System Effects

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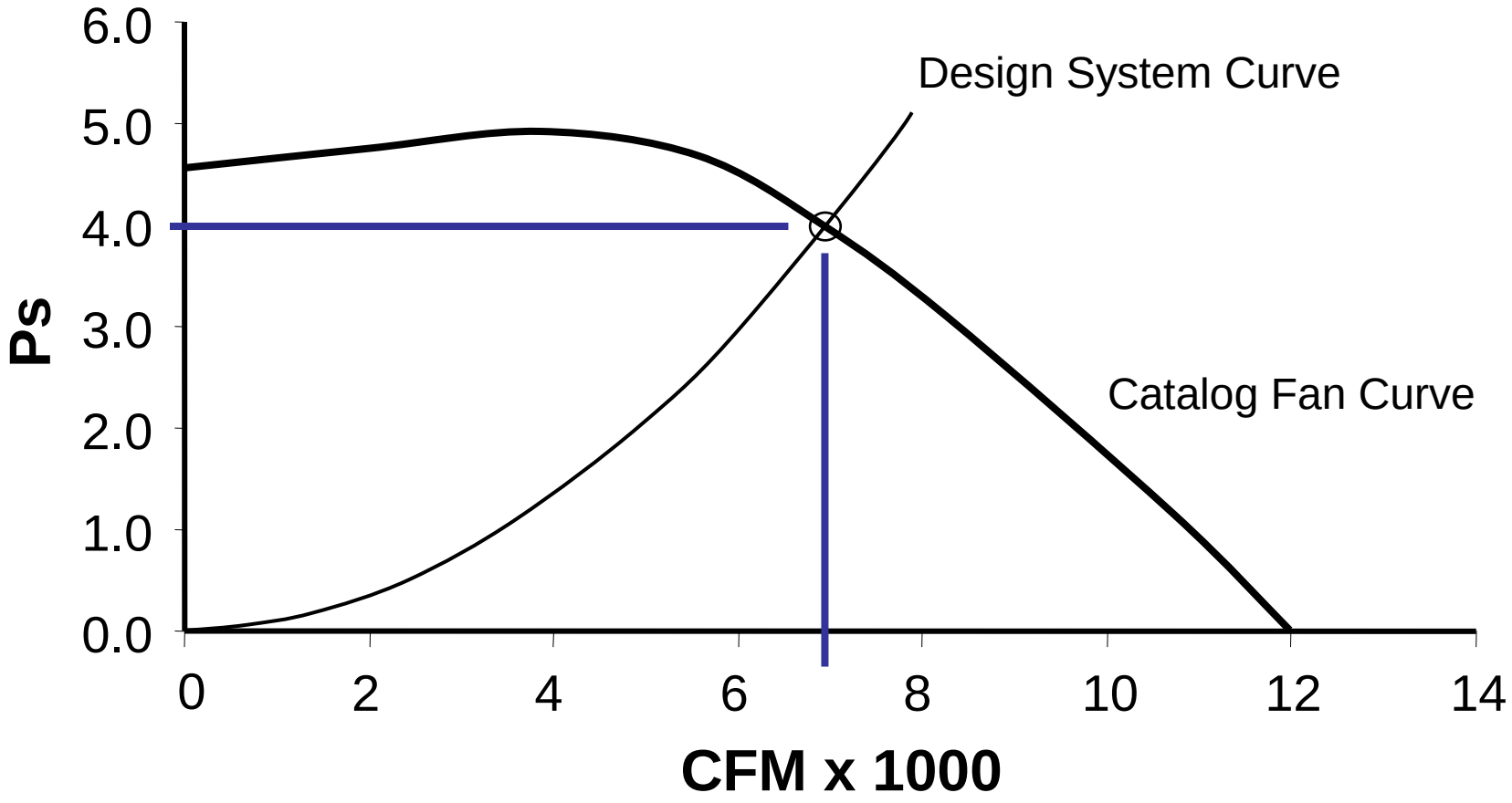
Greenheck Fan Corporation

Design Airflow



Fan Curves

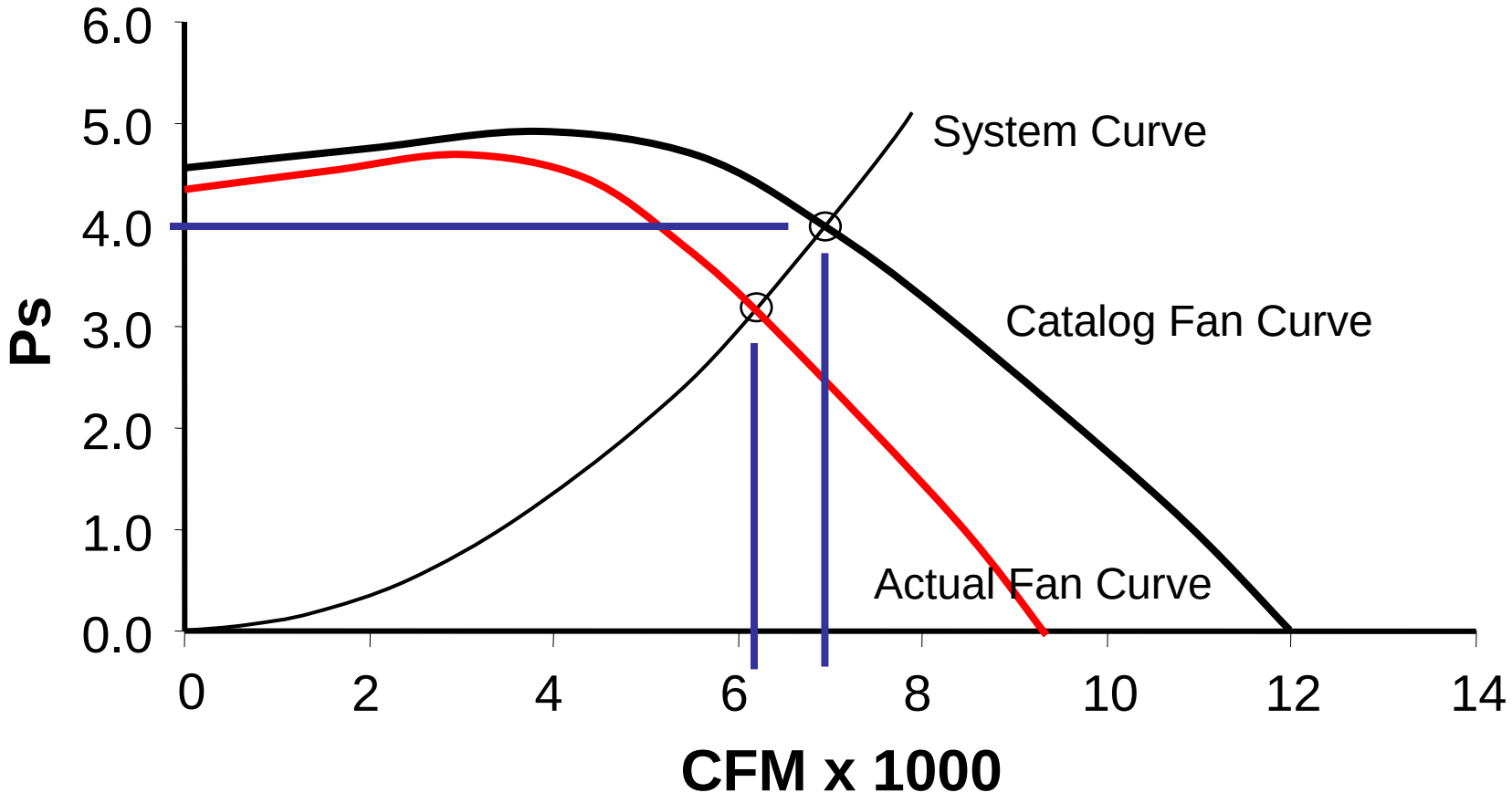
- **Show how a fan will operate in any system (installation)**
- **Based on standardized tests**
  - **AMCA 210**
- **Tested under ideal conditions**

System Effects Defined:

- ***Anything you place in close proximity before or after the fan that effects the cataloged performance.***

System Effects

Actual Airflow



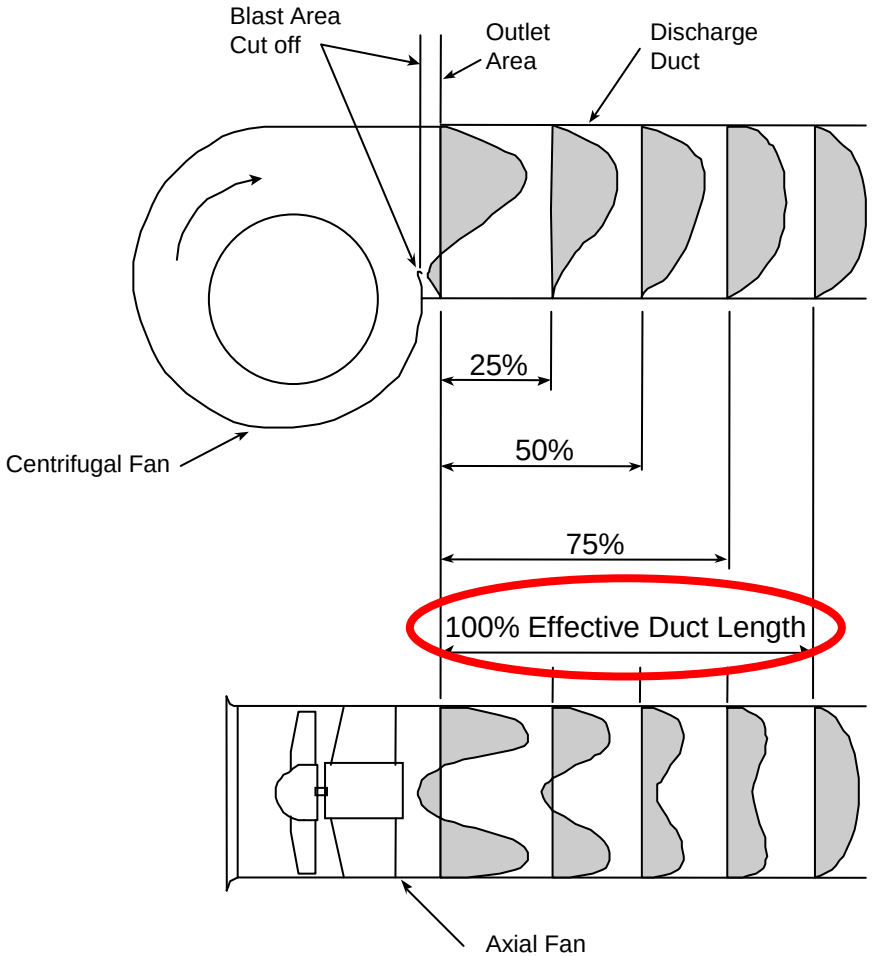
Why System Effect is Important

- **Can decrease performance**
- **Can cause excess vibration**
- **Can cause excess noise**
- **Can require more energy (HP) to achieve rated performance**
- **Takes time to determine and understand**

Three most common causes of deficient performance of a fan/system are:

- **Improper outlet connections**
- **Non-uniform inlet flow**
- **Swirl at the inlet**

Fan Outlet Velocity Profiles



Adapted from AMCA Publication 201-202, *Fans and Systems*.

