



AMCA International

Minimizing System Effect

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Air System Engineering & Technology (ASET) Conference-US

San Antonio, TX • Hyatt Regency San Antonio Riverwalk • March 6 - 7, 2018

Professional Development Hours (PDH) Certificates

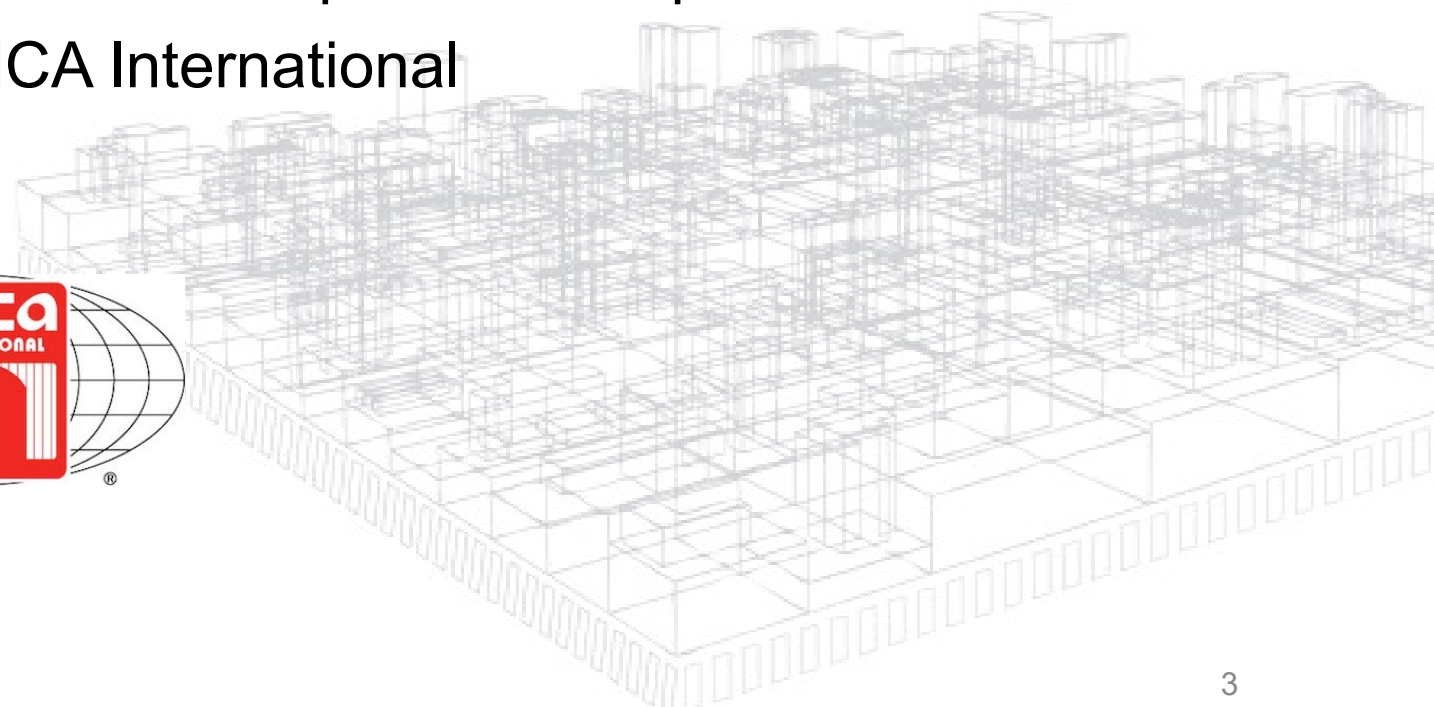
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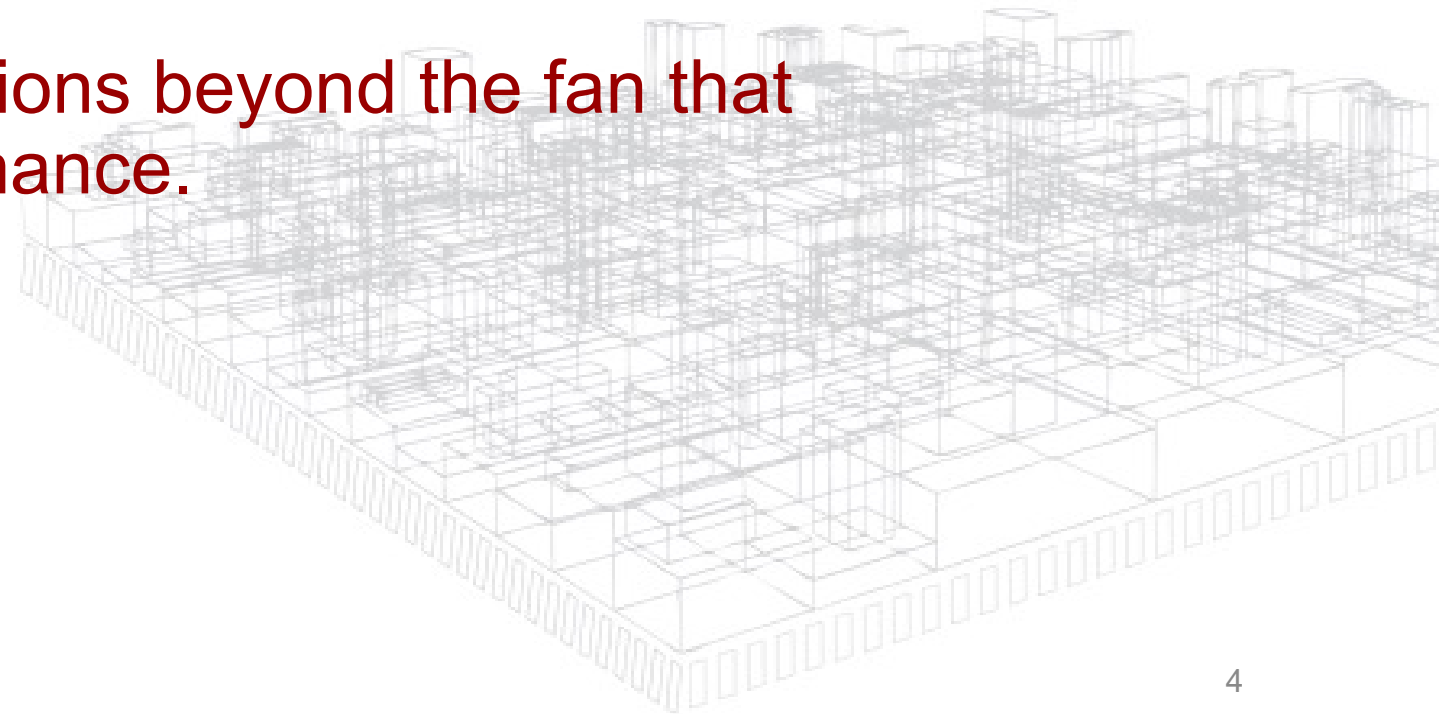
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Learning Objectives

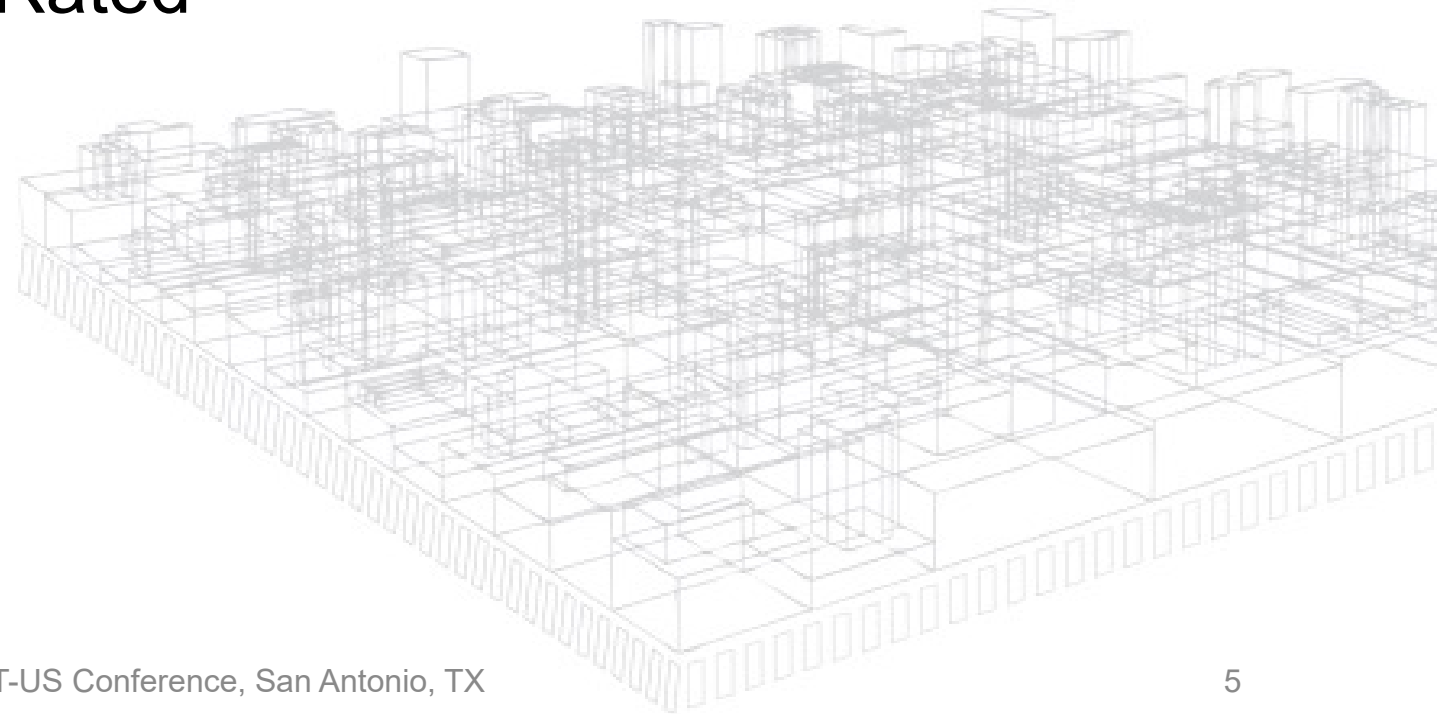
- Review the primary engineering principles involved in fan operation, rating, and performance.
- Understand conditions beyond the fan that impact fan performance.



