMCA 202
 - AMCA 203
 - AMCA 205

Questions?

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