Effective Duct Length

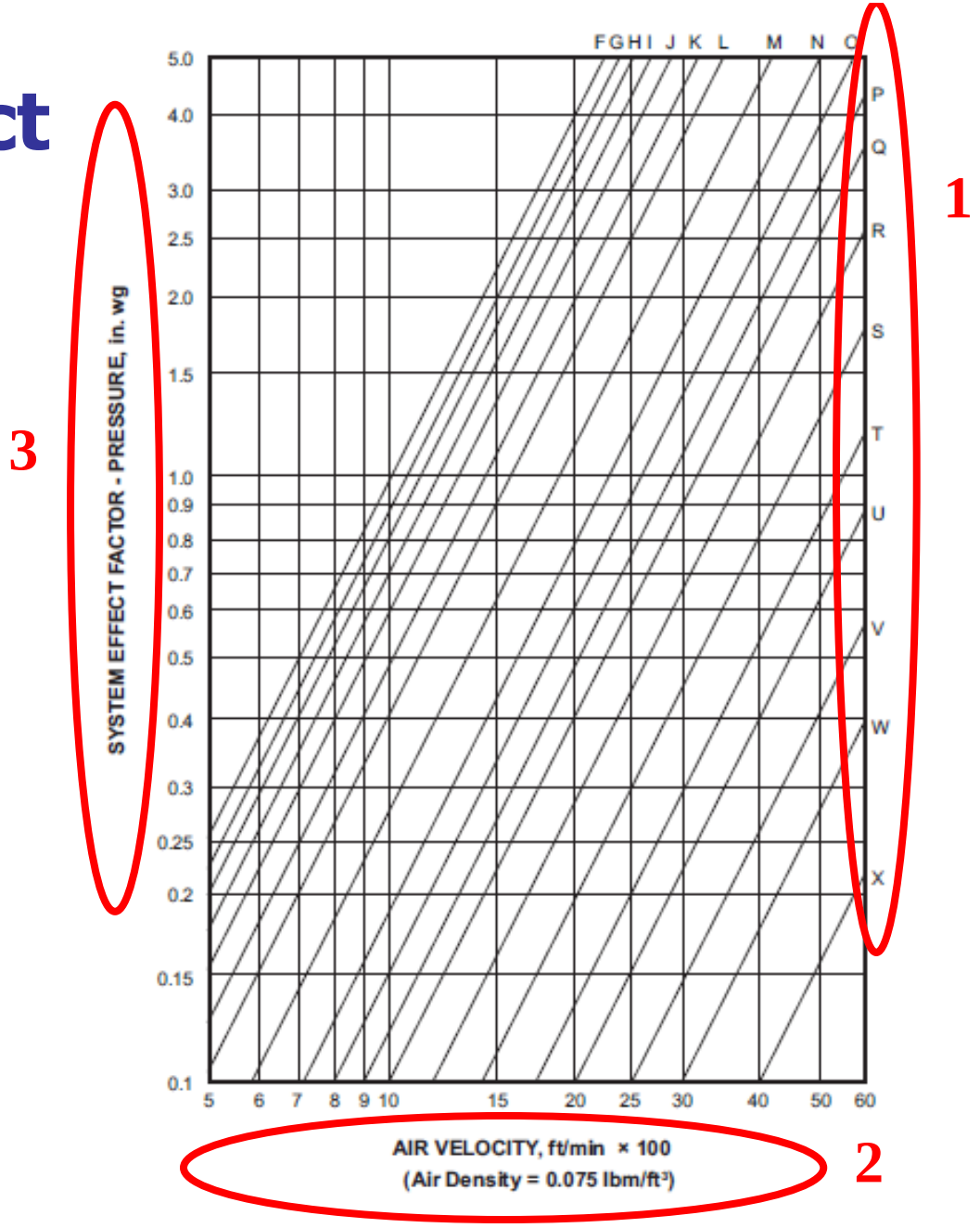
Effective Duct Length = 2.5 Duct Diameters for 2,500 FPM or less

Add 1 duct diameter for each additional 1,000 FPM

For rectangular ducts, the equivalent duct diameter is

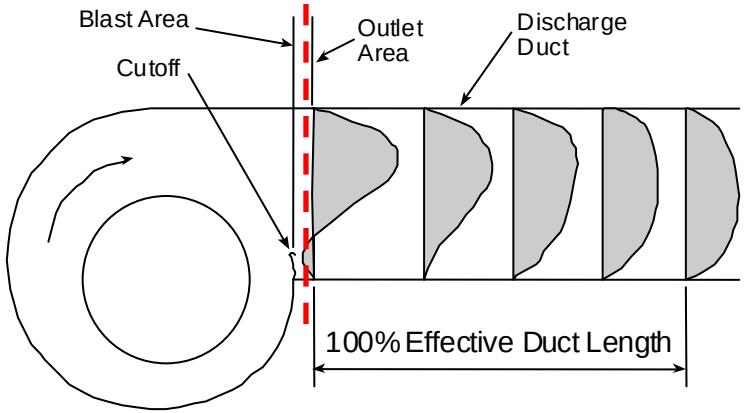
(4 x width x length / 3.14) ^ 0.5

System Effect Curve



Adapted from AMCA Publication 201-202, *Fans and Systems*.

System Effect Curves for Outlet Ducts - Centrifugal Fans



	No Duct	12% Effective Duct	25% Effective Duct	50% Effective Duct	100% Effective Duct
Blast Area / Outlet Area	System Effect Curve				
0.4	P	R-S	U	W	--
0.5	P	R-S	U	W	--
0.6	R-S	S-T	U-V	W-X	--
0.7	S	U	W-X	--	--
0.8	T-U	VW	X	--	--
0.9	W-W	W-X	--	--	--
1.0	--	--	--	--	--

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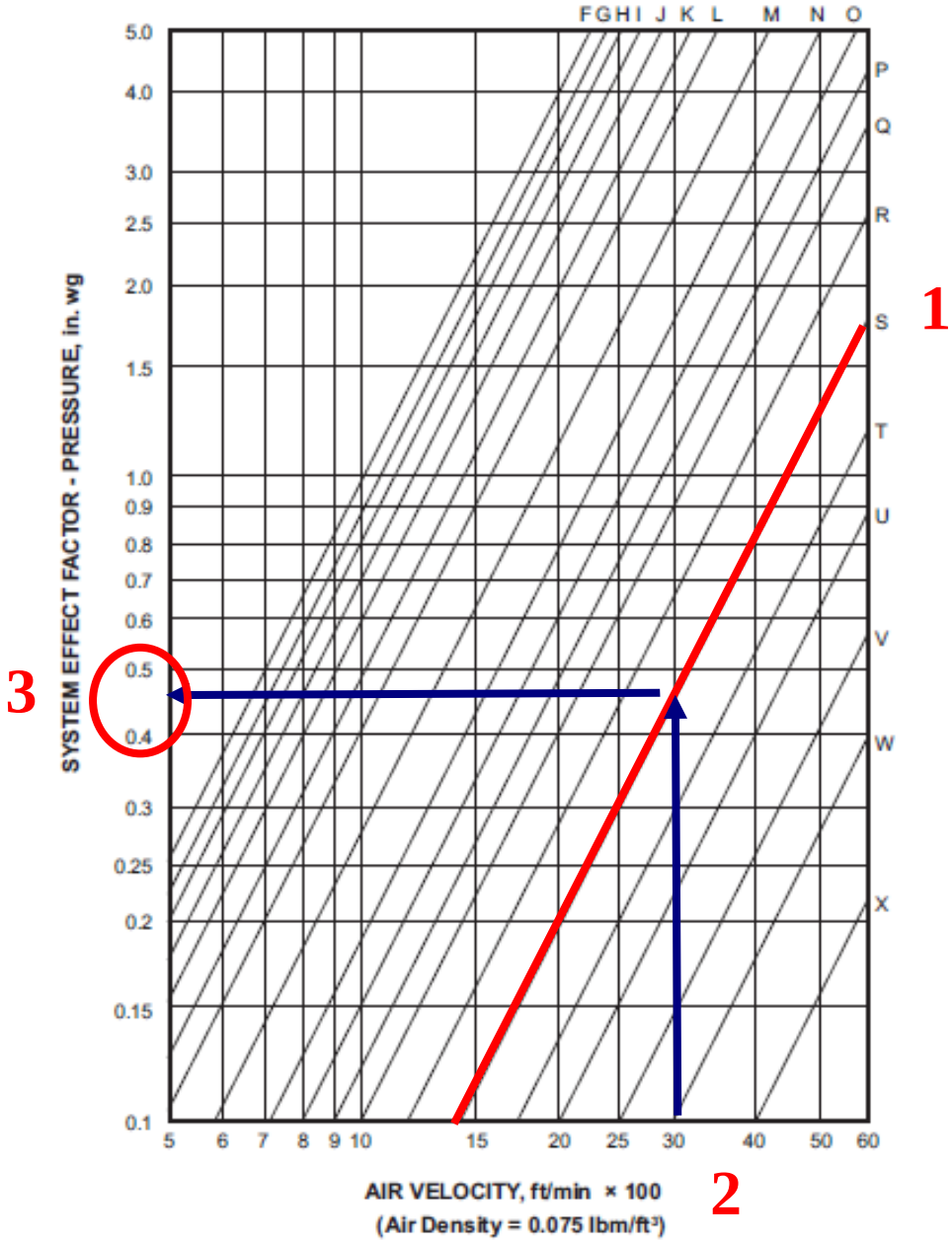
System Effect Curve

+0.45 in w.g.



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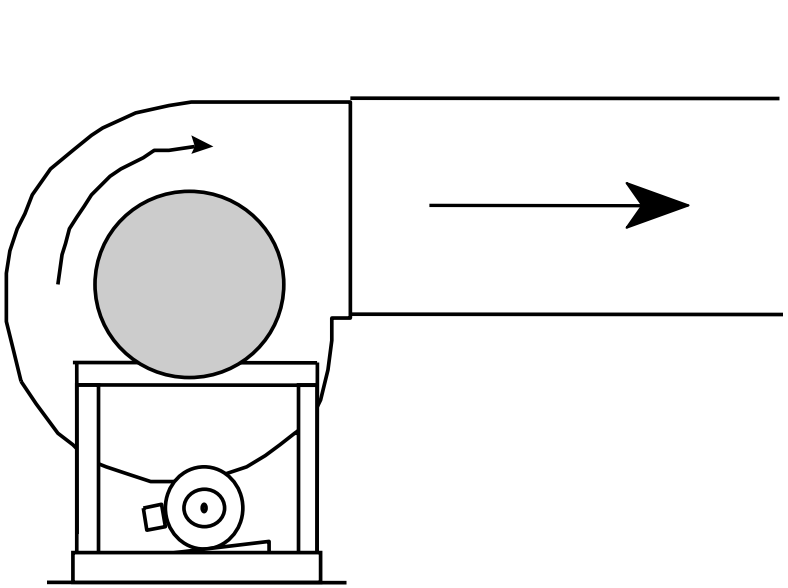
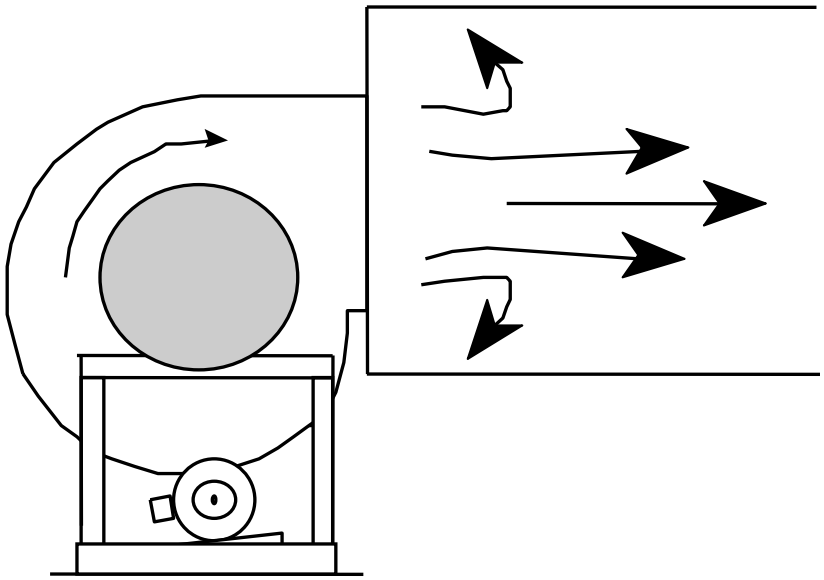
Outlet Conditions