Fan Fundamentals

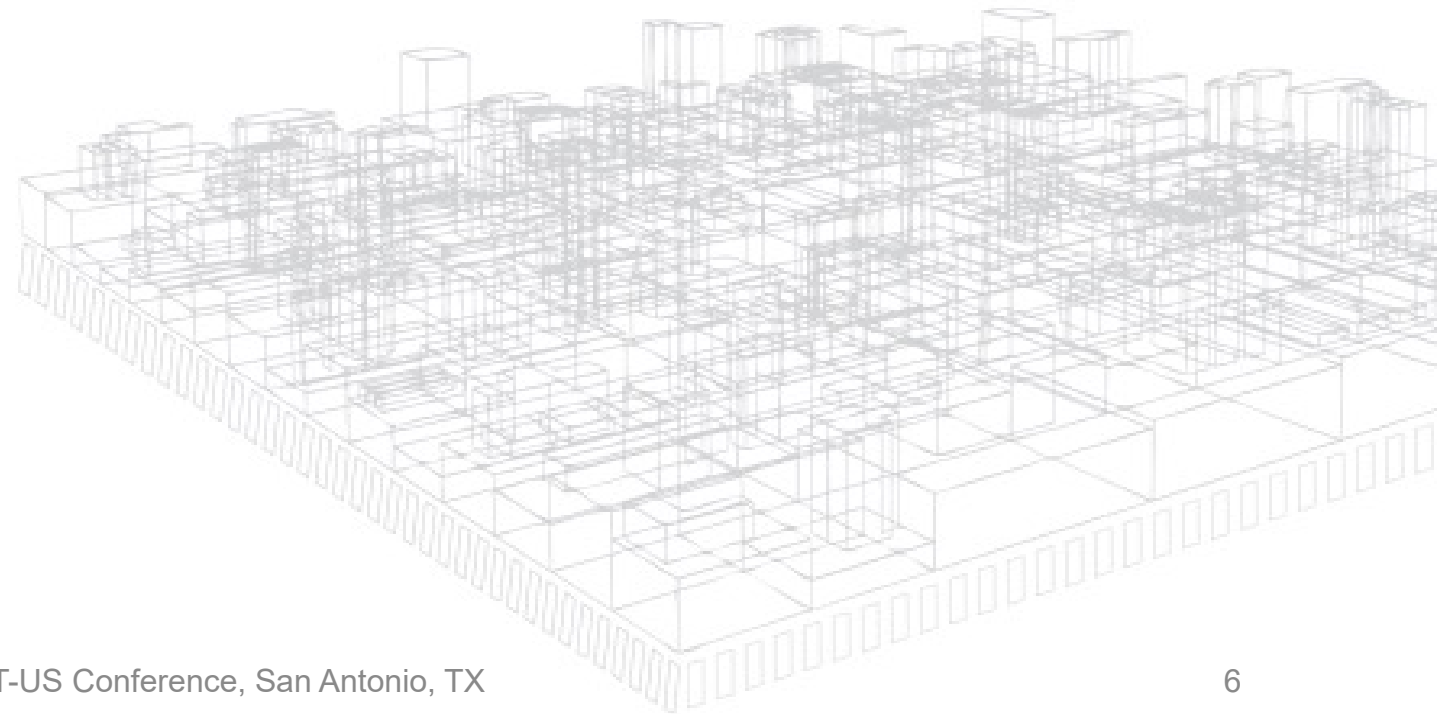
Subjects

- Fan Laws
- How Fans are Tested and Rated
- Various Fan Types
- System Effects

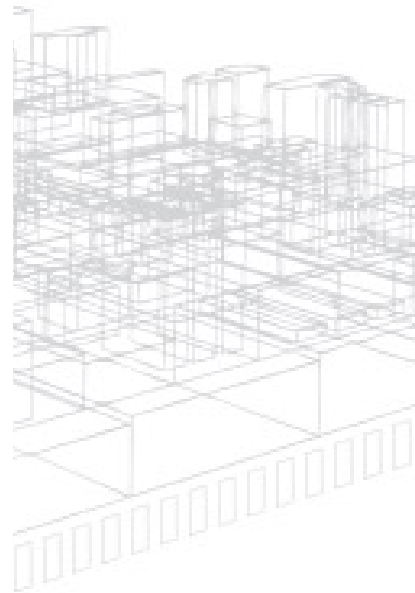
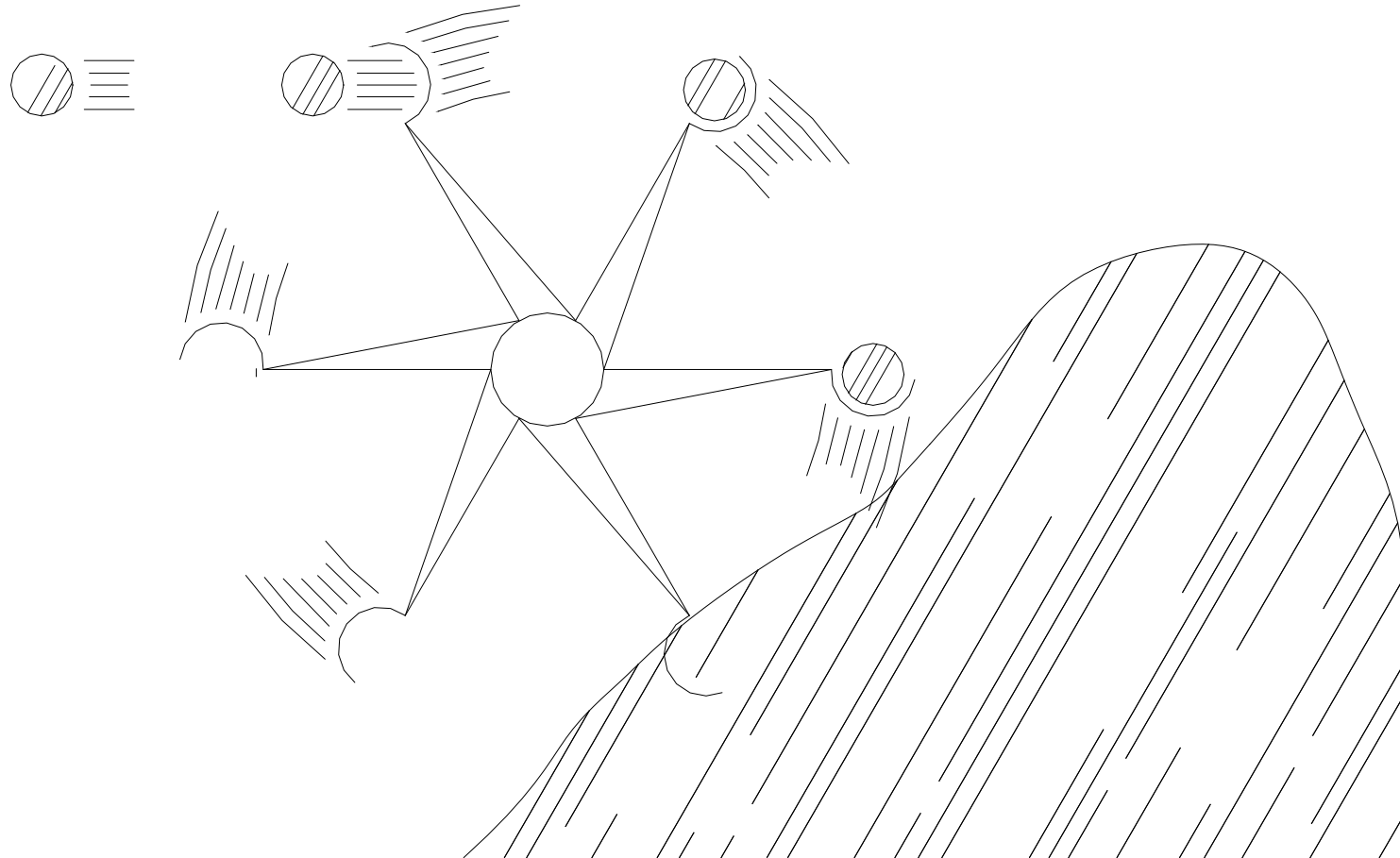


Key Terms

- CFM
- SP (Ps)
- VP (Pv)
- RPM
- BHP
- kW

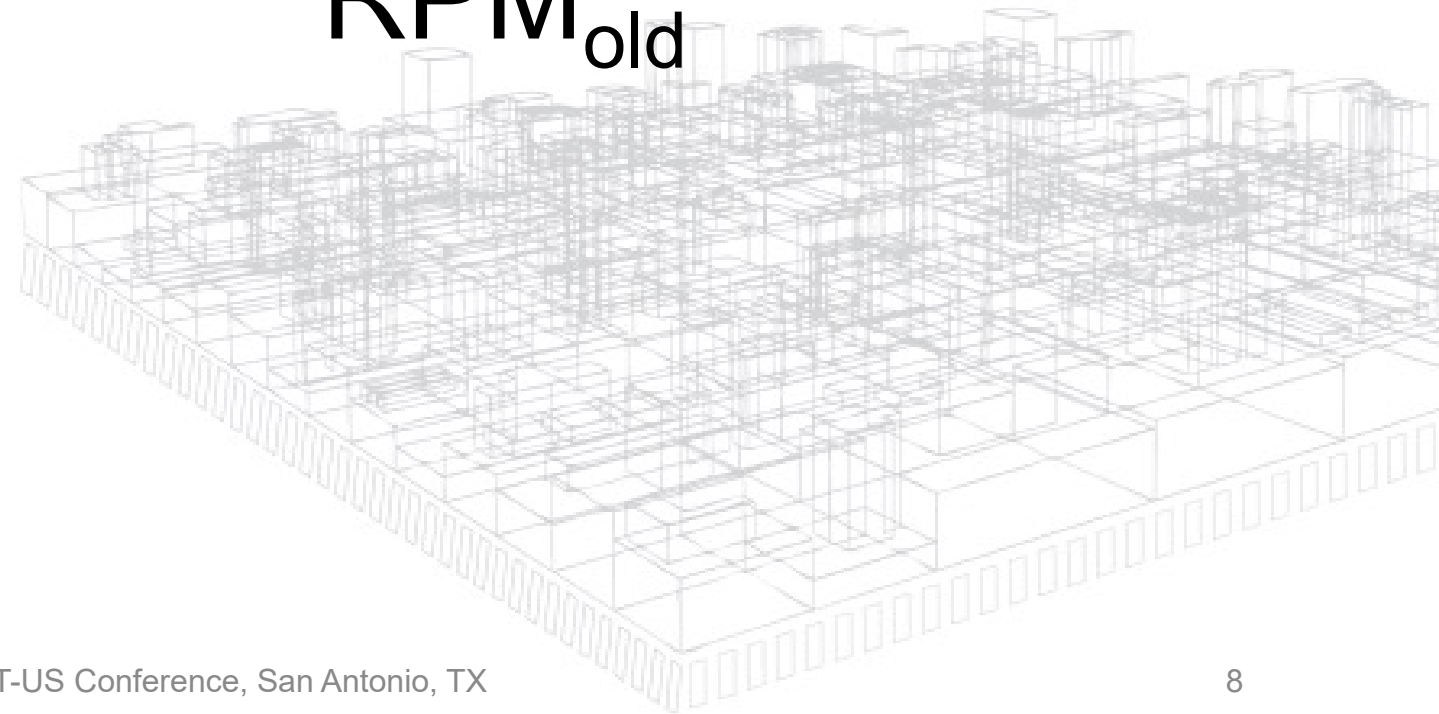


Fan Laws



Fan Laws

$$\frac{\text{CFM}_{\text{new}}}{\text{CFM}_{\text{old}}} = \frac{\text{RPM}_{\text{new}}}{\text{RPM}_{\text{old}}}$$



Fan Laws

- CFM = **10,000**

- SP = 1"

- RPM = **1,000**

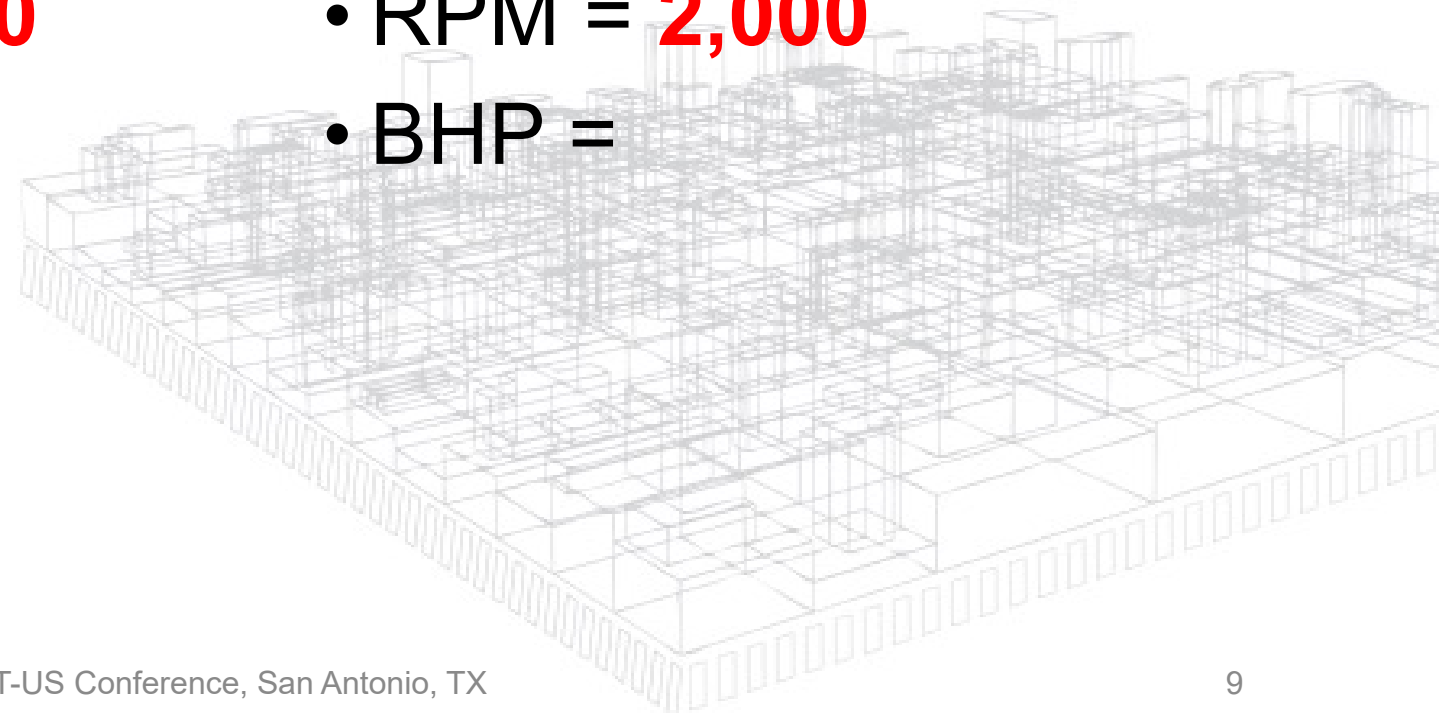
- BHP = 10

- CFM =

- SP =

- RPM = **2,000**

- BHP =



Fan Laws

- CFM = **10,000**

- SP = 1"