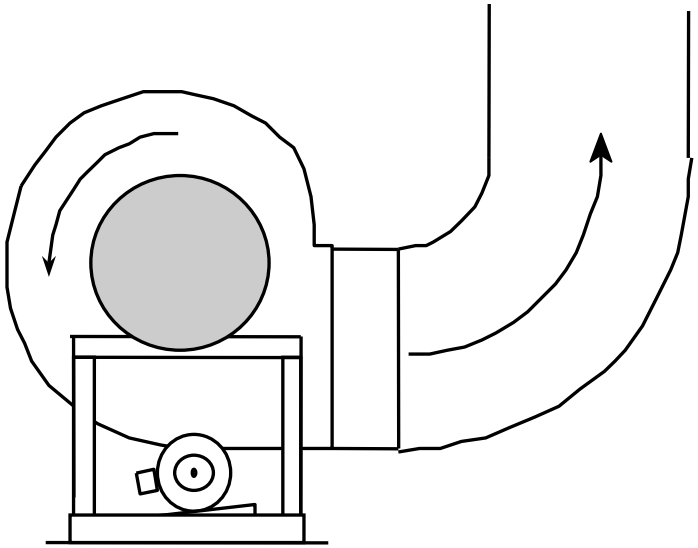


Good

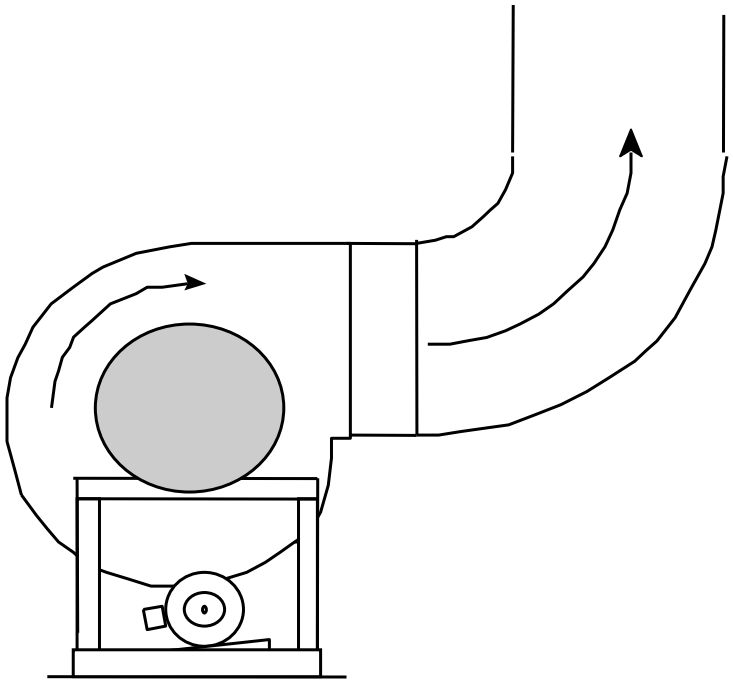


Poor

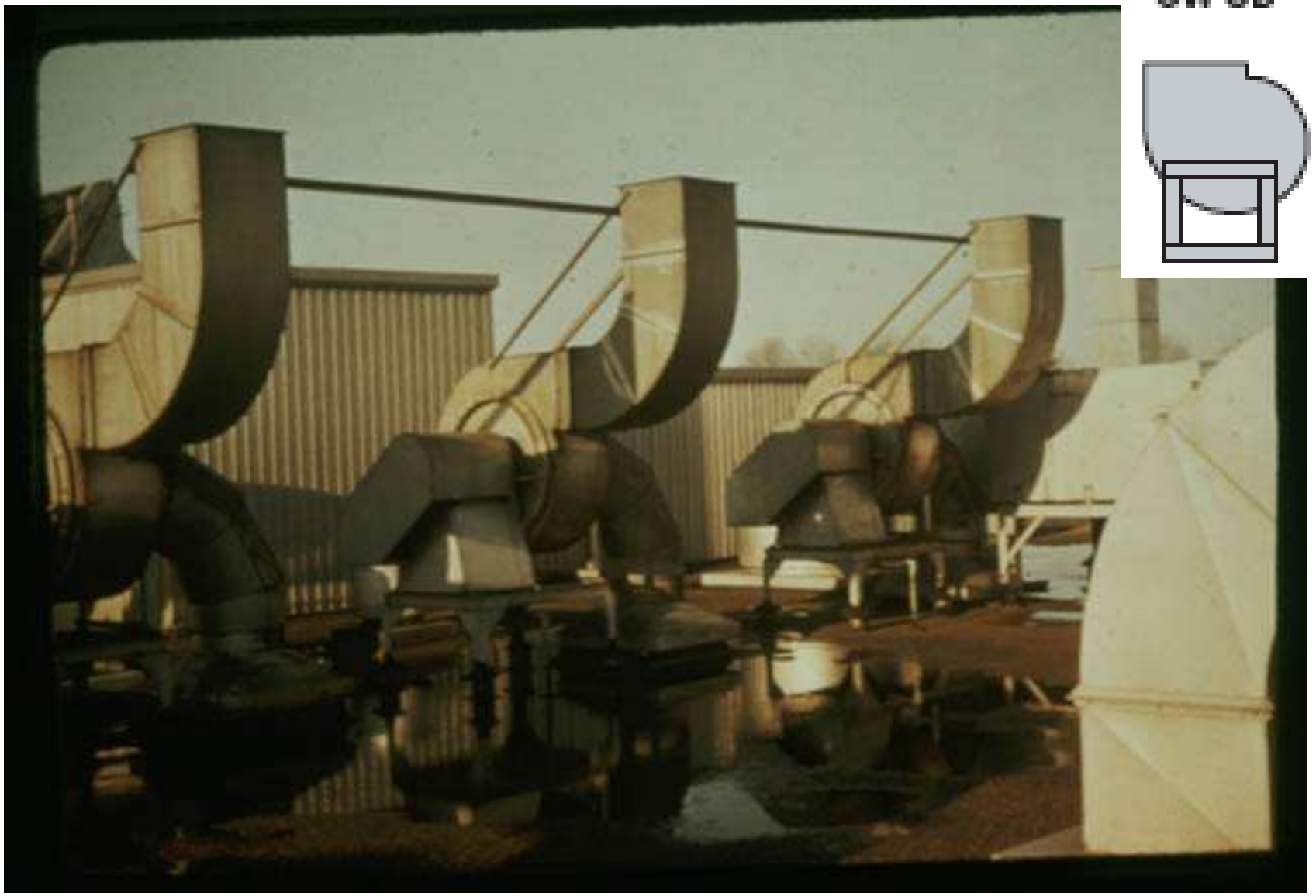
Outlet Elbows



Better

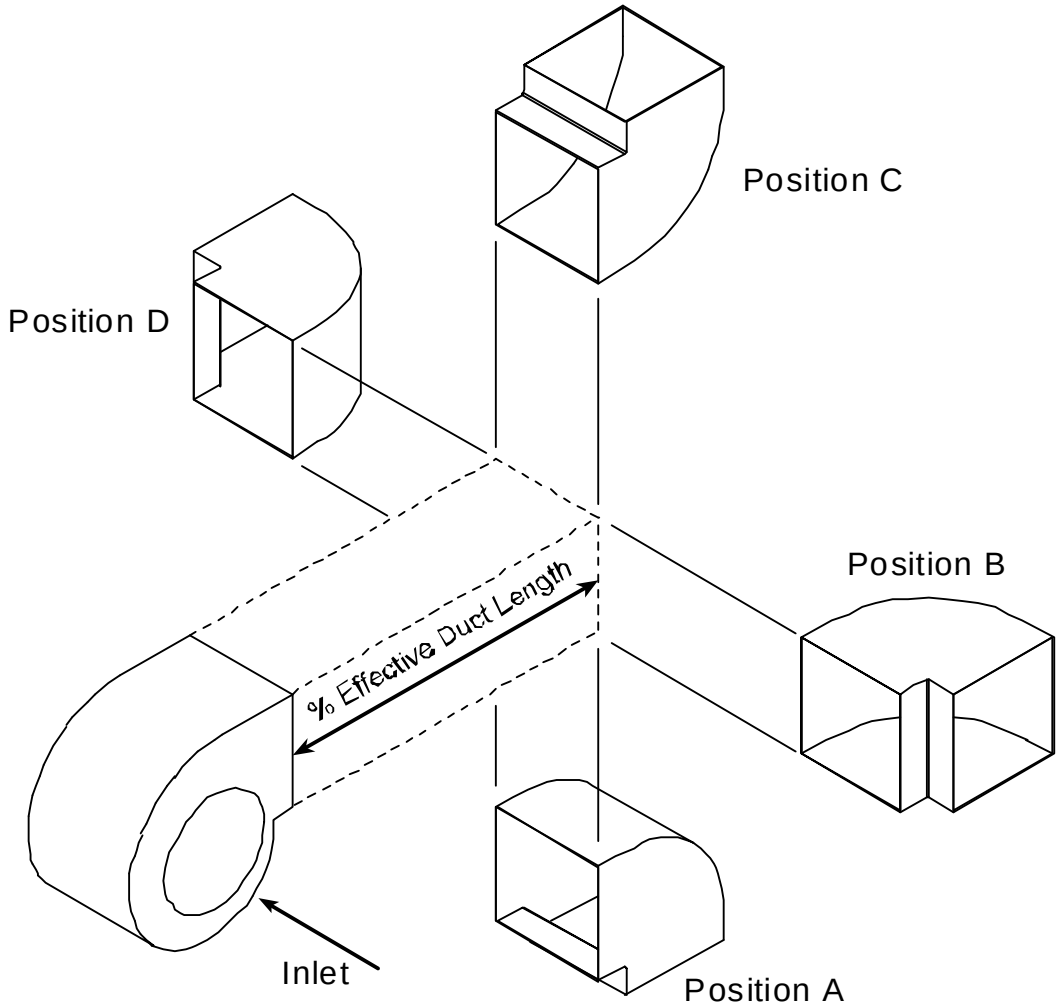


Poor


CW UB


CCW TAU
03/05/2009 14:30

Outlet Elbows - Centrifugal Fans



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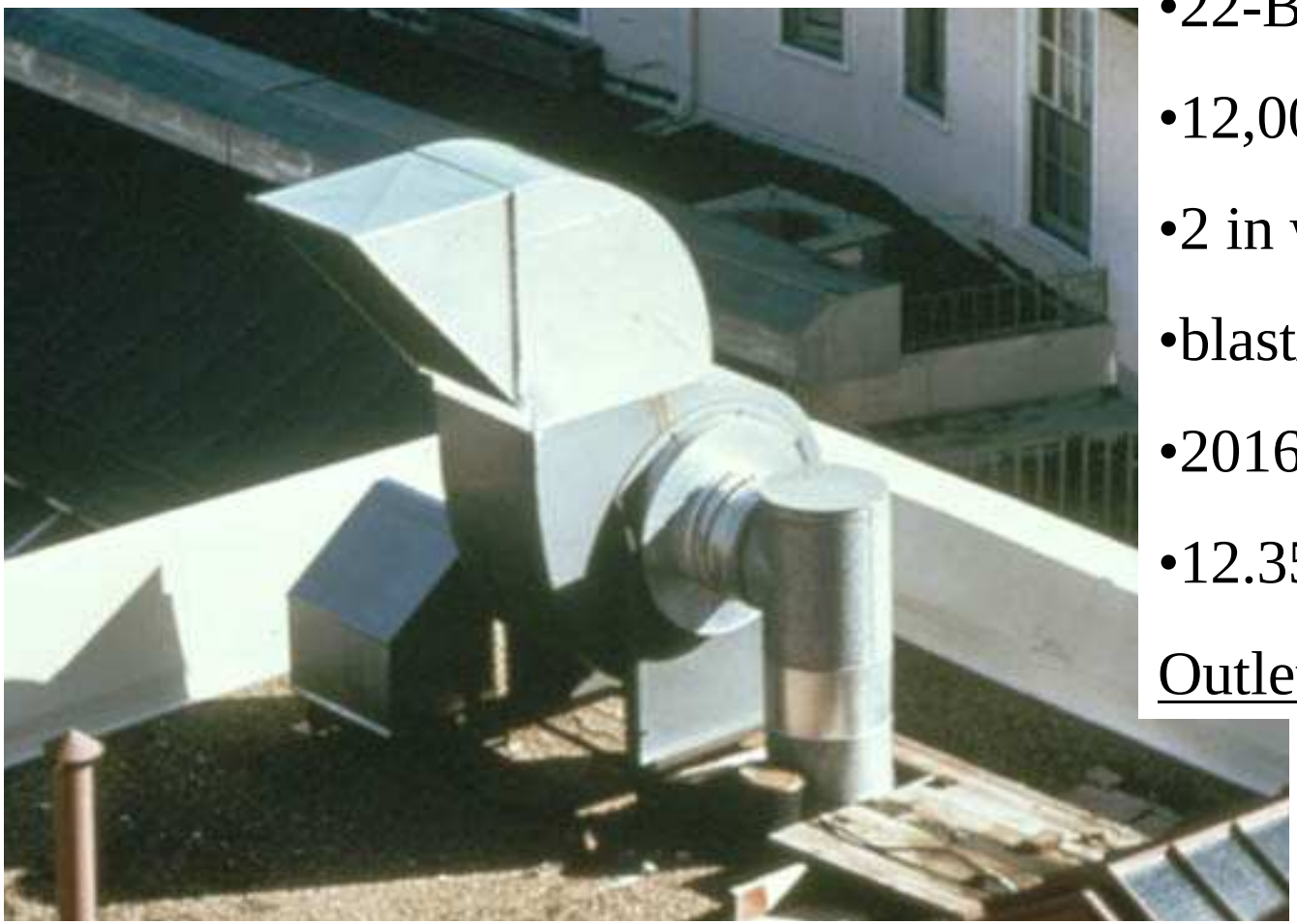


Example:

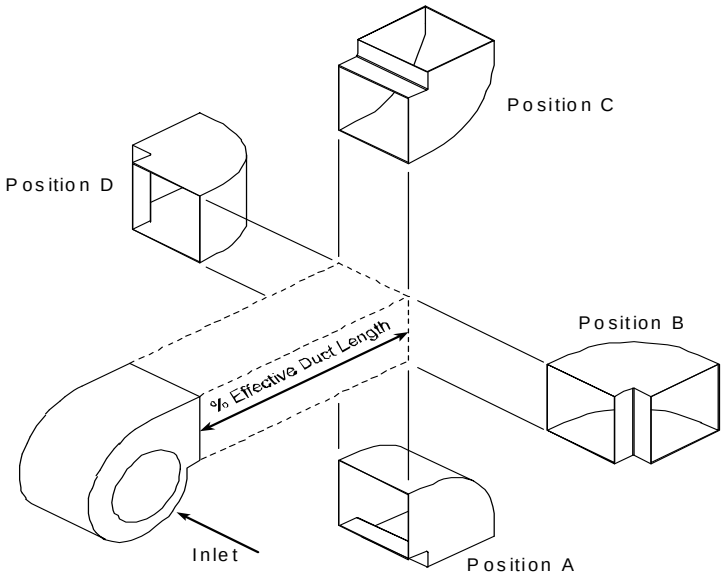
- 22-BISW
- 12,000 CFM (4,200 fpm)
- 2 in w.g.
- blast/outlet ratio = 0.7
- 2016 rpm
- 12.35 bhp (15 hp motor)

<u>Outlet System Effect?</u>

System Effect Curves for SWSI Fans

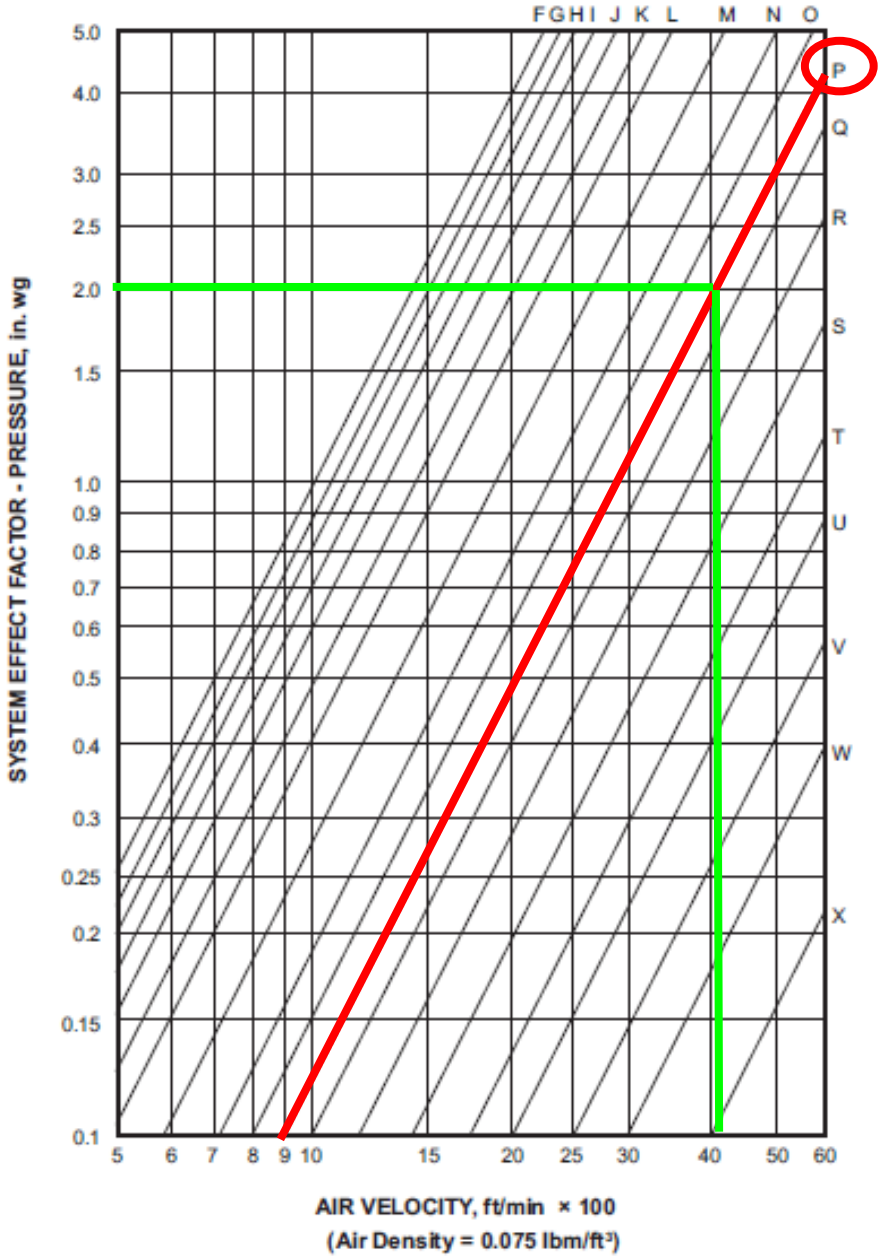
Blast Area / Outlet Area	Outlet Elbow Position	No Outlet Duct	12% Effective Duct	25% Effective Duct	50% Effective Duct	100% Effective Duct
0.4	A	N	O	P-Q	S	
	B	M-N	N	O-P	R-S	
	C	L-M	M	N	Q	
	D	L-M	M	N	Q	
0.5	A	O-P	P-Q	R	T	
	B	N-O	O-P	Q	S-T	N
	C	M-N	N	O-P	R-S	O
	D	M-N	N	O-P	R-S	
0.6	A	Q	Q-R	S	U	S
	B	P	Q	R	T	Y
	C	N-O	O	Q	S	S
	D	N-O	O	Q	S	T
0.7	A	R-S	S	T	V	E
	B	Q-R	R-S	S-T	U-V	M
	C	P	Q	R-S	T	
	D	P	Q	R-S	T	E
0.8	A	S	S-T	T-U	W	F
	B	R-S	S	T	V	F
	C	Q-R	R	S	U-V	E
	D	Q-R	R	S	U-V	C
0.9	A	T	T-U	U-V	W	T
	B	S	S-T	T-U	W	
	C	R	S	S-T	V	F
	D	R	S	S-T	V	A
1	A	T	T-U	U-V	W	C
	B	S-T	T	U	W	T
	C	R-S	S	T	V	O
	D	R-S	S	T	V	R

Adapted from AMCA Publication 201-202, *Fans and Systems*.



AMCA International Publication
201-90

System Effect Curve



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System Effect Curves for SWSI Fans

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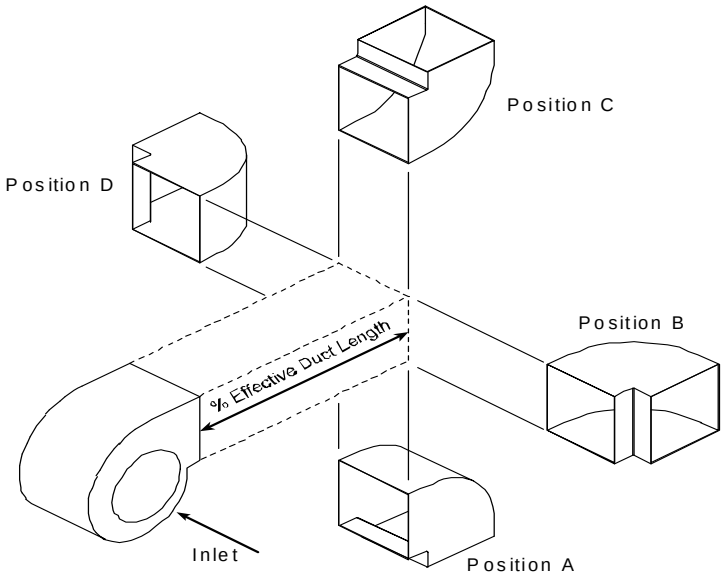
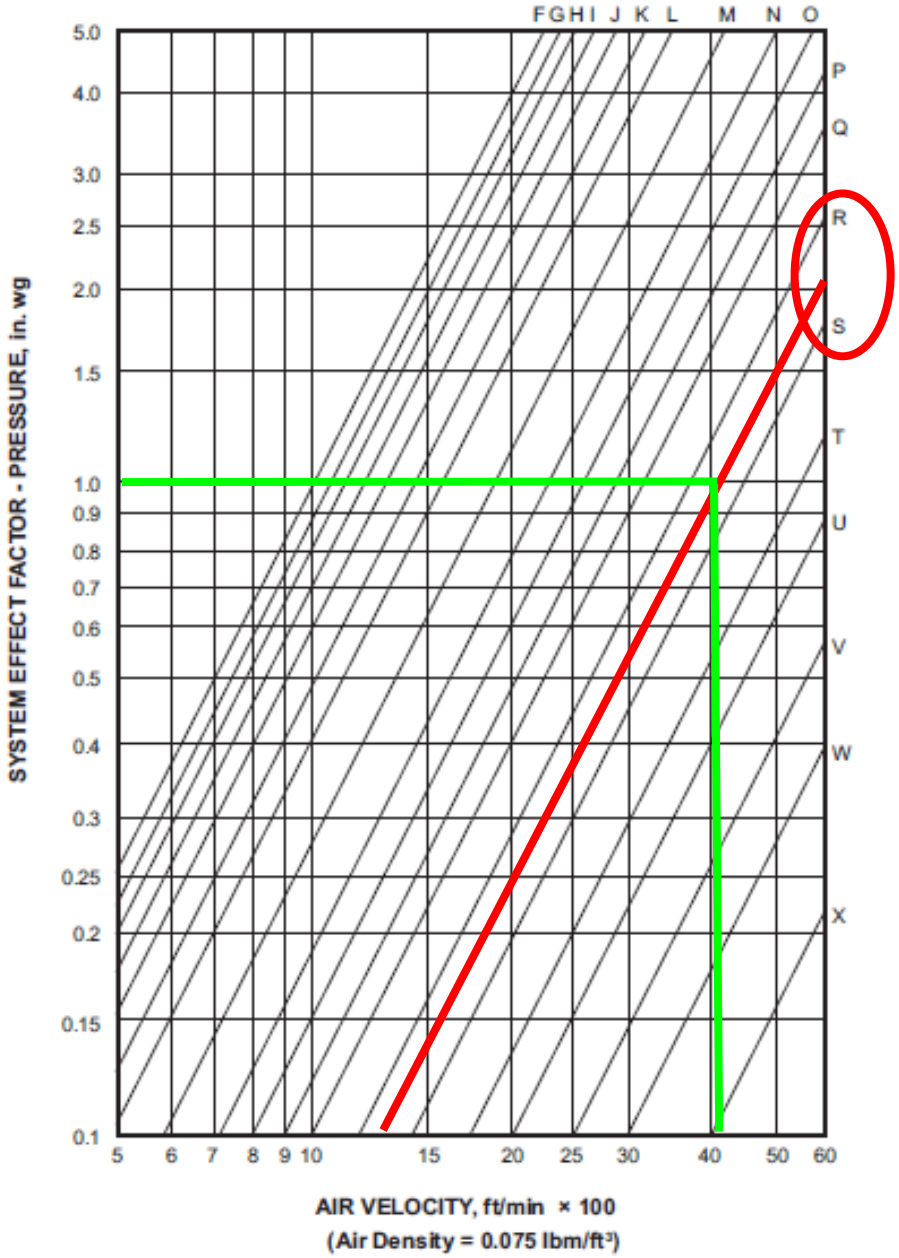
0.4	A	N	O	P-Q	S	
	B	M-N	N	O-P	R-S	
	C	L-M	M	N	Q	
	D	L-M	M	N	Q	
0.5	A	O-P	P-Q	R	T	
	B	N-O	O-P	Q	S-T	N
	C	M-N	N	O-P	R-S	O
	D	M-N	N	O-P	R-S	
0.6	A	Q	Q-R	S	U	S
	B	P	Q	R	T	Y
	C	N-O	O	Q	S	S
	D	N-O	O	Q	S	T
0.7	A	R-S	S	T	V	E
	B	Q-R	R-S	S-T	U-V	M
	C	P	Q	R-S	T	
	D	P	Q	R-S	T	E
0.8	A	S	S-T	T-U	W	F
	B	R-S	S	T	V	F
	C	Q-R	R	S	U-V	E
	D	Q-R	R	S	U-V	C
0.9	A	T	T-U	U-V	W	T
	B	S	S-T	T-U	W	
	C	R	S	S-T	V	F
	D	R	S	S-T	V	A
1	A	T	T-U	U-V	W	C
	B	S-T	T	U	W	T
	C	R-S	S	T	V	O
	D	R-S	S	T	V	R