- RPM = **1,000**

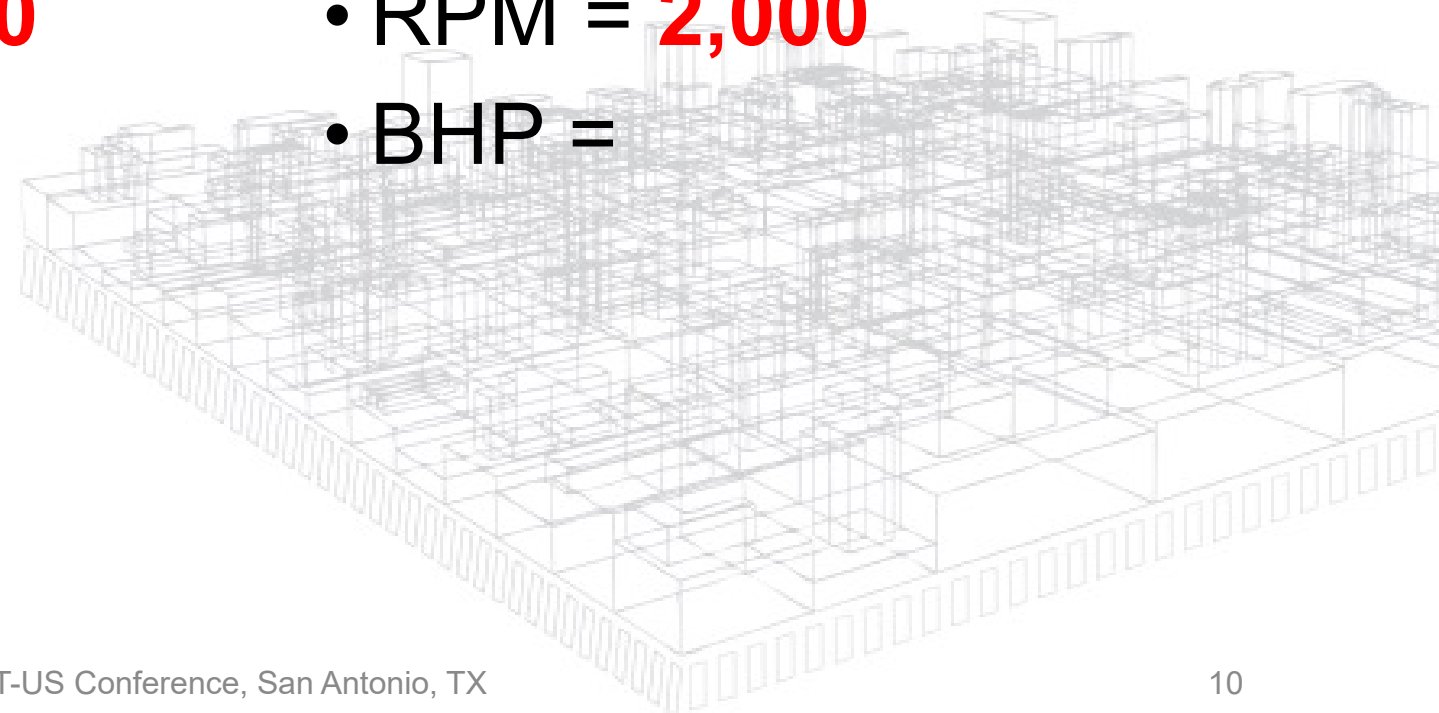
- BHP = 10

- CFM = **20,000**

- SP =

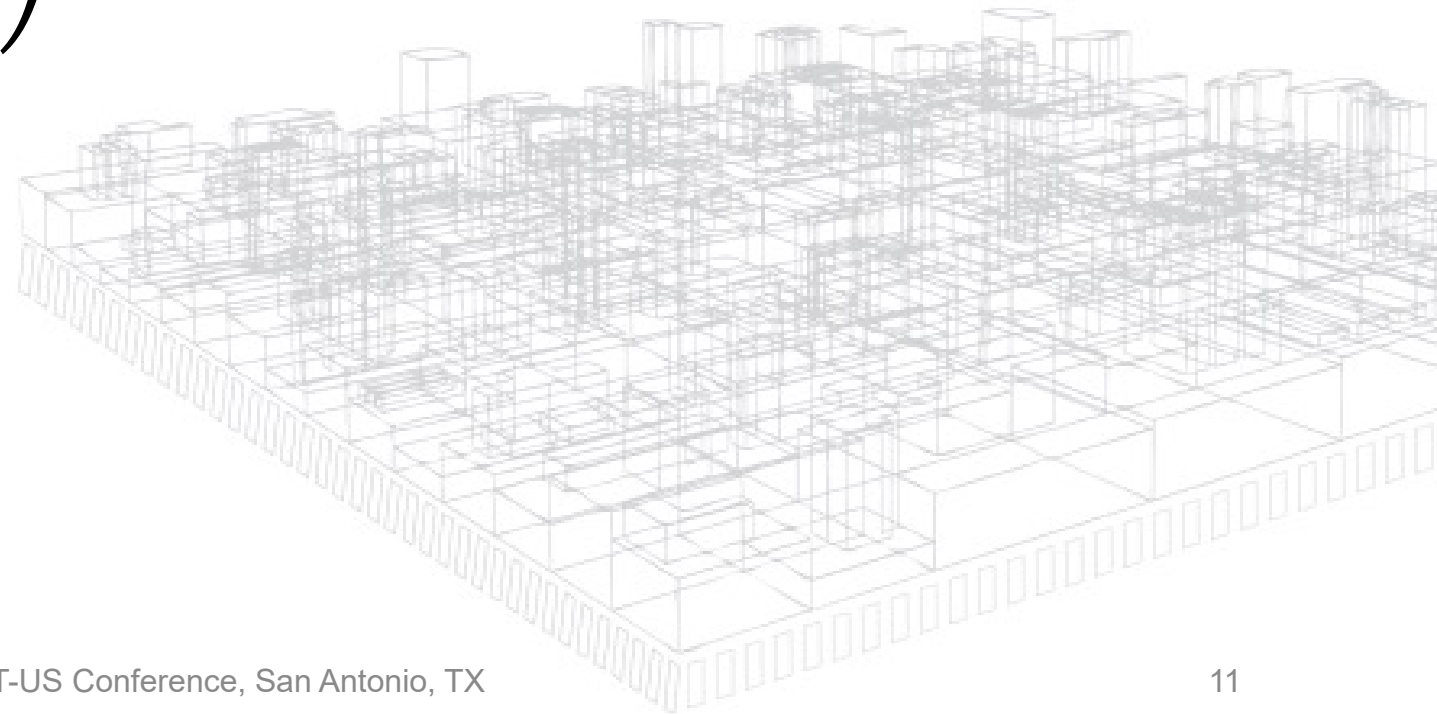
- RPM = **2,000**

- BHP =



Fan Laws

$$\frac{SP_{new}}{SP_{old}} = \left(\frac{RPM_{new}}{RPM_{old}} \right)^2$$



Fan Laws

- CFM = 10,000

- SP = **1"**

- RPM = **1,000**

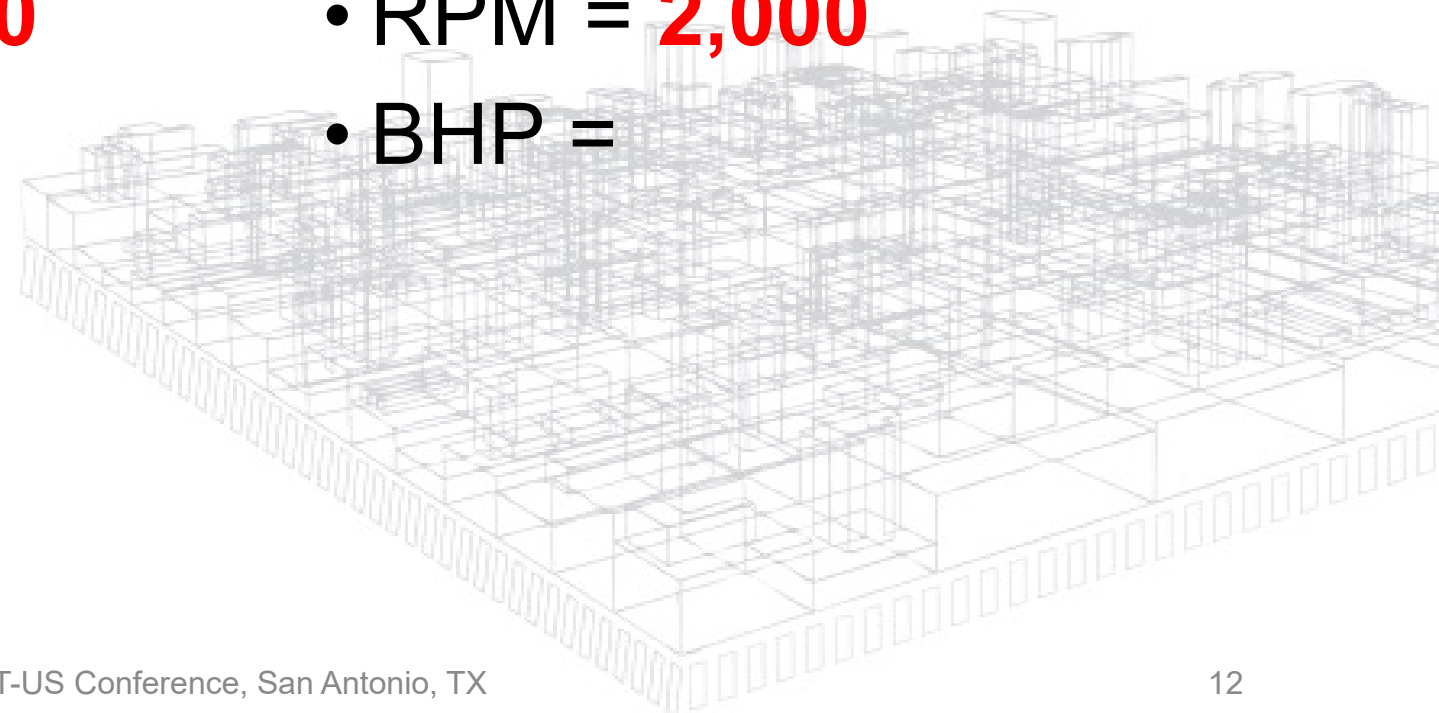
- BHP = 10

- CFM = 20,000

- SP =

- RPM = **2,000**

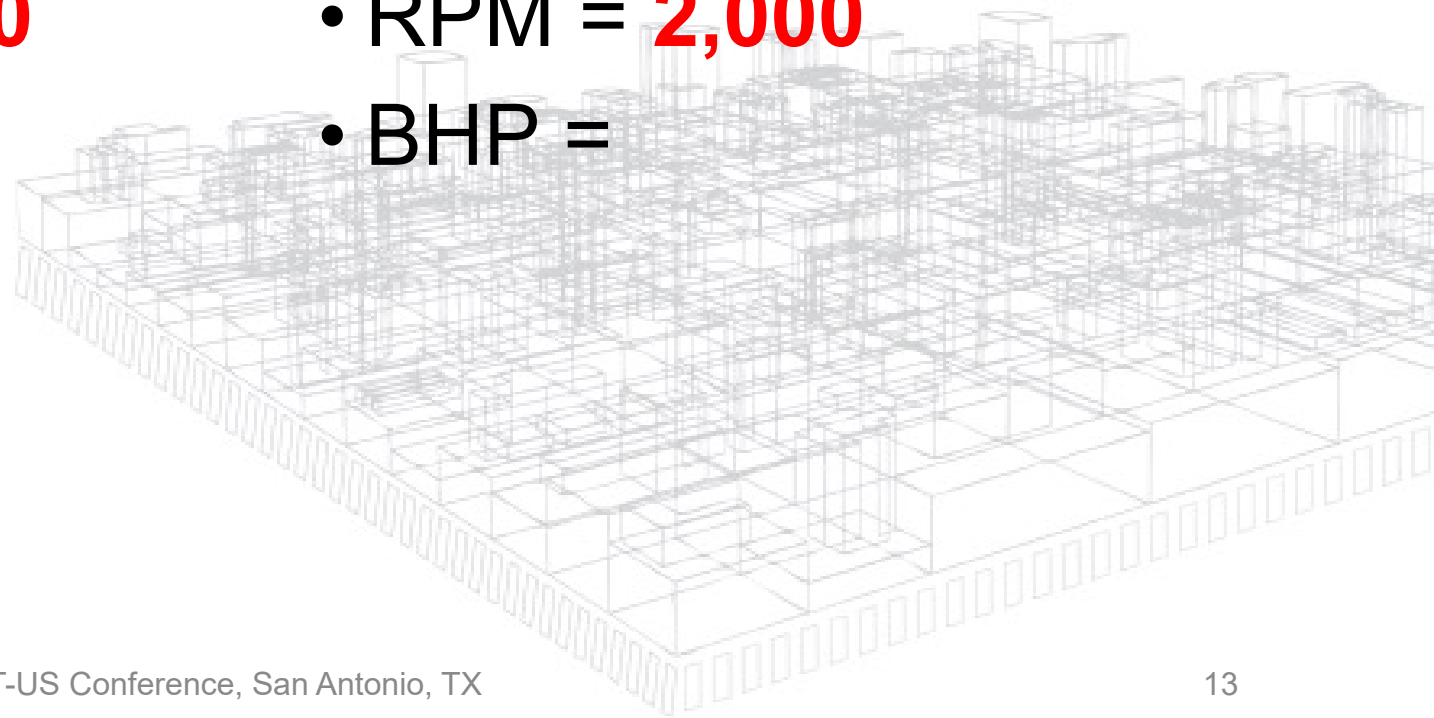
- BHP =



Fan Laws

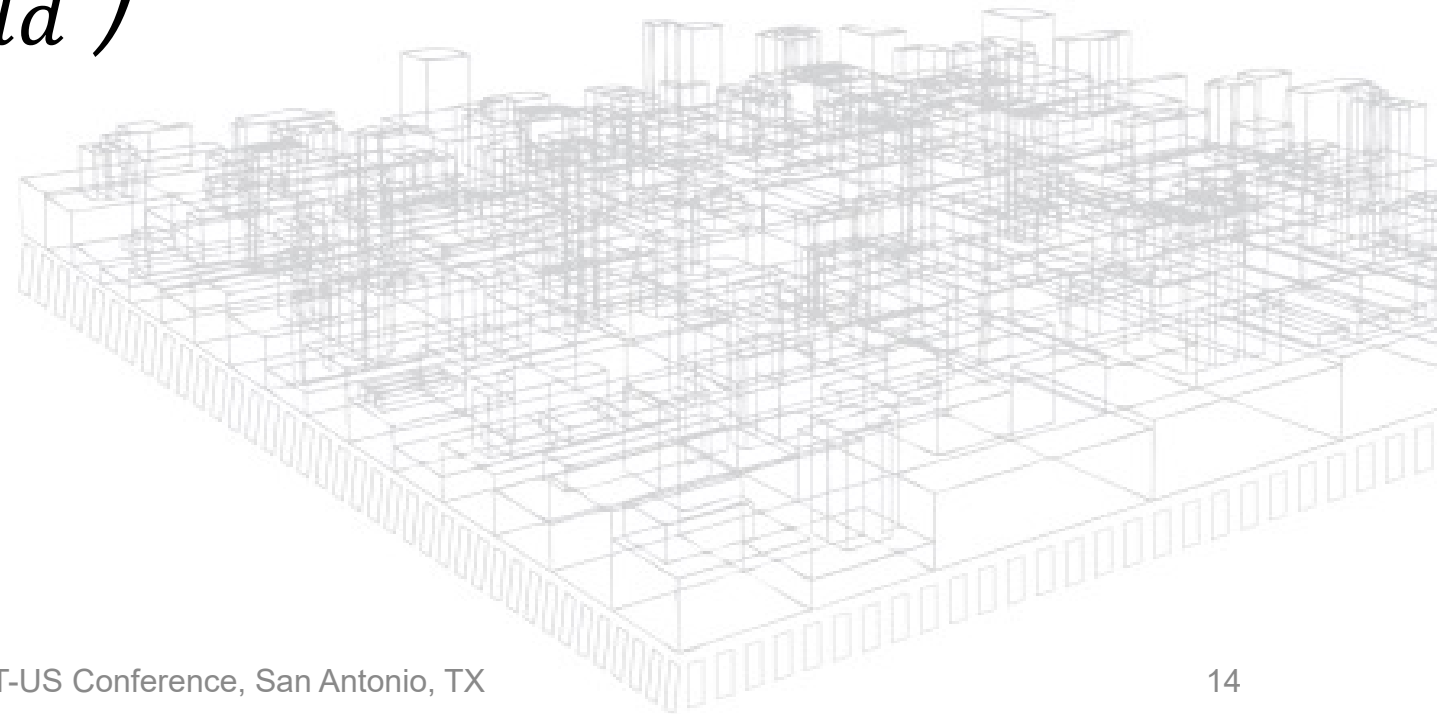
- CFM = 10,000
- SP = **1"**
- RPM = **1,000**
- BHP = 10

- CFM = 20,000
- SP = **4"**
- RPM = **2,000**
- BHP =



Fan Laws

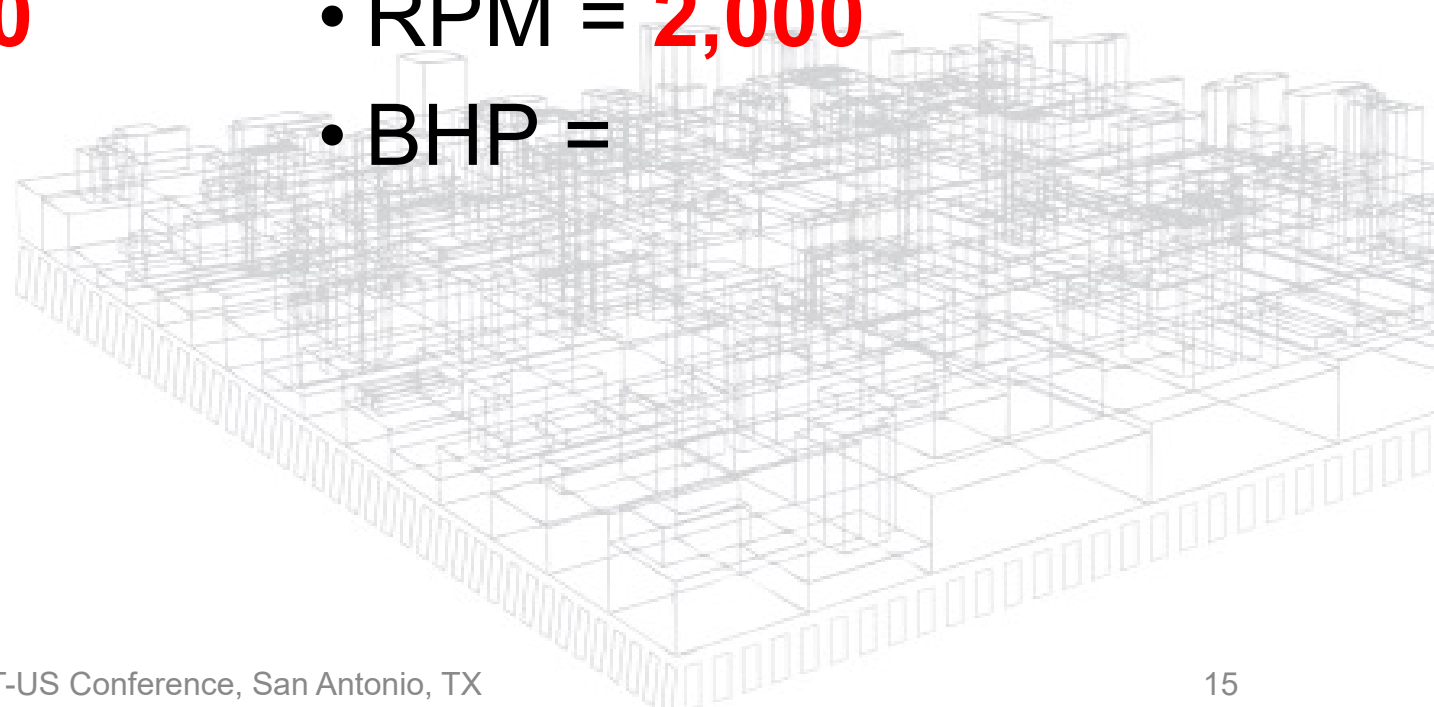
$$\frac{BHP_{new}}{BHP_{old}} = \left(\frac{RPM_{new}}{RPM_{old}} \right)^3$$