Adapted from AMCA Publication 201-202, *Fans and Systems*.



AMCA International Publication
201-90

System Effect Curve



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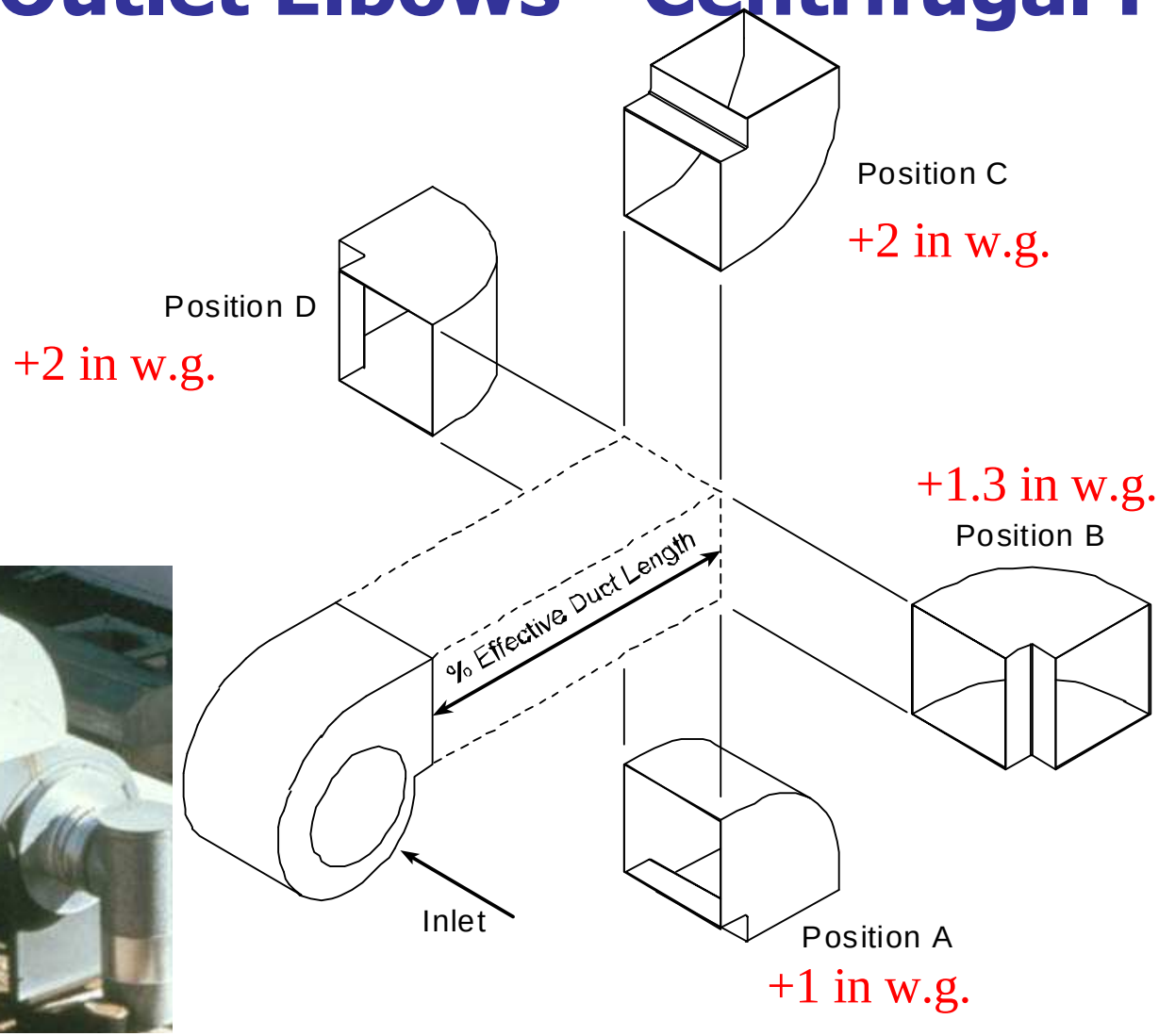
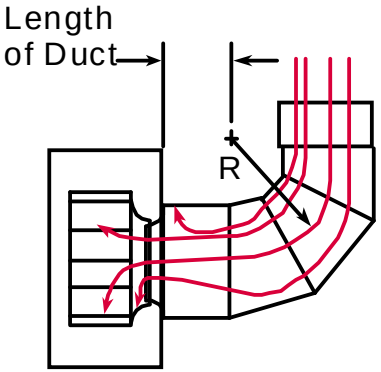
Outlet Elbows - Centrifugal Fans



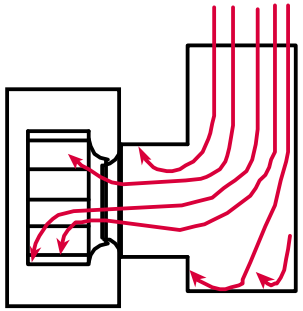
Three most common causes of deficient performance of a fan/system are:

- Improper outlet connections
- Non-uniform inlet flow
- Swirl at the inlet

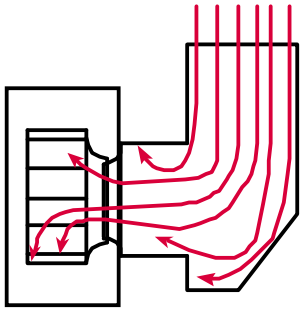
Inlet Conditions



Inlet with 3-piece elbow



Inlet with rectangular inlet Duct

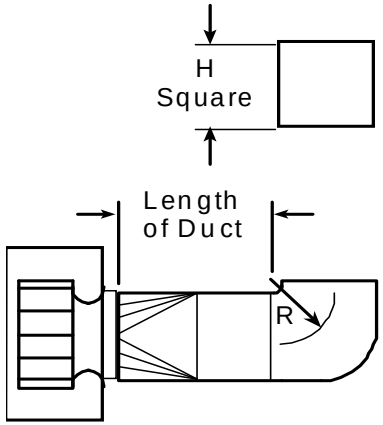


Inlet with special designed inlet box

System Effect - Square elbow and turning vanes

System Effect Curves

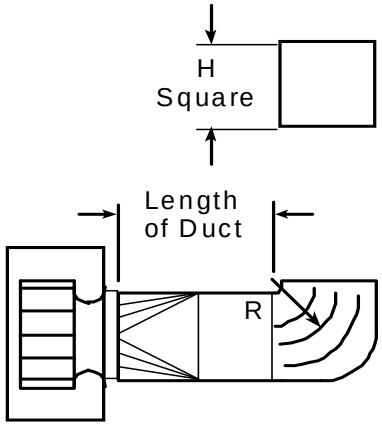
R/D	No Duct	2D Duct	5D Duct
0.5	O	Q	S
0.75	P	R	S-T
1.0	R	S-T	U-V
2.0	S	T-U	V



Square elbow - no turning vanes

System Effect Curves

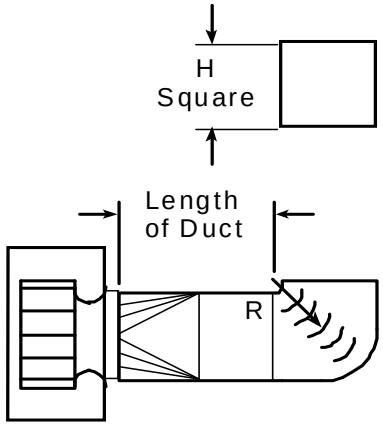
R/D	No Duct	2D Duct	5D Duct
0.5	S	T-U	V
1.0	T	U-V	W
2.0	V	V-W	W-X



Square elbow - long turning vanes

System Effect Curves

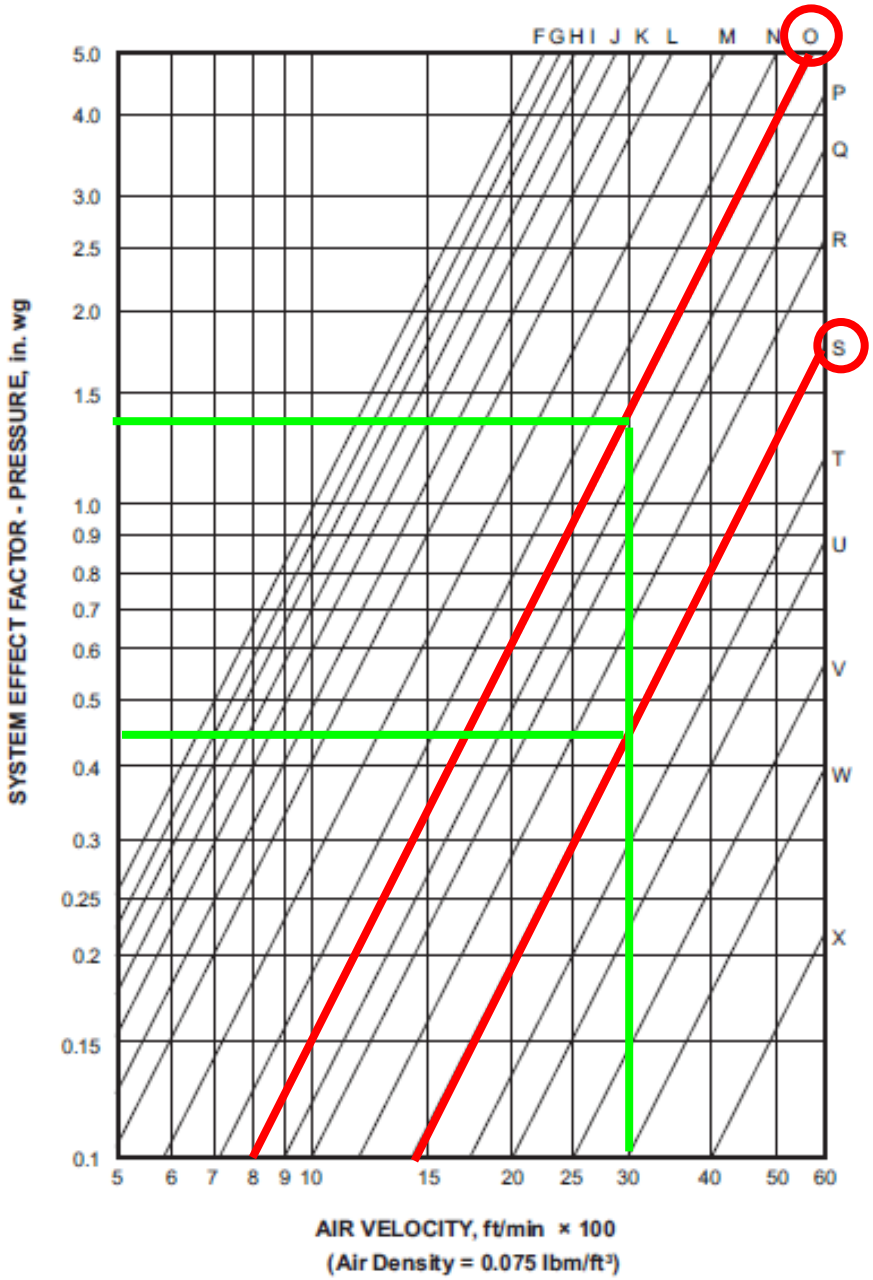
R/D	No Duct	2D Duct	5D Duct
0.5	S	T-U	V
1.0	T	U-V	W
2.0	V	V-W	W-X