Fan Laws

- CFM = 10,000
- SP = 1"
- RPM = **1,000**
- BHP = **10**

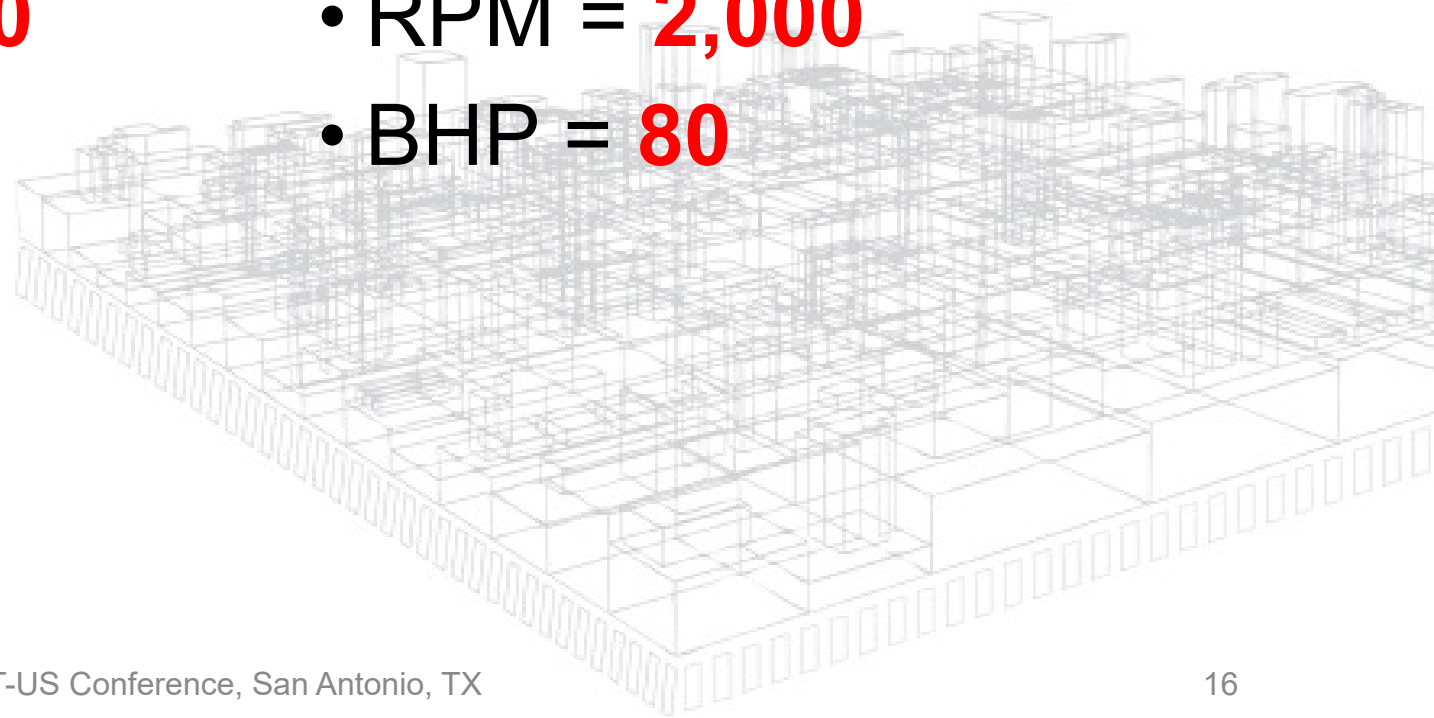
- CFM = 20,000
- SP = 4"
- RPM = **2,000**
- BHP =