Square elbow - short turning vanes

Adapted from AMCA Publication 201-202, *Fans and Systems*.

System Effect Curve

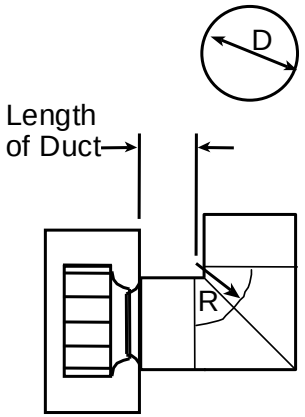


Adapted from AMCA Publication 201-202, *Fans and Systems*.

System Effect on round inlet ducts

System Effect Curves

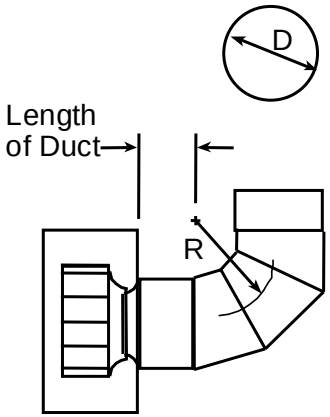
R/D	No Duct	2D Duct	5D Duct
--	N	P	R-S



2 piece mitered round section

System Effect Curves

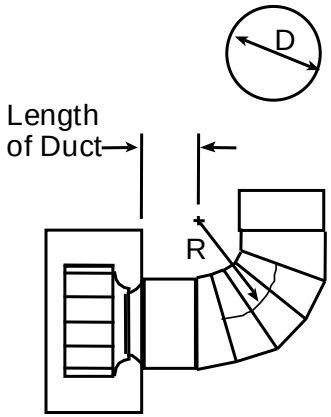
R/D	No Duct	2D Duct	5D Duct
0.5	O	Q	S
0.75	Q	R-S	T-U
1.0	R	S-T	U-V
2.0	R-S	T	U-V
3.0	S	T-U	V



3 piece mitered round section

System Effect Curves

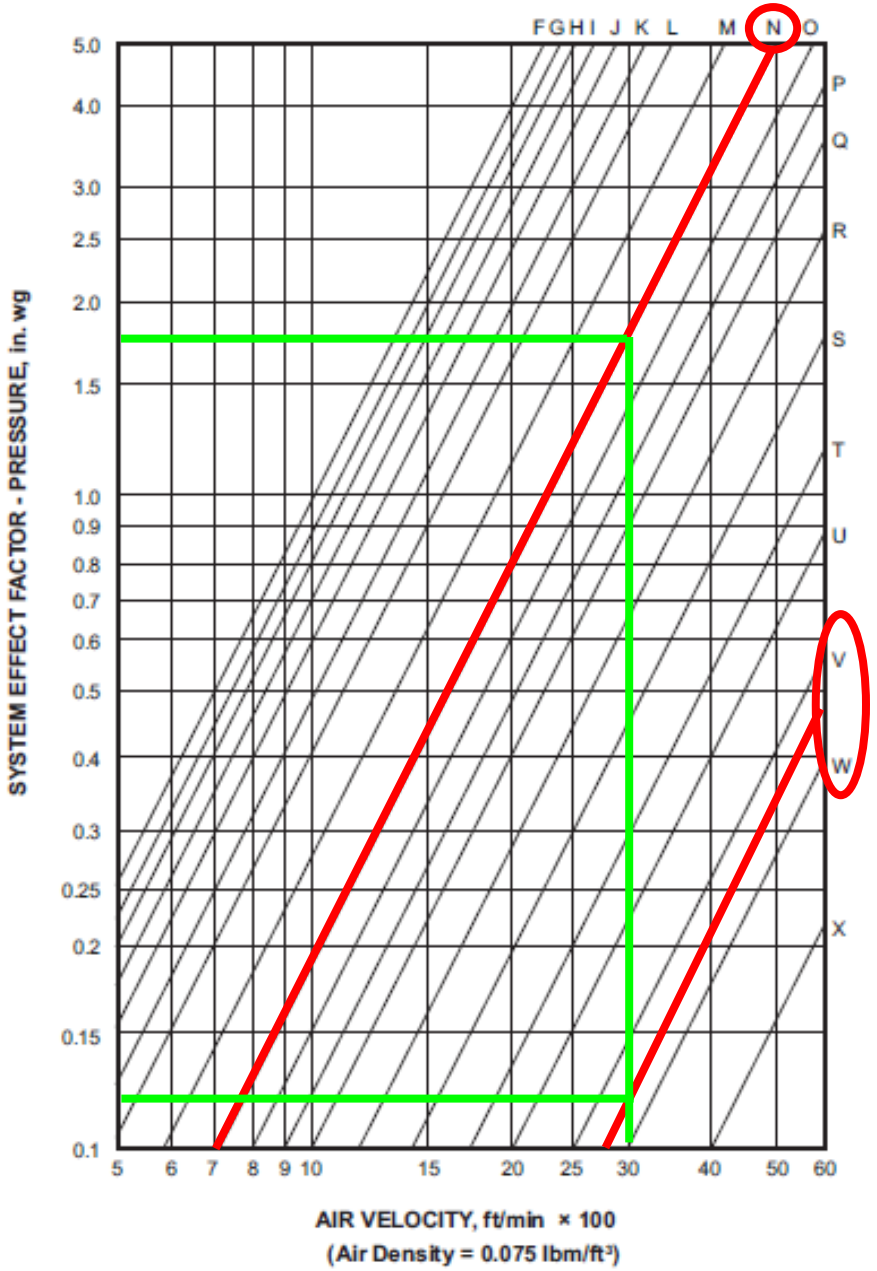
R/D	No Duct	2D Duct	5D Duct
0.5	P-Q	R-S	T
0.75	Q-R	S	U
1.0	R	S-T	U-V
2.0	R-S	T	U-V
3.0	S-T	U	V-W



4 or more piece mitered round section

Adapted from AMCA Publication 201-202, *Fans and Systems*.

System Effect Curve



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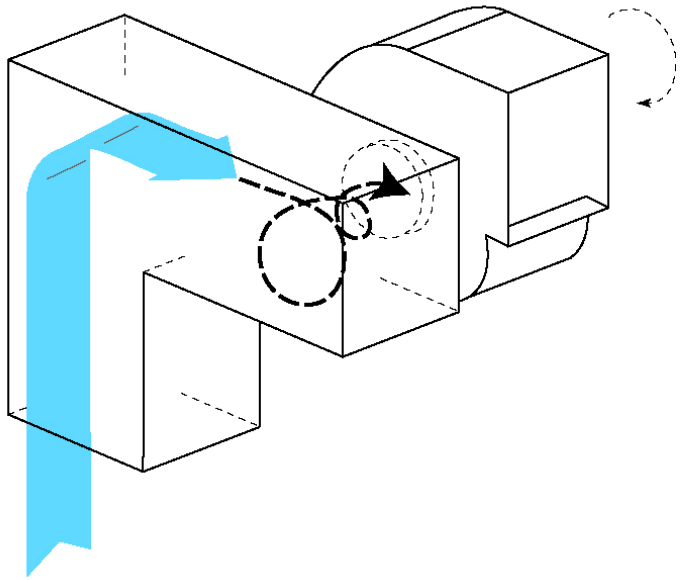
Three most common causes of deficient performance of a fan/system are:

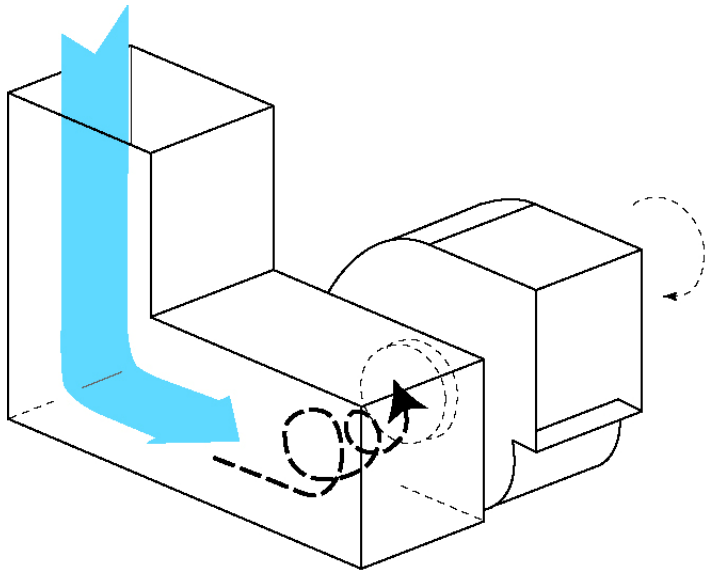
- Improper outlet connections
- Non-uniform inlet flow
- Swirl at the inlet

Inlet Swirl

Pre-Rotation

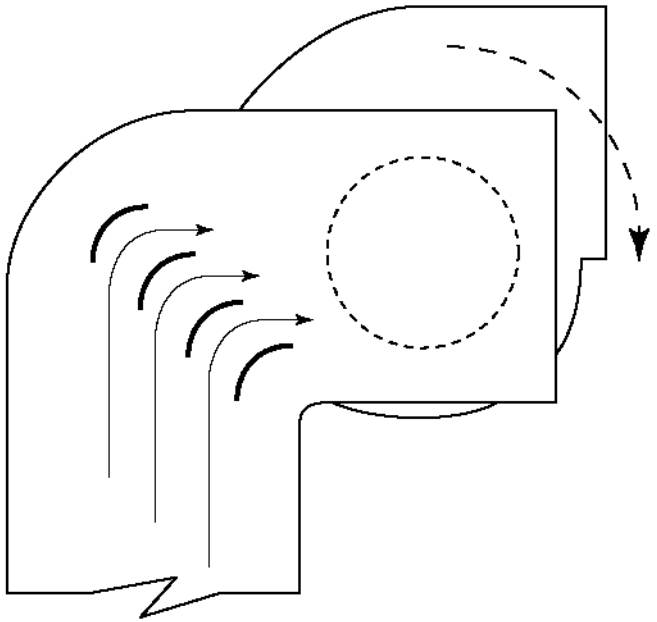


Counter-Rotation



Inlet Swirl

Best solution for inlet swirl is turning vanes.