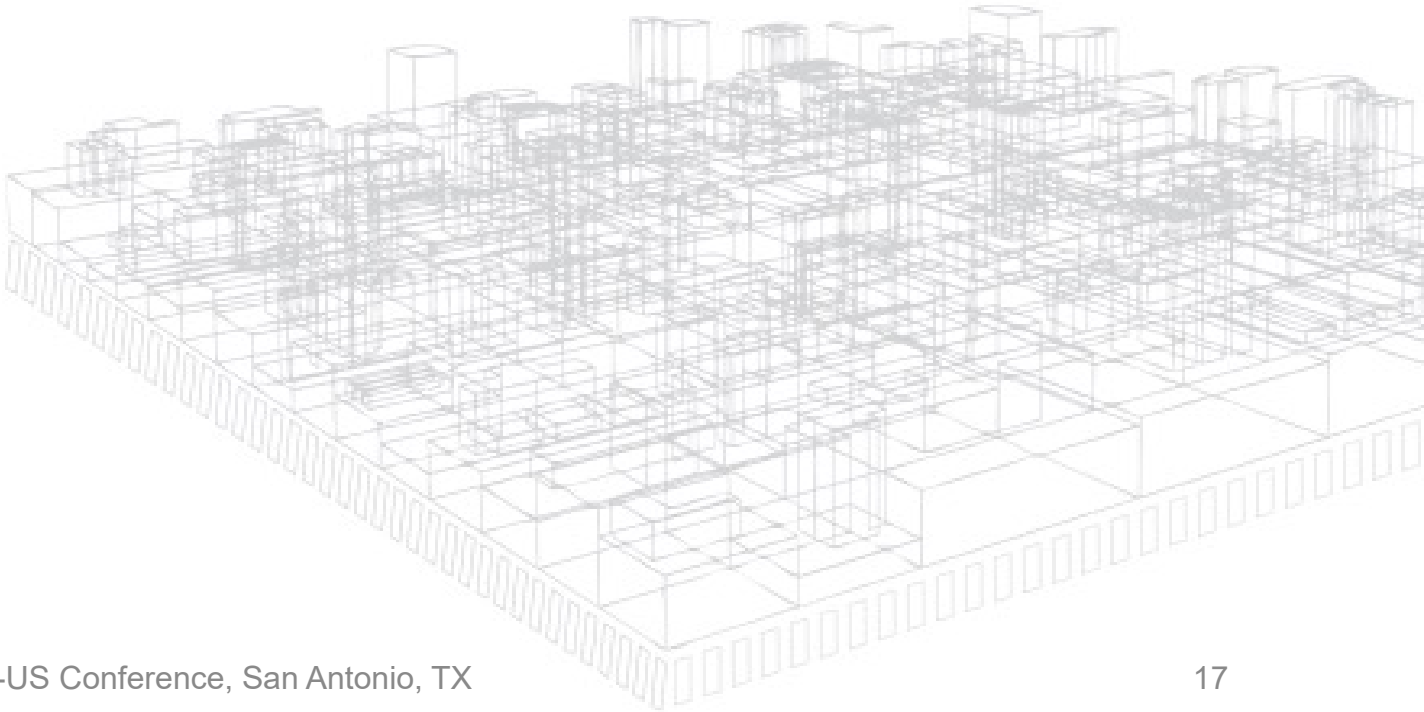
Fan Laws

- CFM = 10,000
- SP = 1
- RPM = **1,000**
- BHP = **10**

- CFM = 20,000
- SP = 4"
- RPM = **2,000**
- BHP = **80**



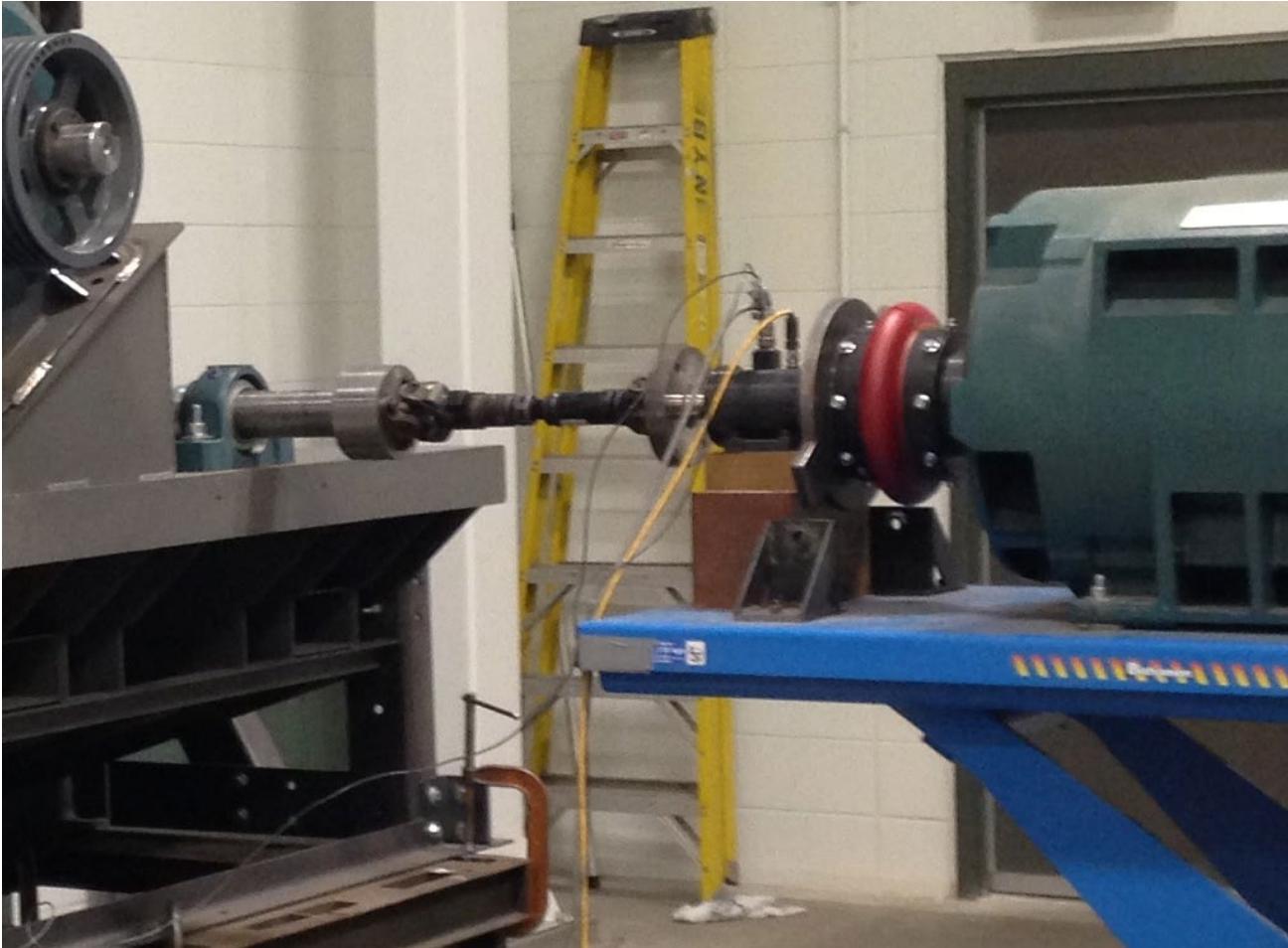
Testing



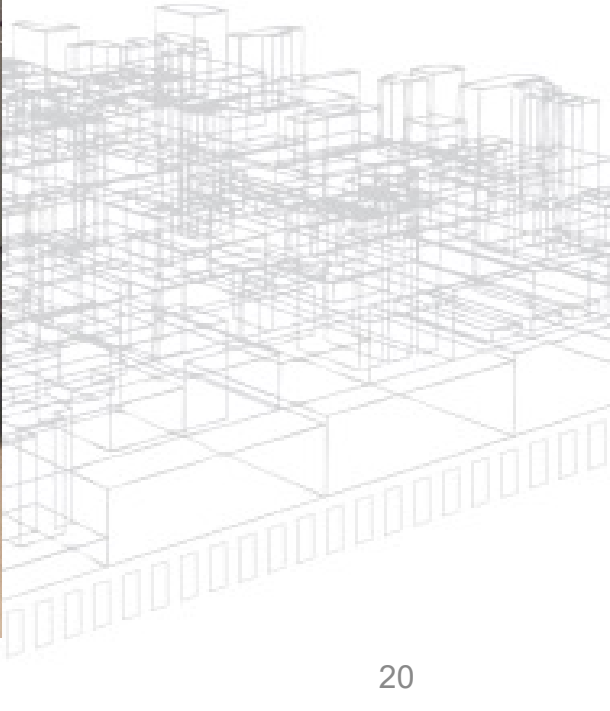
Testing



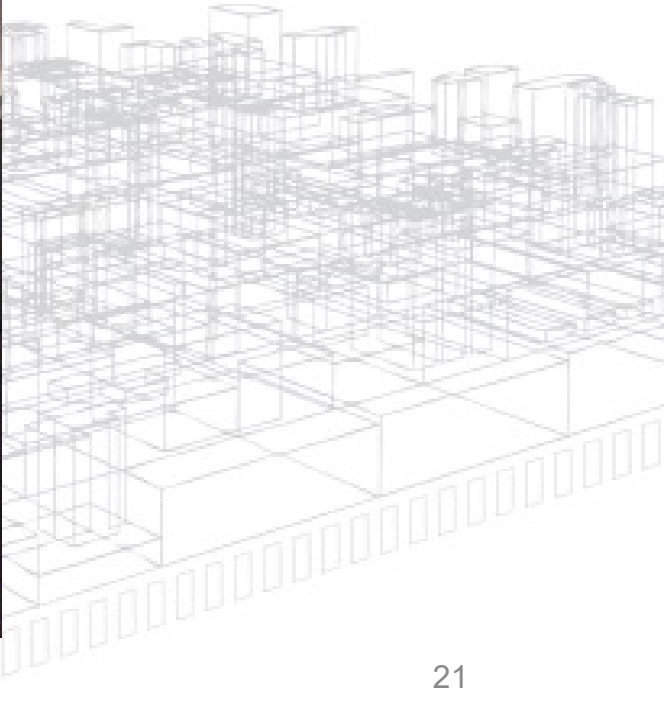
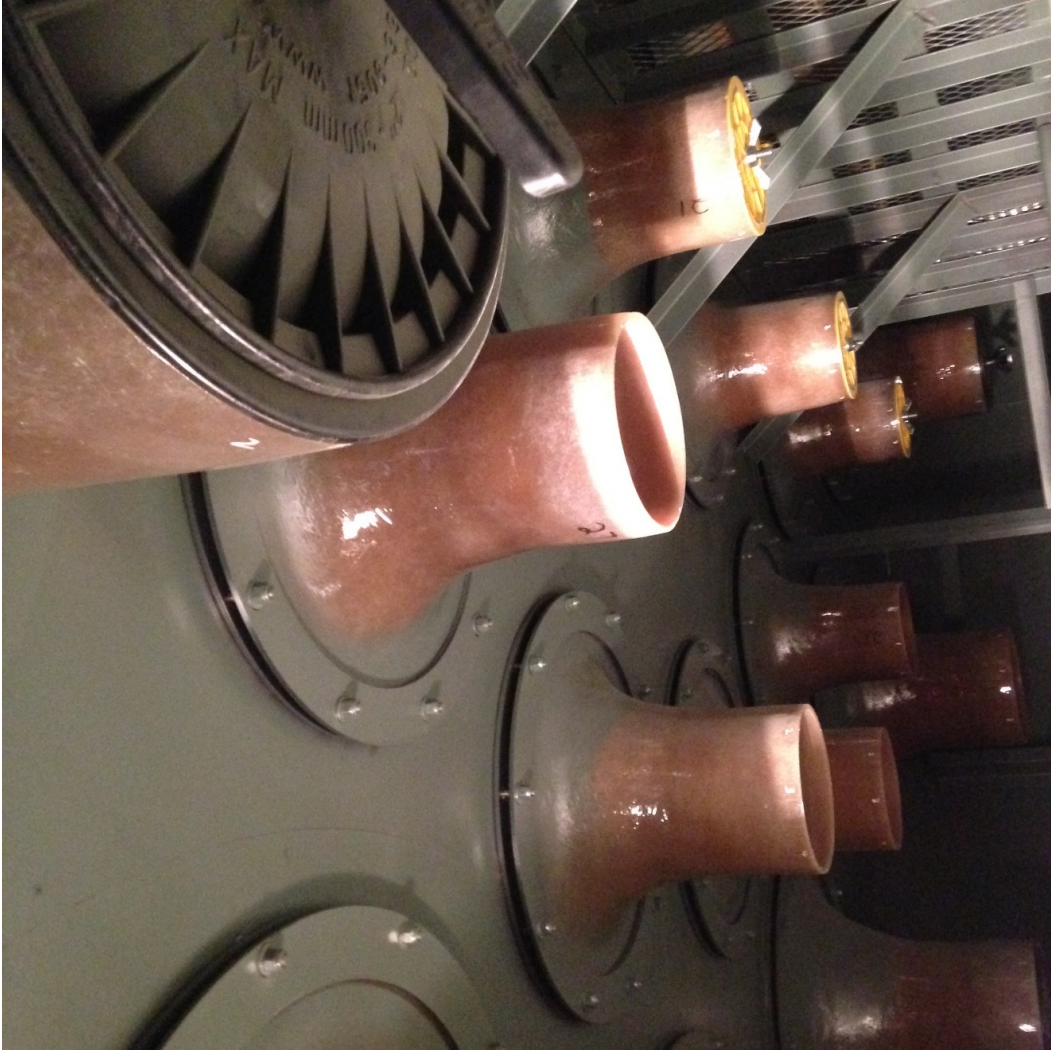
Testing



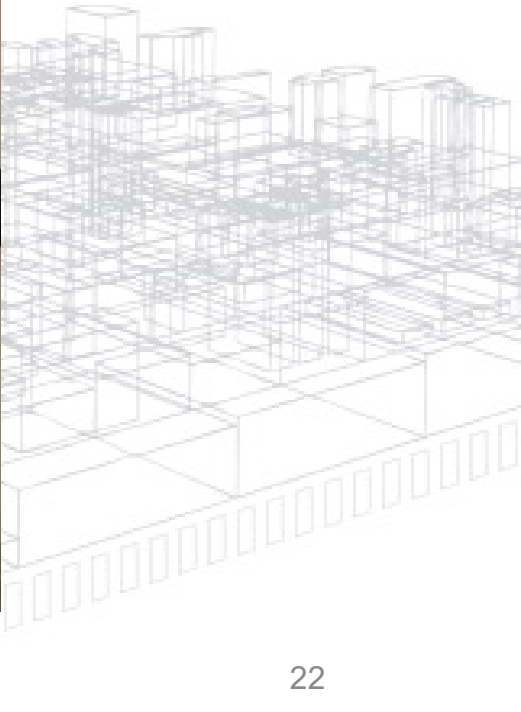
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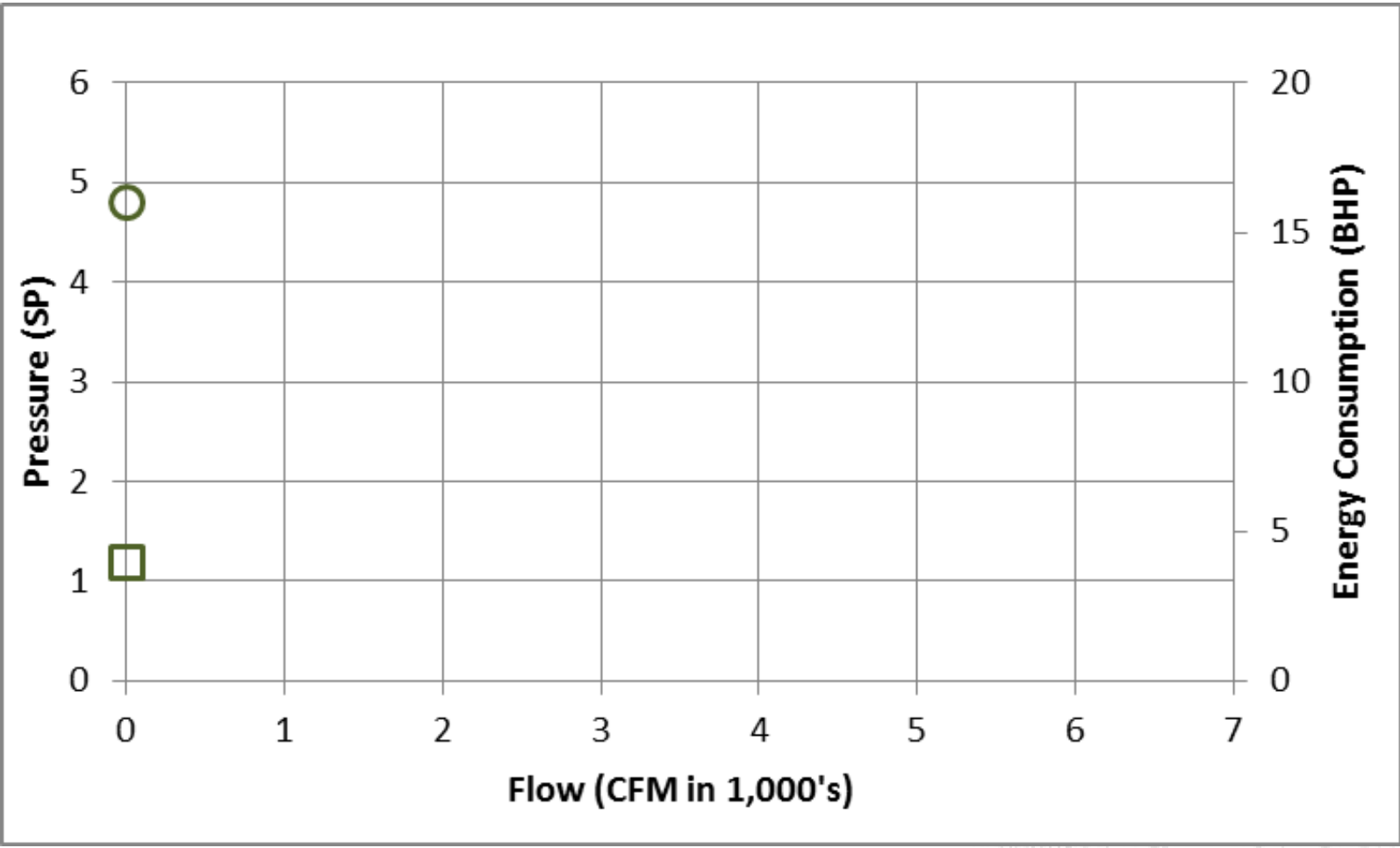
Testing



Testing



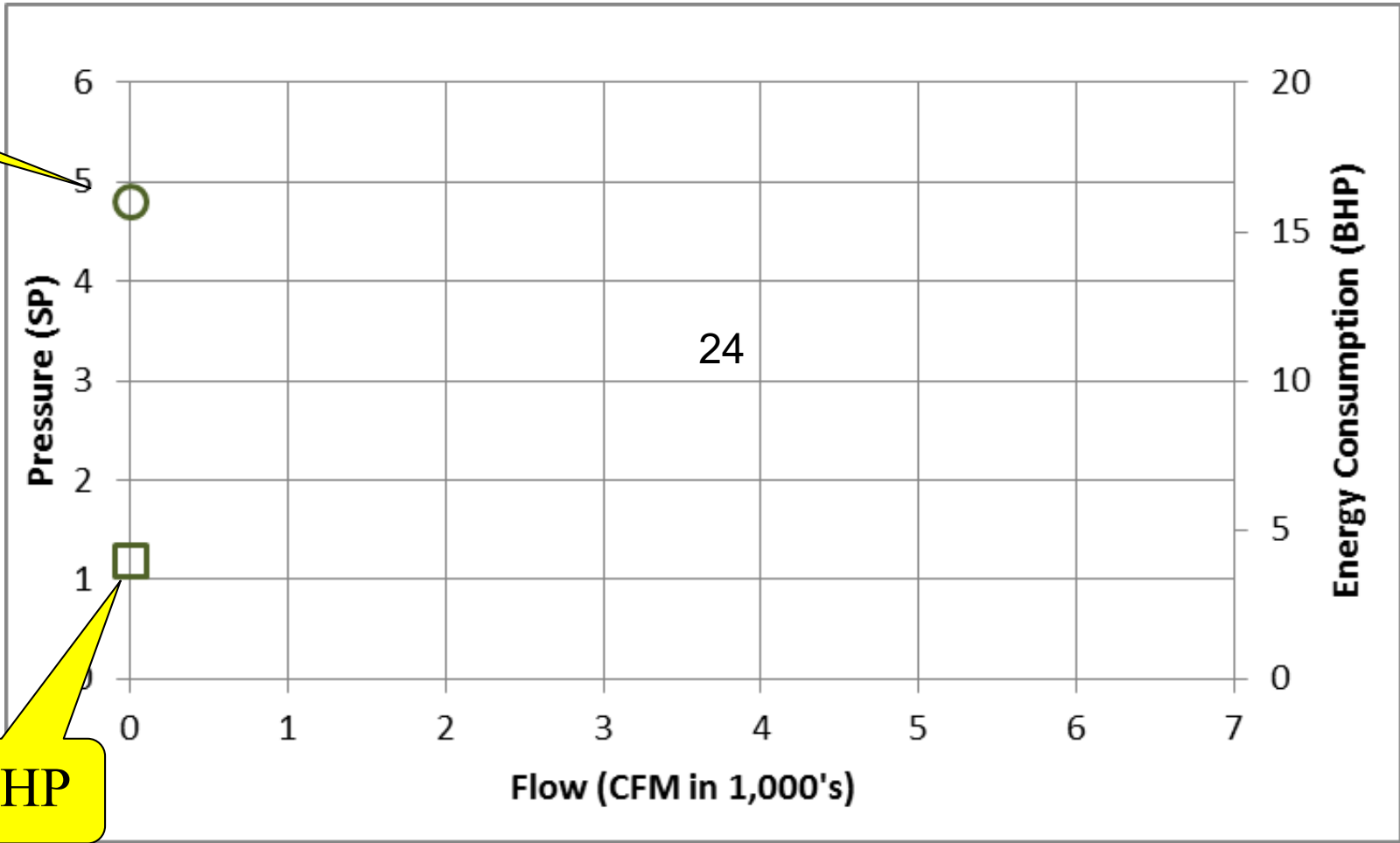
Testing



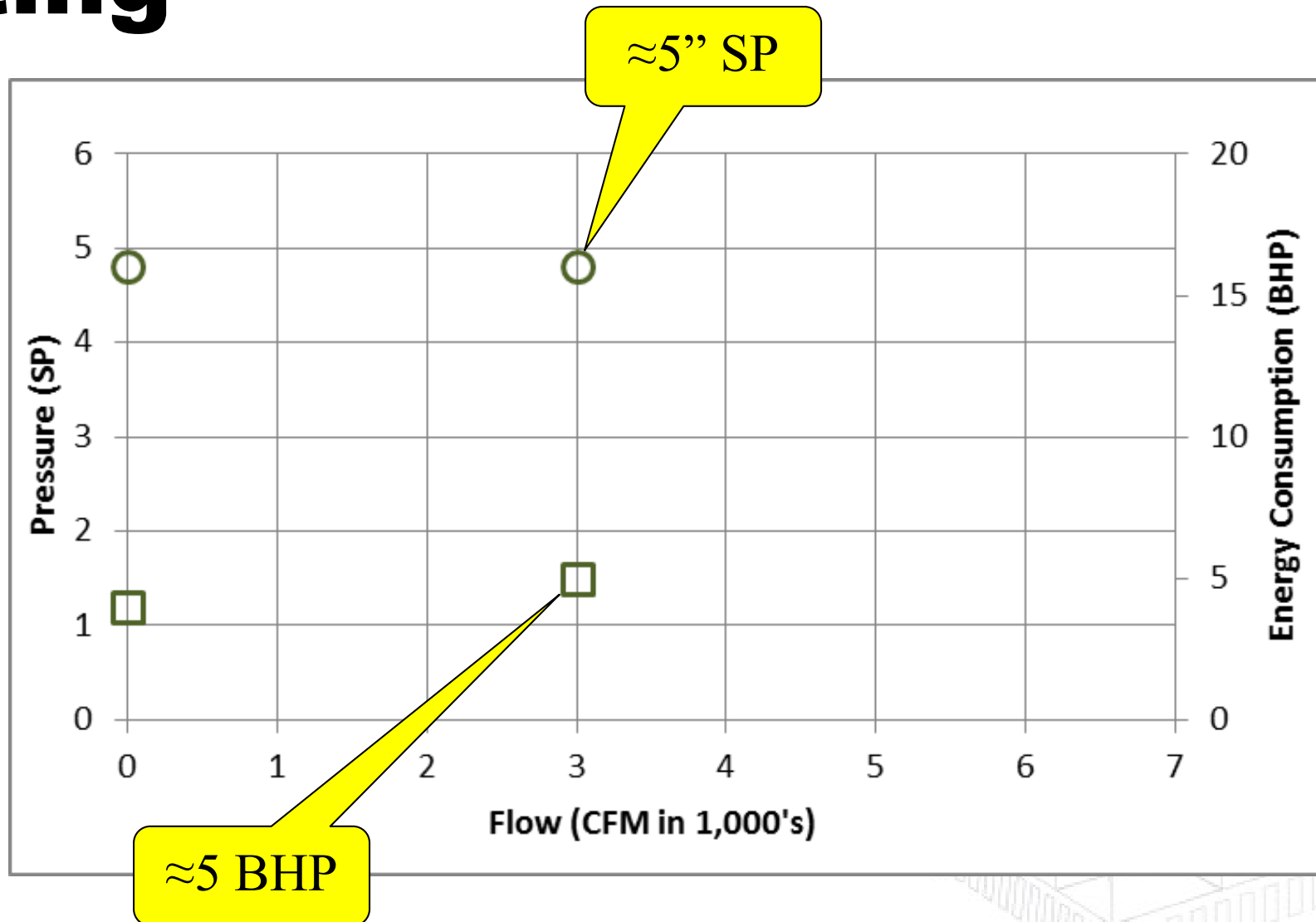
Testing

≈5" SP

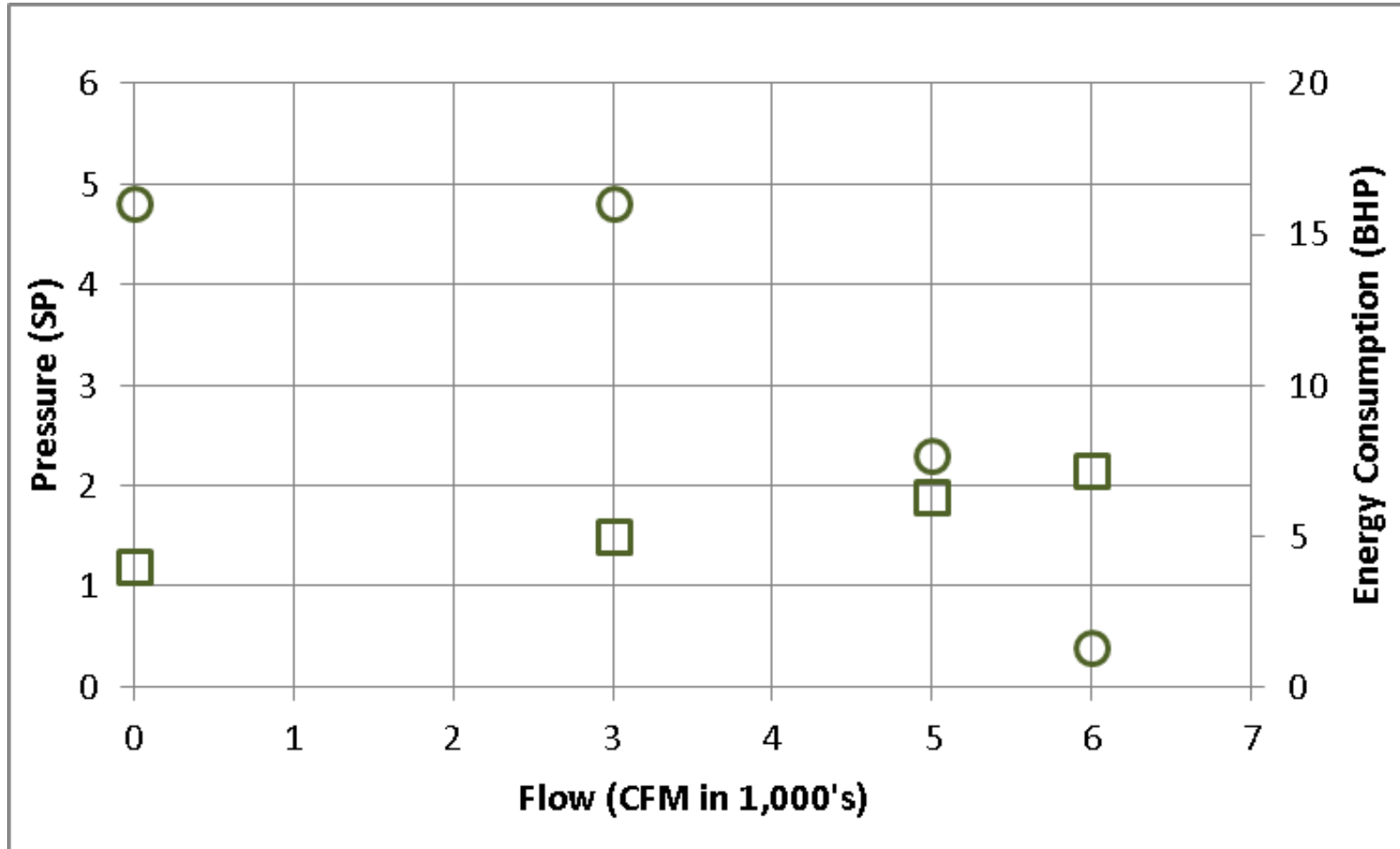
≈4 BHP



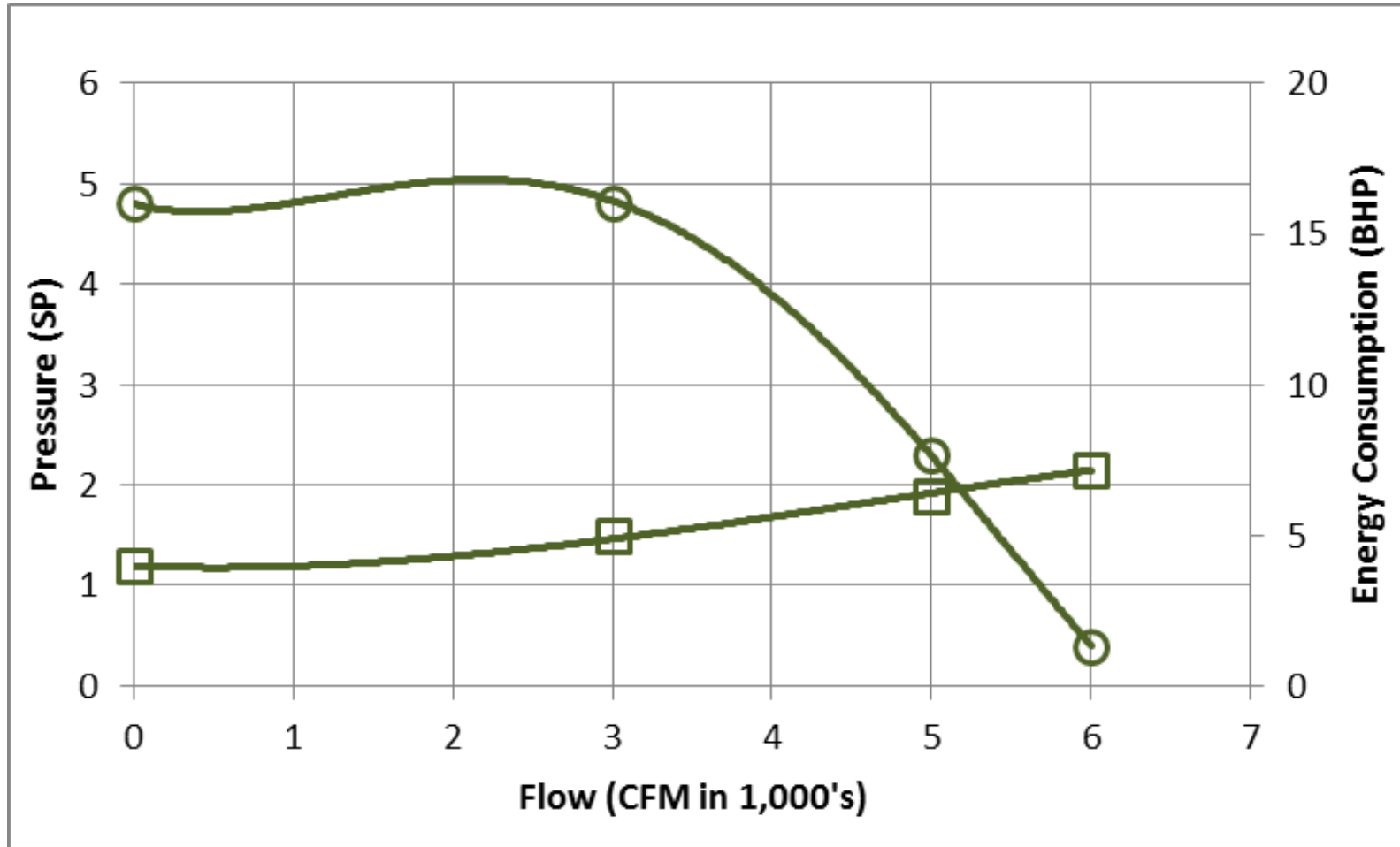
Testing



Testing



Fan Performance Curve



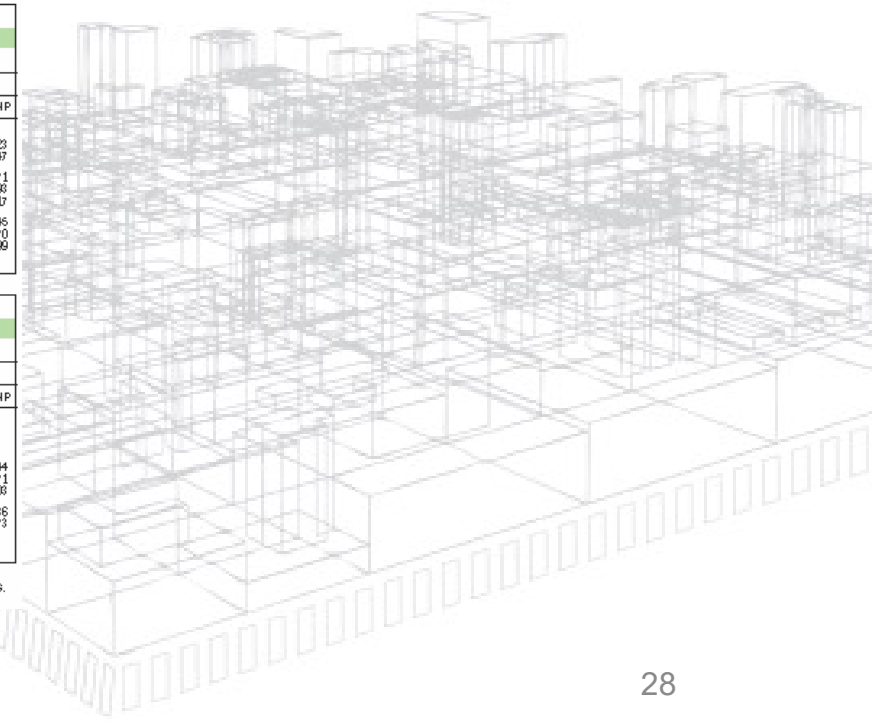
Catalog Performance Tables

MODEL 405		WITH EVASE		Wheel diameter: 40.3" Wheel circumference: 10.5'						Outlet area: 10.2 sq. ft. Maximum BHP = 24.5 $\left(\frac{\text{RPM}^3}{1000}\right)$		AF-30=2035 RPM AF-40=2470 RPM AF-50=2640 RPM											
CFM	OV	18"SP		22"SP		26"SP		28"SP		30"SP		34"SP		38"SP		42"SP		46"SP		48"SP		50"SP	
		RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
2400	2348	1540	76.9	1891	96	1828	115	1896	125	1960	135	2005	157	2200	189	2320	242	2462	263	2478	281	2630	296
2600	2500	1674	83.9	1936	105	1885	124	1942	135	1995	145	2050	167	2210	204	2340	242	2493	263	2492	281	2630	314
2800	2657	1815	91.5	1975	115	1938	135	1998	146	2050	156	2100	179	2260	227	2390	262	2542	281	2501	318	2651	334
3100	3112	1965	107	1975	126	1986	146	1947	160	2000	170	2111	194	2221	218	2320	242	2493	263	2478	281	2630	296
3400	3365	1921	119	1927	140	1933	162	1990	173	2036	186	2133	218	2241	245	2339	260	2463	266	2492	301	2630	314
3700	3620	1785	132	1880	154	1977	177	2023	188	2071	200	2173	227	2262	251	2360	278	2462	304	2501	318	2651	334
3900	3895	1850	147	1919	170	2014	195	2078	207	2124	220	2212	244	2302	271	2398	297	2481	325	2526	340	2667	354
4200	4129	1920	164	2004	188	2069	212	2131	225	2176	238	2260	265	2341	291	2429	319	2510	347	2559	362	2698	378
4400	4398	1991	181	2071	206	2150	232	2192	245	2235	260	2312	286	2396	315	2469	342	2562	372	2598	389	2629	402
4700	4638	2068	202	2144	228	2218	254	2259	268	2298	281	2373	311	2449	340	2519	367	2594	397	2633	418		

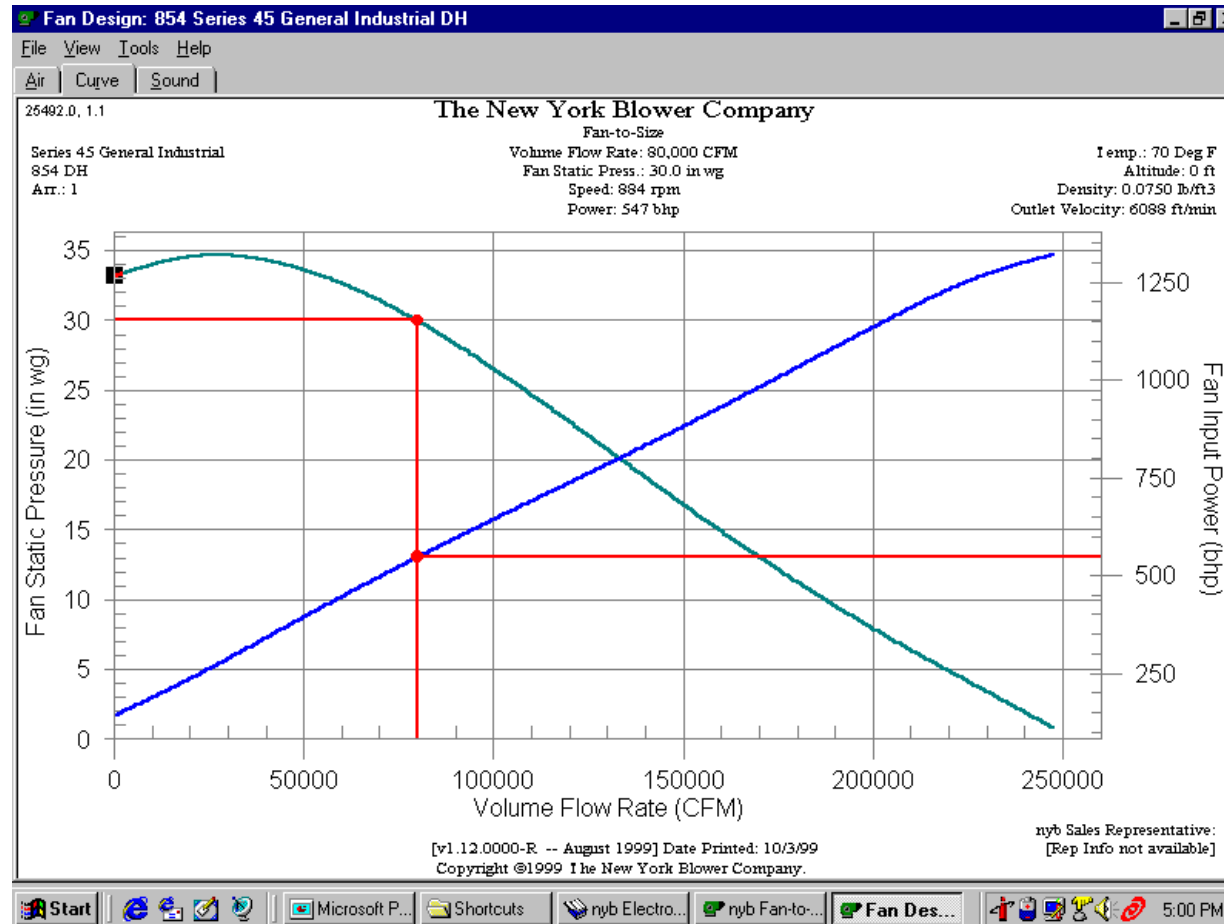
MODEL 445		WITH EVASE		Wheel diameter: 44.5" Wheel circumference: 11.7'						Outlet area: 12.5 sq. ft. Maximum BHP = 40.3 $\left(\frac{\text{RPM}^3}{1000}\right)$		AF-30=1850 RPM AF-40=2230 RPM AF-50=2400 RPM											
CFM	OV	18"SP		22"SP		26"SP		28"SP		30"SP		34"SP		38"SP		42"SP		46"SP		48"SP		50"SP	
		RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
3000	2938	1409	67.6	1571	120	1651	144	1722	157	1790	169	1856	190.0	2009	206	2106	236	2164	254	2240	311	2289	323
3300	3254	1485	76.8	1654	131	1731	155	1790	170	1852	183	1919	210	1996	216	2106	236	2164	254	2240	311	2289	323
3600	3510	1565	85.9	1694	144	1762	170	1822	185	1885	192	1940	227	2015	235	2106	236	2164	254	2240	311	2289	323
3900	3765	1609	93.1	1616	158	1722	185	1773	200	1823	215	1874	244	2019	273	2116	306	2209	337	2294	358	2301	371
4200	4021	1656	105	1656	172	1752	201	1805	217	1851	231	1901	283	2029	290	2155	323	2221	360	2352	376	2306	395
4600	4377	1604	119	1607	187	1700	217	1840	234	1884	249	1928	323	2066	315	2150	348	2215	382	2280	401	2320	417
4900	4633	1651	135	1748	205	1834	235	1878	252	1924	270	2009	330	2092	316	2177	372	2257	405	2305	428	2343	445
5200	4889	1718	151	1801	224	1884	257	1923	273	1964	289	2040	335	2124	359	2205	395	2291	436	2325	462	2361	470
5600	5244	1780	173	1856	244	1933	279	1971	294	2010	312	2060	348	2166	385	2243	423	2315	459	2358	482	2391	499
5800	5700	1844	235	1915	257	1989	301	2025	319	2064	338	2137	374	2206	410	2280	450	2364	490	2390	510		