The CALL !!!

"My fan isn't performing, come fix it."

"I ordered 3,000 cfm at 1 inch

Balancer said I have 2,500 at 3/4 inch."

What's the PROBLEM?

- Fan?
- Motor?
- Inlet conditions?
- Outlet conditions?

Let's Look at Installation!!!

Back to The CALL!

Givens:

- Centrifugal Fan
- 3,000 cfm at 1 inch static pressure
- 13 by 13 inch fan discharge / duct size
- 9 by 13 inch blast area
- **NO** duct length after discharge

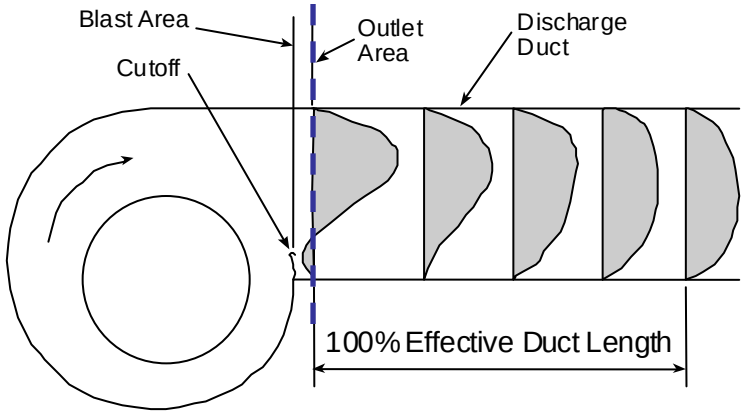
- 3,000 cfm / (13 x 13) = 2556 FPM

- Equiv. Duct Dia. = (4 x 13 x 13 / 3.14)^0.5 = 14.5 inches

  Effective duct length = 2.5 + 1 = 3.5 ducts = 3.5 x 14.5 inches = 4 ft

- Blast Area / Outlet Area = (9 x 13) / (13 x 13) = 0.7

System Effect Curves for Outlet Ducts - Centrifugal Fans



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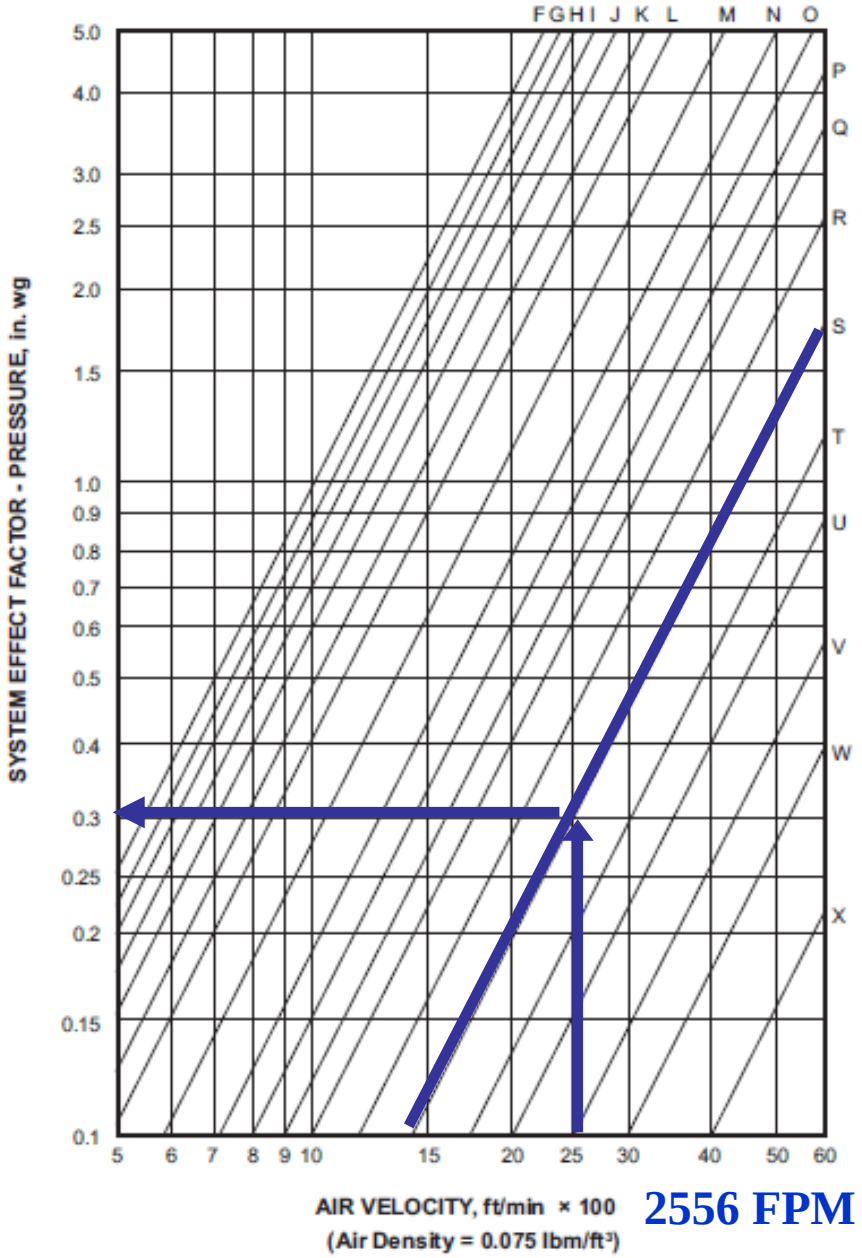
0.5	P	R-S	U	W	--
0.6	R-S	S-T	U-V	W-X	--
0.7	S	U	W-X	--	--
0.8	T-U	VW	X	--	--
0.9	W-W	W-X	--	--	--
1.0	--	--	--	--	--

Adapted from AMCA Publication 201-202, *Fans and Systems*.

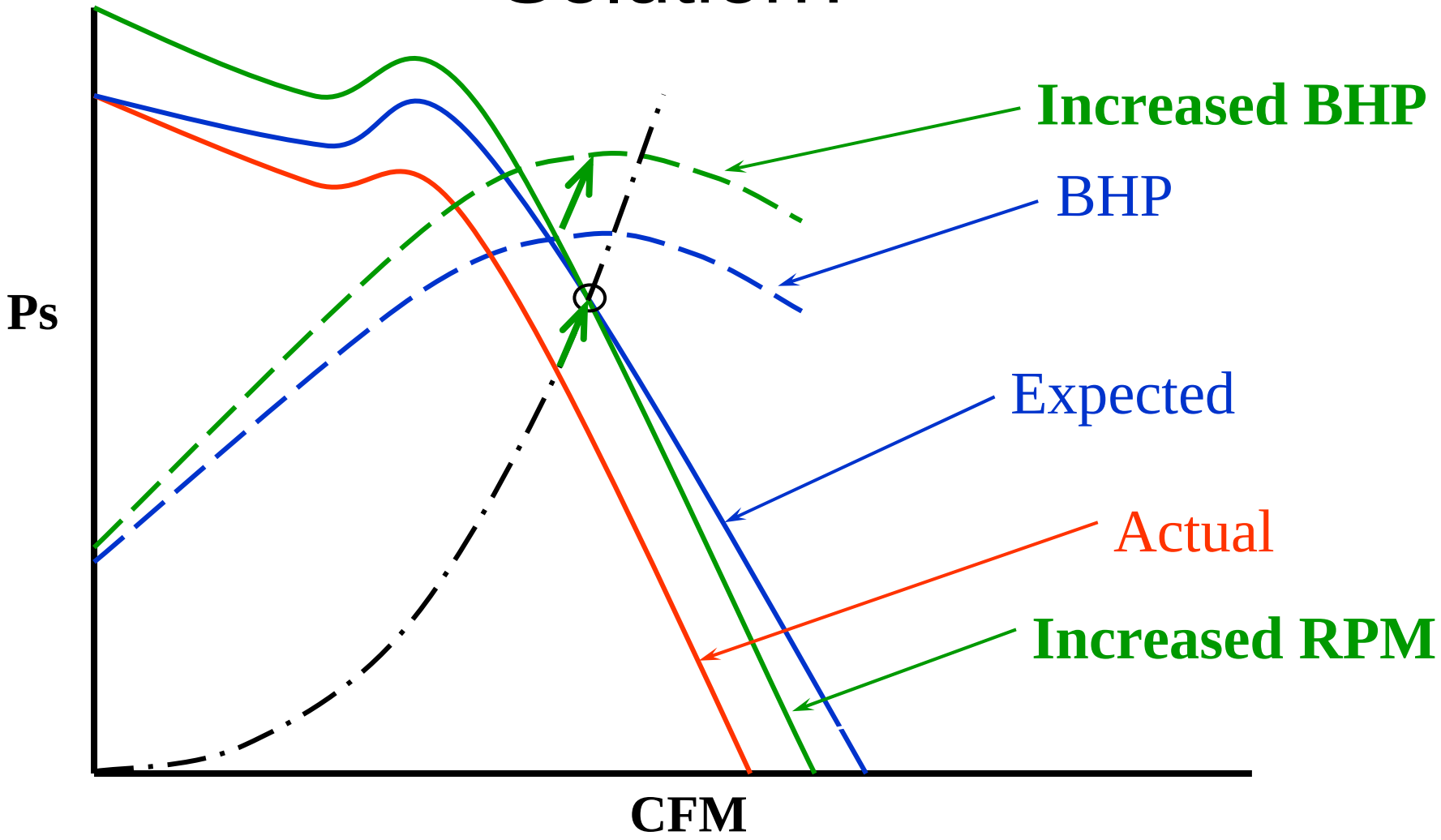
System Effect Curve

System Effect Factor (no duct) ~ 0.3 inches



Adapted from AMCA Publication 201-202, *Fans and Systems*.

Solution?



Back to The CALL!

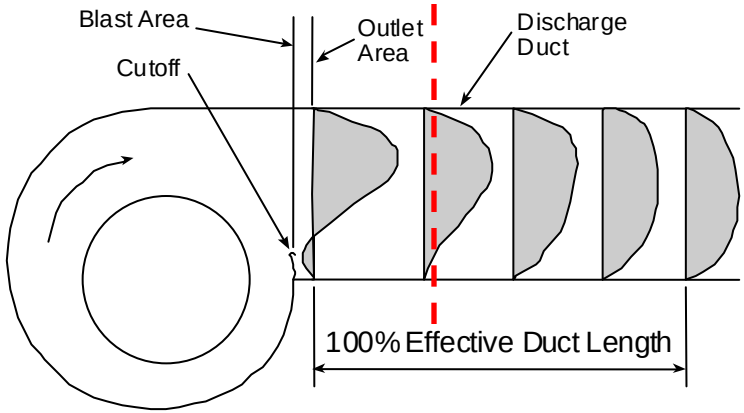
Givens:

- Centrifugal Fan
- 3,000 cfm at 1 inch static pressure
- 13 by 13 inch fan discharge / duct size
- 9 by 13 inch blast area

- **What if they placed a 12 inch duct after the discharge?**

(1 ft of duct length = 25% of the effective length)