MODEL 495		WITH EVASE		Wheel diameter: 49.0" Wheel circumference: 12.3'						Outlet area: 15.3 sq. ft. Maximum BHP = 65.5 $\left(\frac{\text{RPM}^3}{1000}\right)$		AF-30=1675 RPM AF-40=2025 RPM AF-50=2170 RPM											
CFM	OV	18"SP		22"SP		26"SP		28"SP		30"SP		34"SP		38"SP		42"SP		46"SP		48"SP		50"SP	
		RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
3600	2261	1257	116	1380	142	1500	172	1566	187	1610	202	1610	202	1810	236	1903	342	1990	378				
4000	2523	1295	130	1404	158	1507	197	1568	202	1611	218	1611	218	1810	236	1903	342	1990	378	2082	428	2075	444
4400	2885	1336	146	1460	174	1526	205	1572	220	1621	235	1621	235	1810	236	1903	342	1990	378	2154	482	2091	508
4800	3148	1383	164	1471	194	1558	225	1601	241	1646	258	1646	258	1822	329	1905	365	1990	408	2082	428	2075	444
5200	3410	1435	184	1515	215	1596	249	1637	265	1678	281	1678	281	1899	354	1922	388	2000	431	2088	451	2075	471
5600	3672	1493	207	1556	239	1640	272	1679	291	1715	305	1715	305	1967	383	1940	420	2018	452	2154	482	2091	508
6000	3934	1552	232	1621	265	1682	302	1728	320	1760	335	1760	335	1990	413	1989	452	2063	485	2076	515	2110	536
6400	4197	1615	260	1690	296	1744	331	1778	350	1805	370	1805	370	1941	447	2007	489	2072	511	2104	551	2137	573
6800	4459	1682	292	1741	327	1805	365	1834	385	1865	404	1865	404	1989	487	2049	527	2112	571	2142	588		
7200	4721	1748	325	1807	364	1863	401	1892	422	1923	443	1923	443	2037	525	2099	572	2155	615				

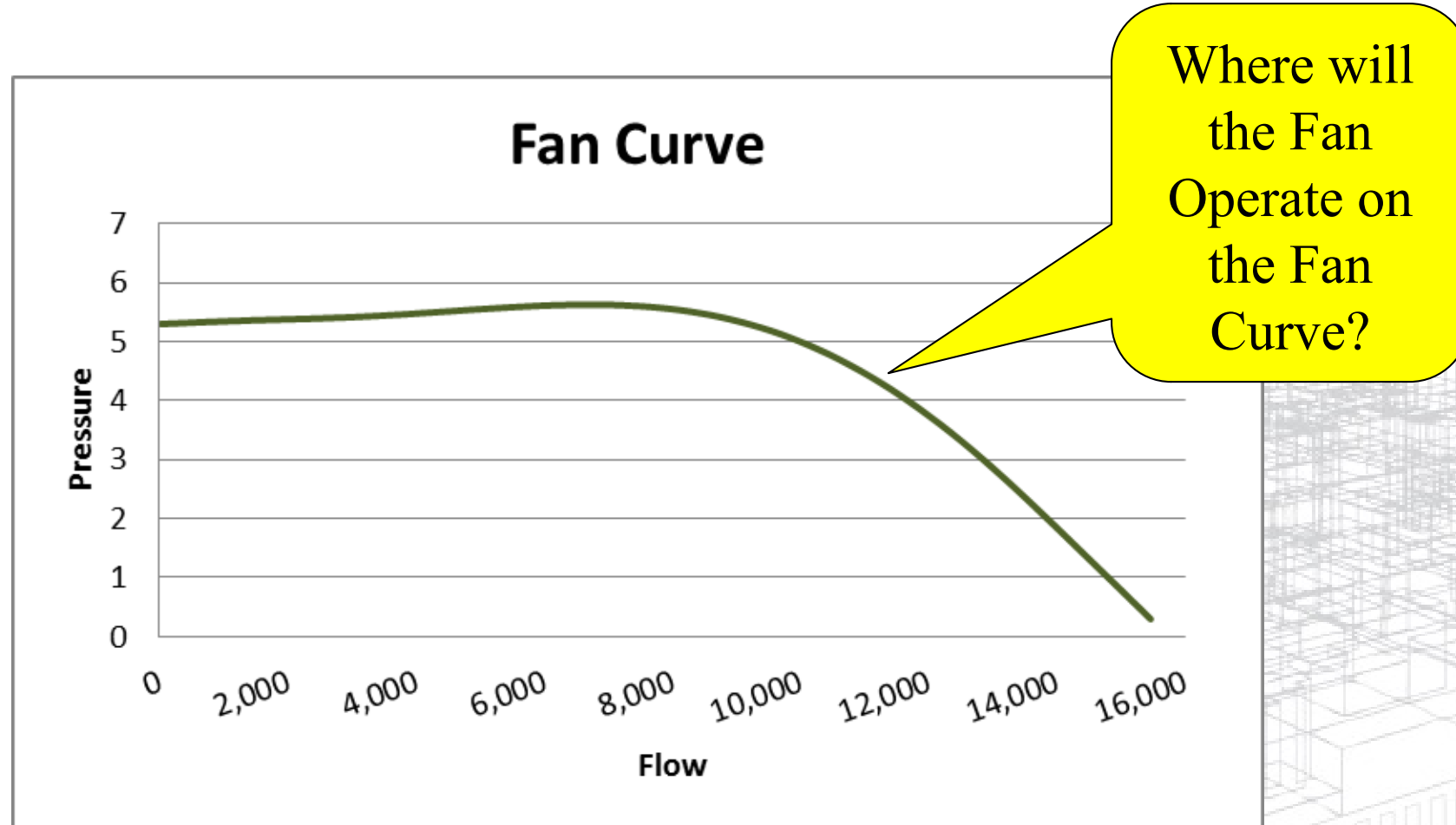
Performance shown is for AF Fans with evase discharges, with outlet ducts, and with or without inlet ducts. BHP does not include belt losses.