System Effect Curves for Outlet Ducts - Centrifugal Fans



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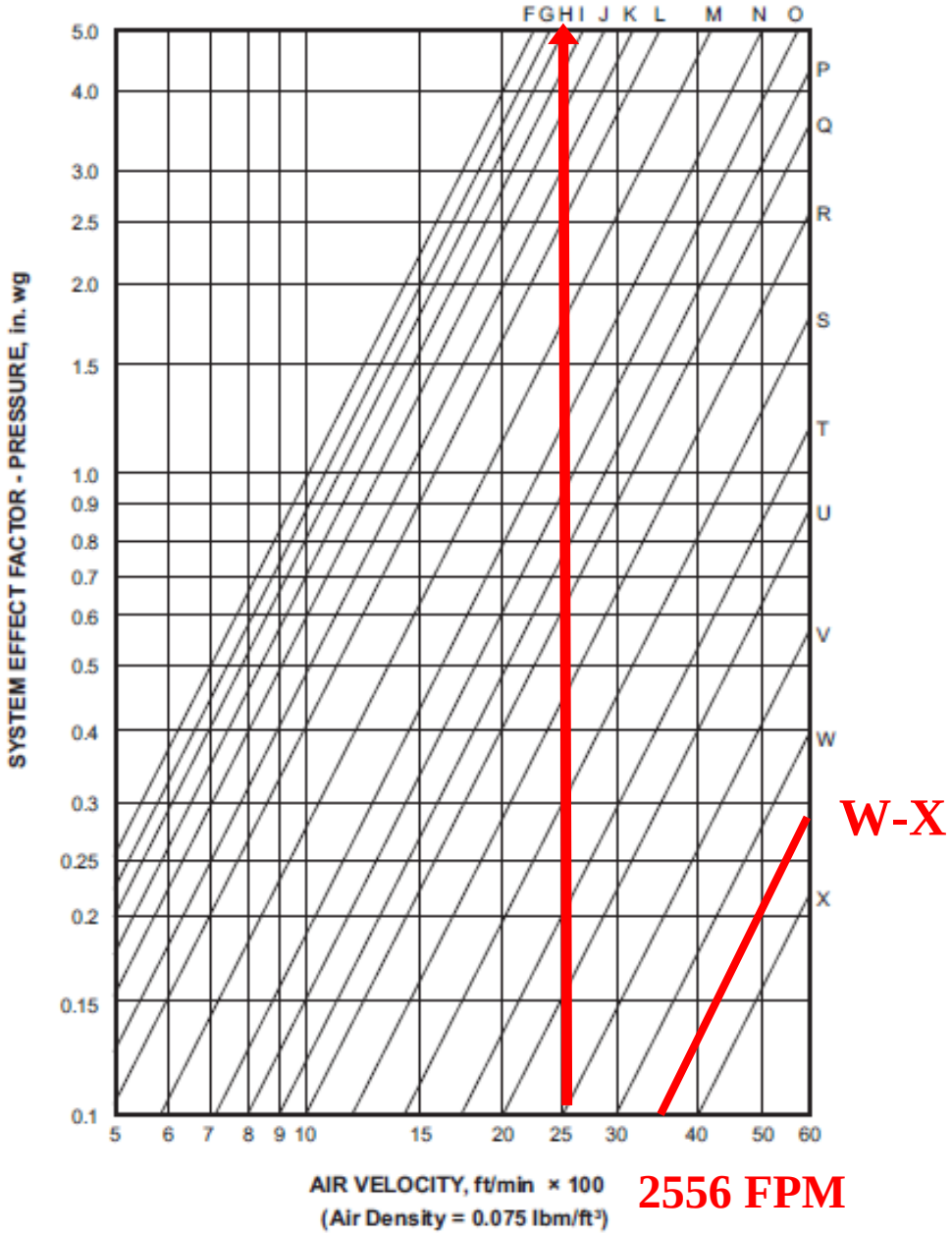
0.6	R-S	S-T	U-V	W-X	--
0.7	S	U	W-X	--	--
0.8	T-U	VW	X	--	--
0.9	W-W	W-X	--	--	--
1.0	--	--	--	--	--

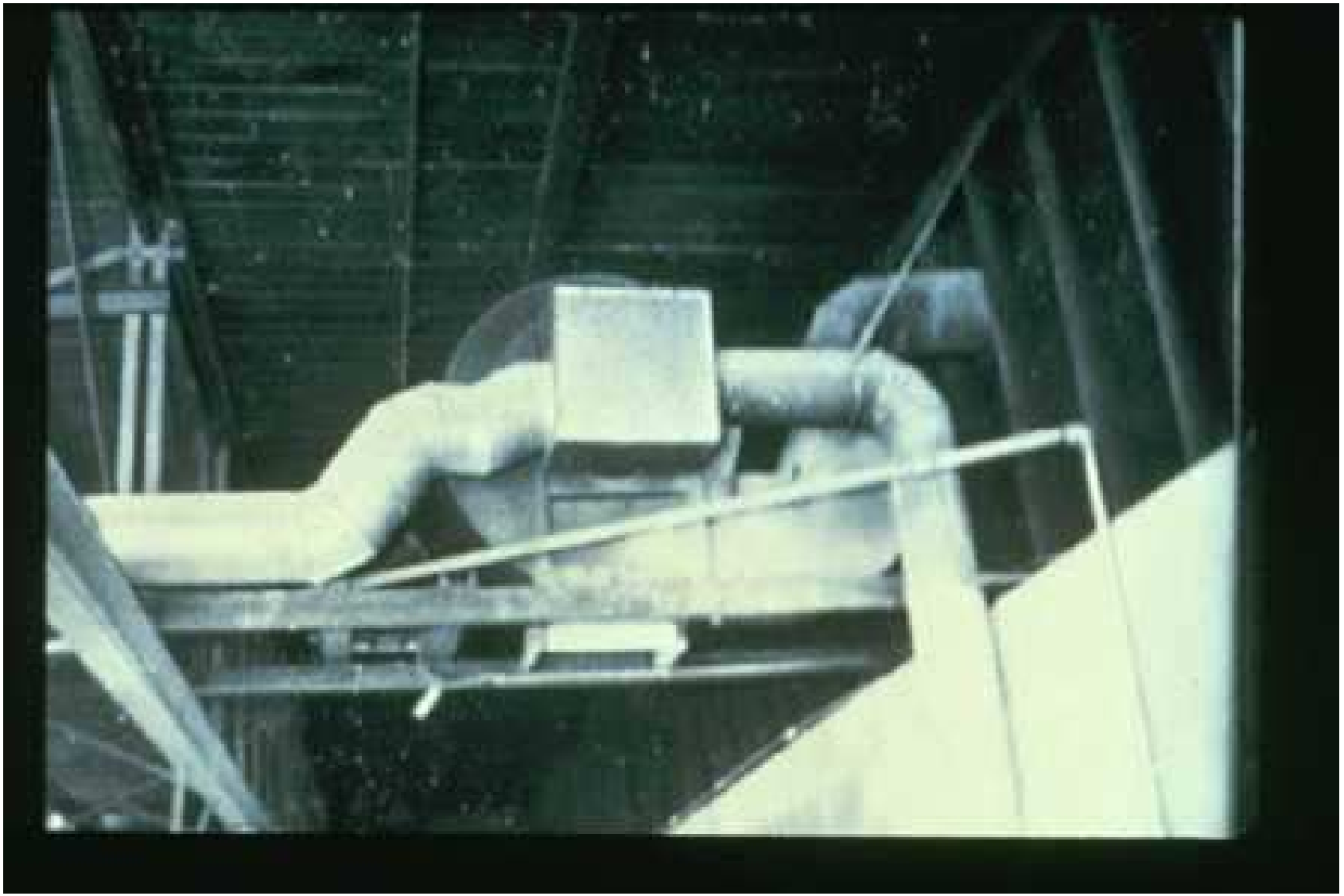
Adapted from AMCA Publication 201-202, *Fans and Systems*.

System Effect Curve

No system effect with 25% effective duct length

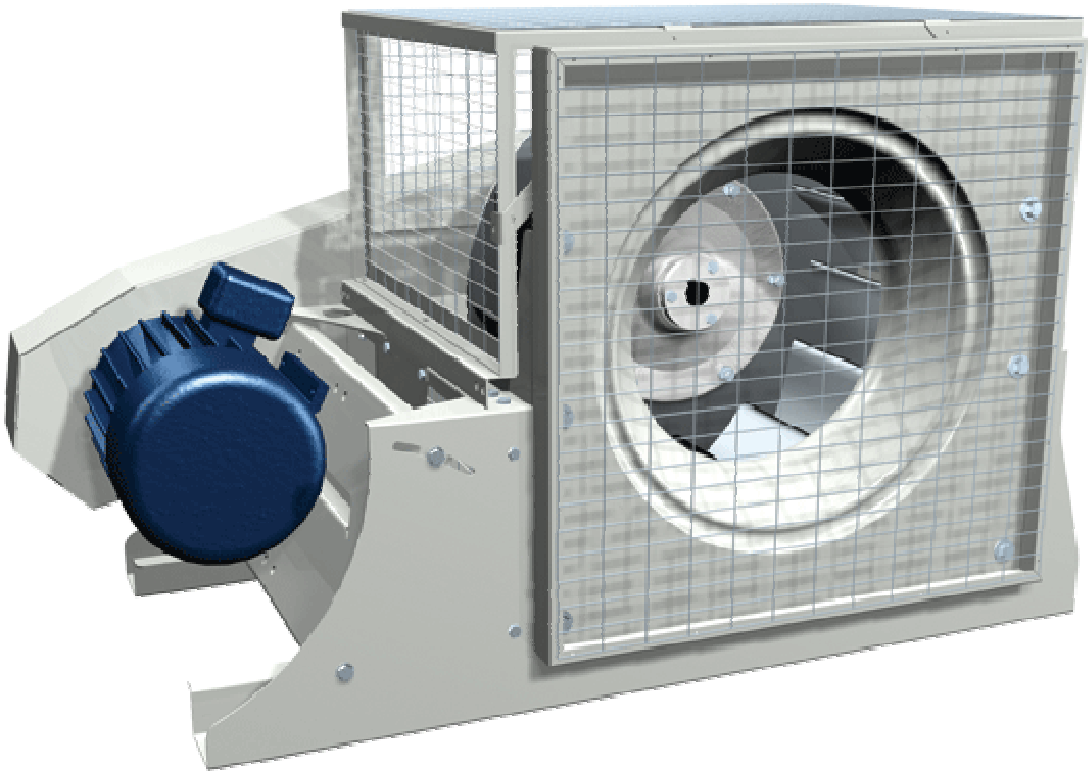


Adapted from AMCA Publication 201-202, *Fans and Systems*.



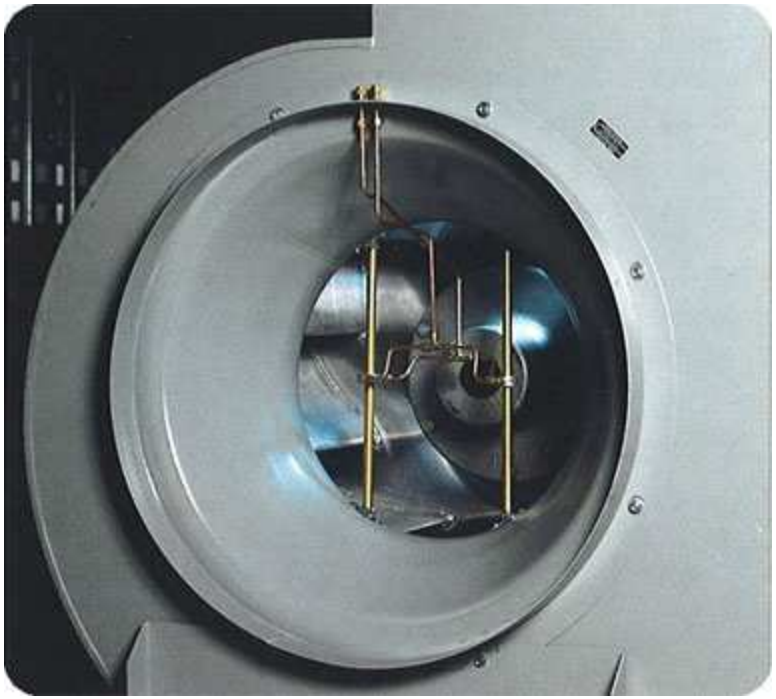
Nice Work!

Flow Probe System Effect



Plenum Fan

Typical Flow Probes



- Mounted into the smallest diameter of the fan inlet venturi
- Use 3/8" to 3/4" tubing that is designed to measure total and static pressure components of airflow

Flow Probe System Effect Video

General Rules of Thumb

- Minimum 2.5 duct diameters on Outlet
- Minimum 5 to 8 duct diameters on Inlet
- Avoid inlet swirl

  - **If any of these general rules are broken, be aware of the system effect results**

Thank You for your Time

Matthew Spink, P.E.
Greenheck Fan Corporation