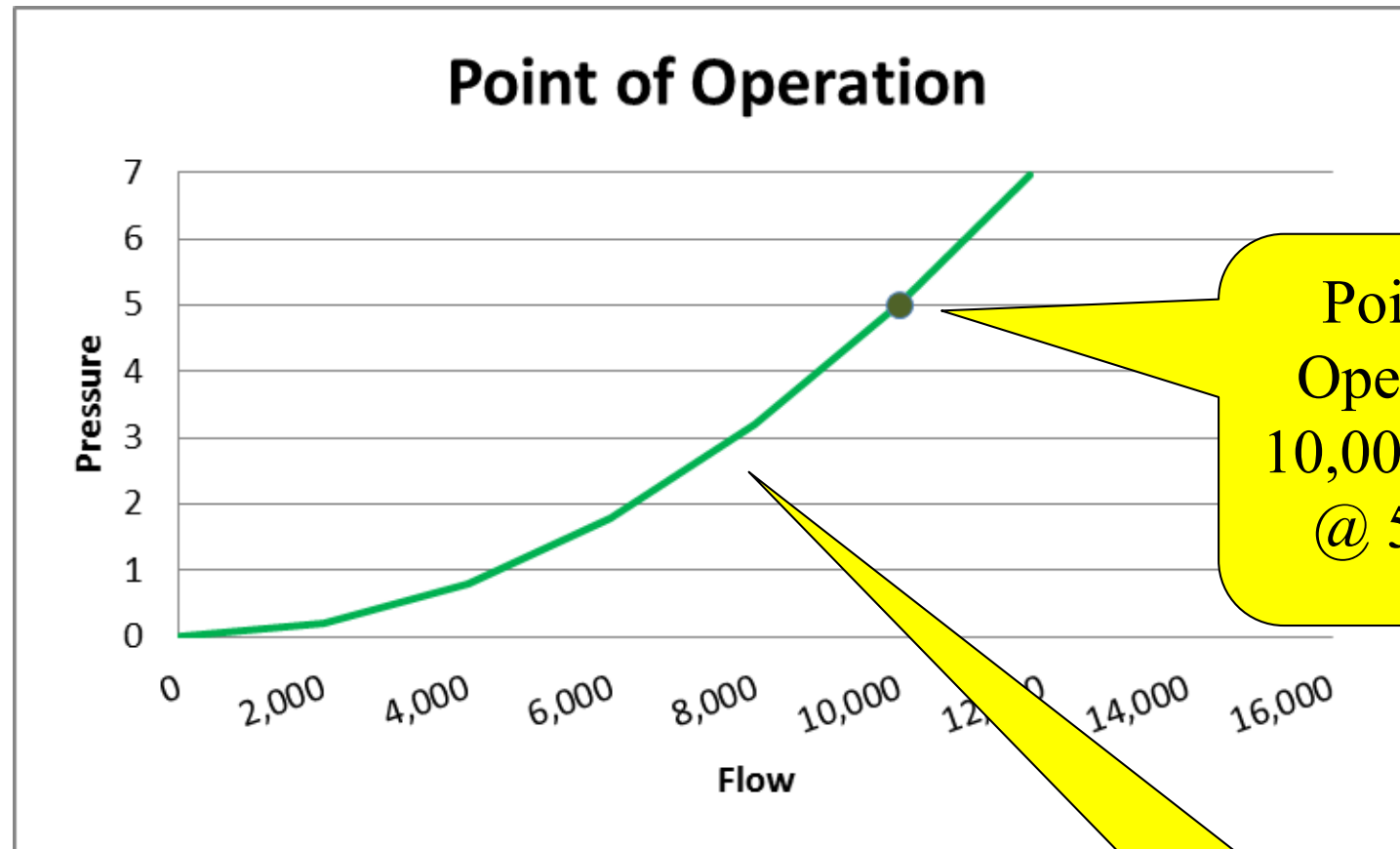
Product Selection Software



Operation in a System



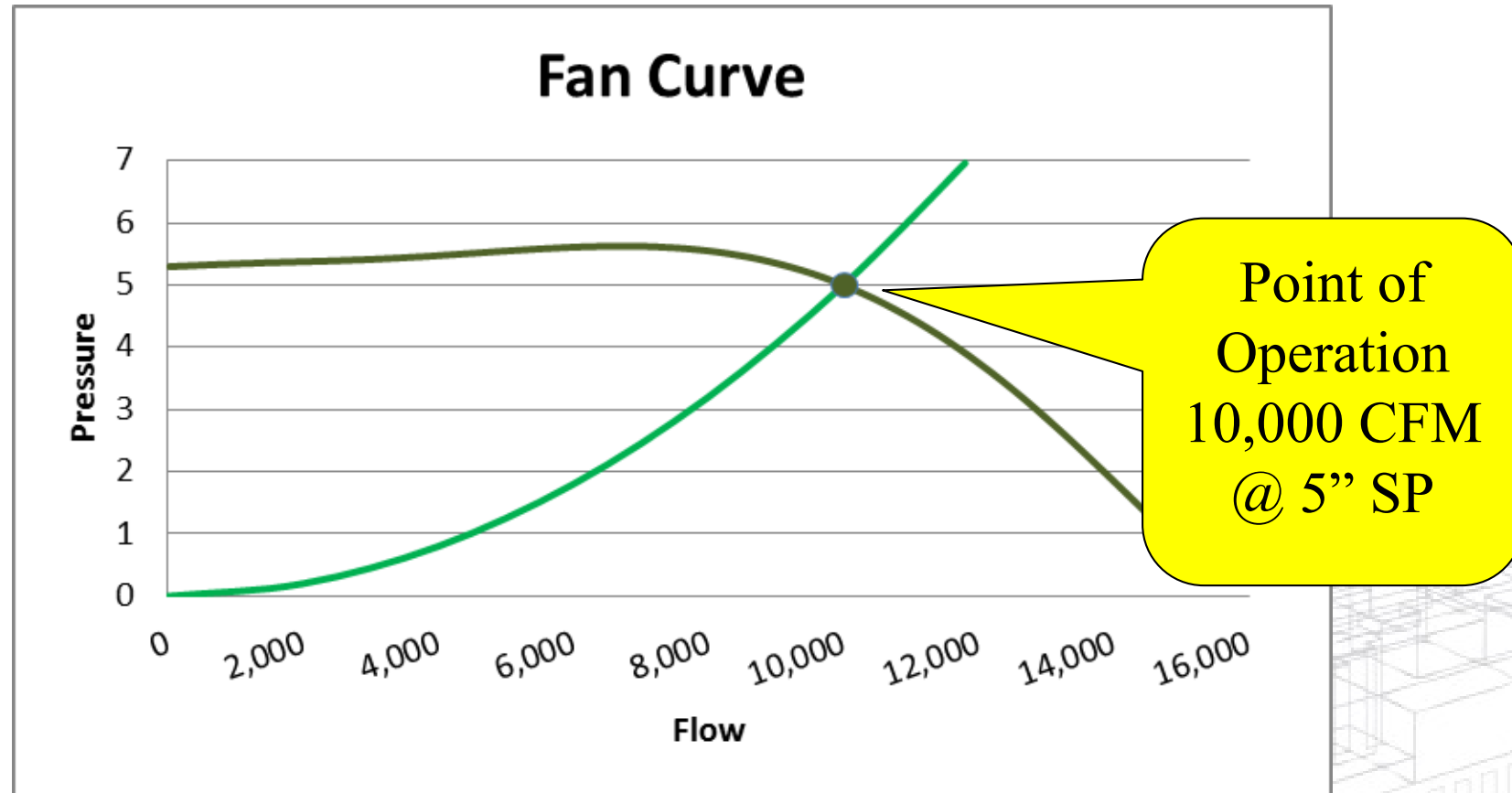
Operation in a System



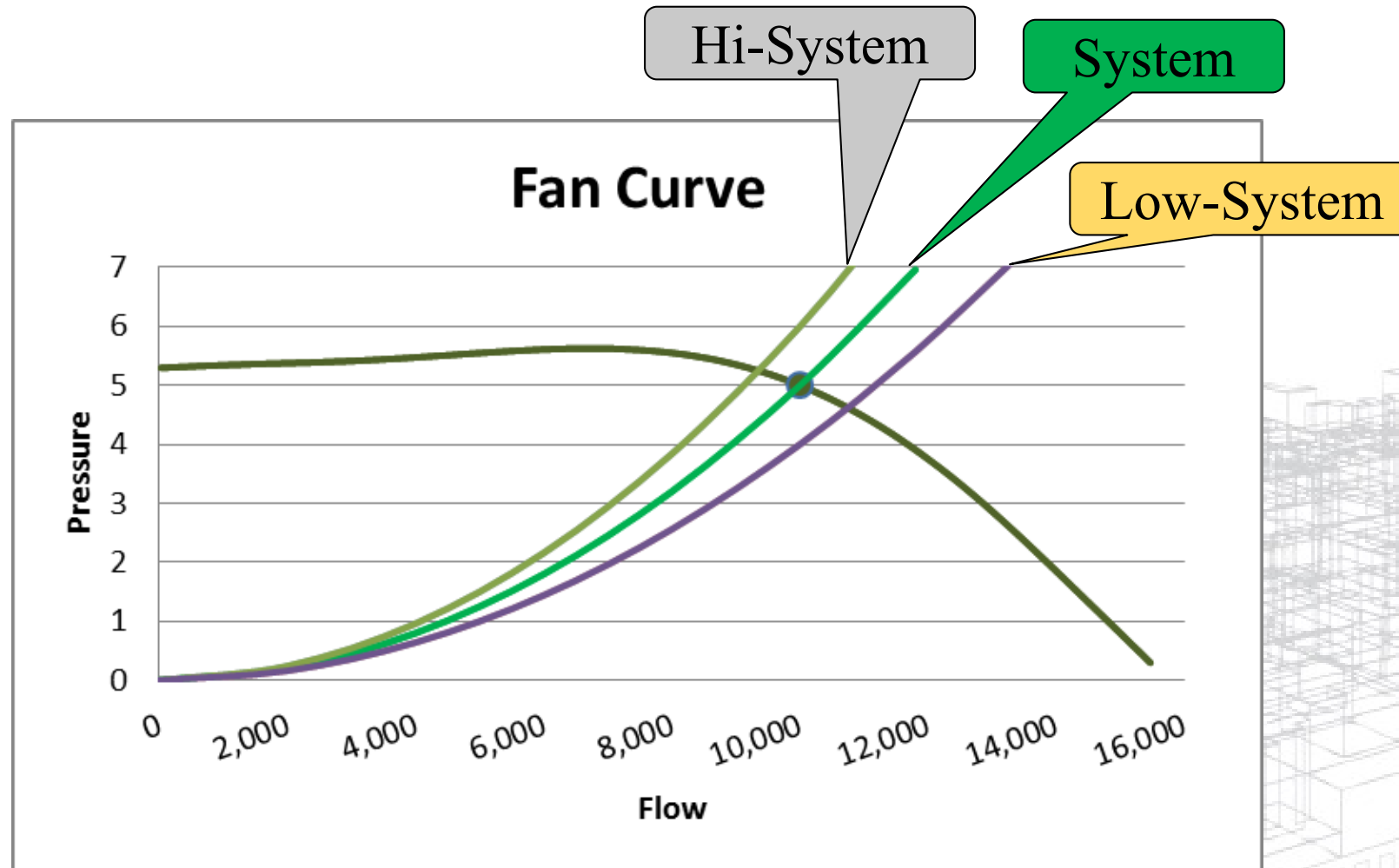
Point of Operation
10,000 CFM
@ 5" SP

$$\Delta SP = \Delta CFM^2$$

Operation in a System

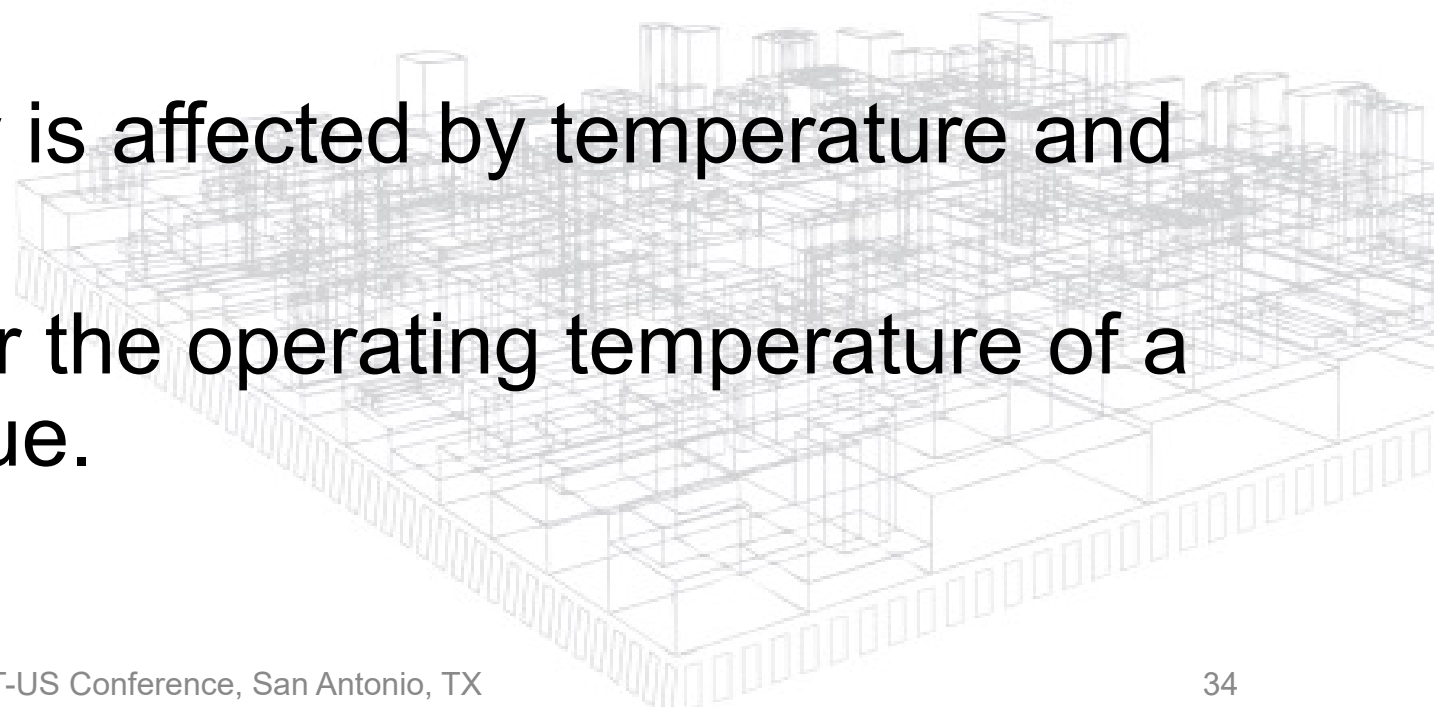


Operation in a System



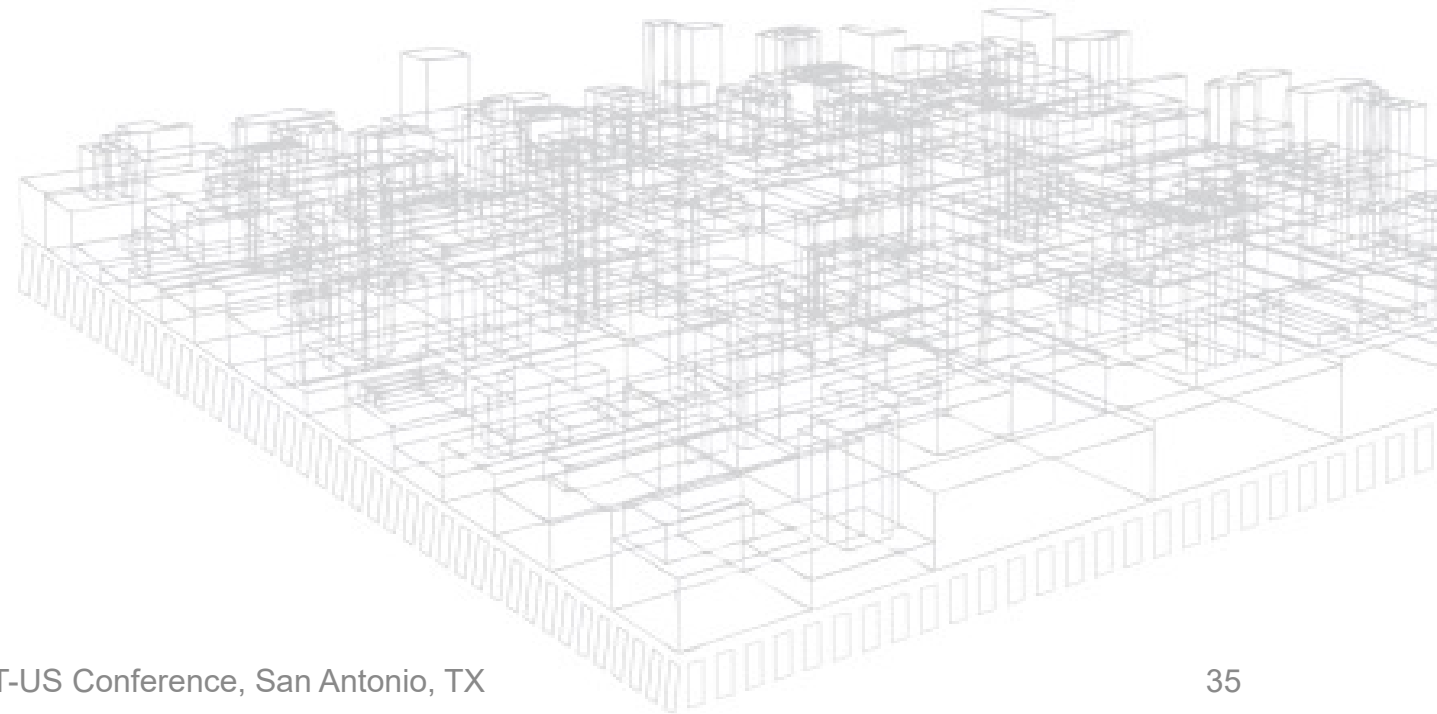
Density and Airstream

- A fan's operation is impacted by the density and the component make-up of the gas stream moving through the fan.
- The gas stream density is affected by temperature and altitude.
- The primary concern for the operating temperature of a fan is a *mechanical* issue.

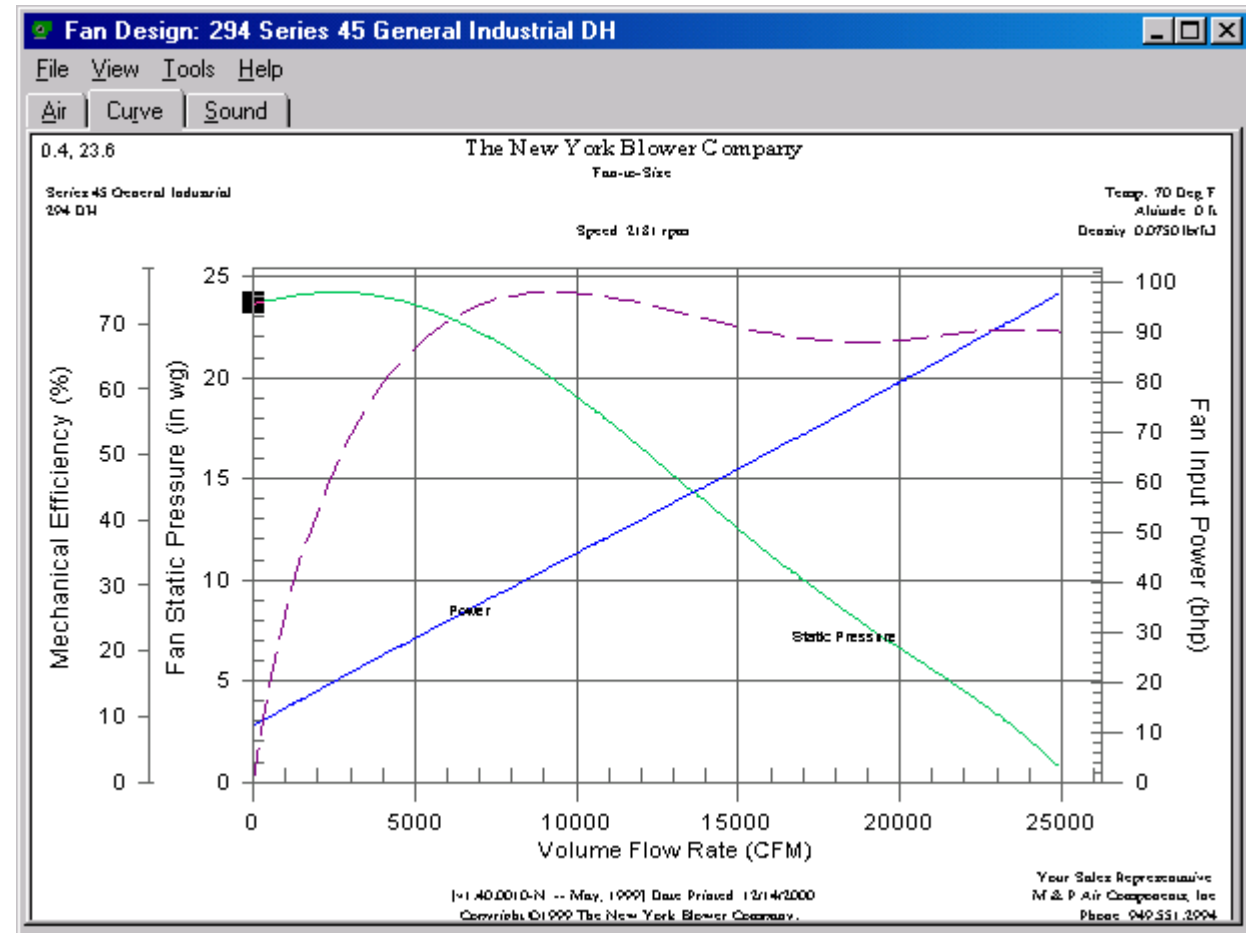


Fan Types

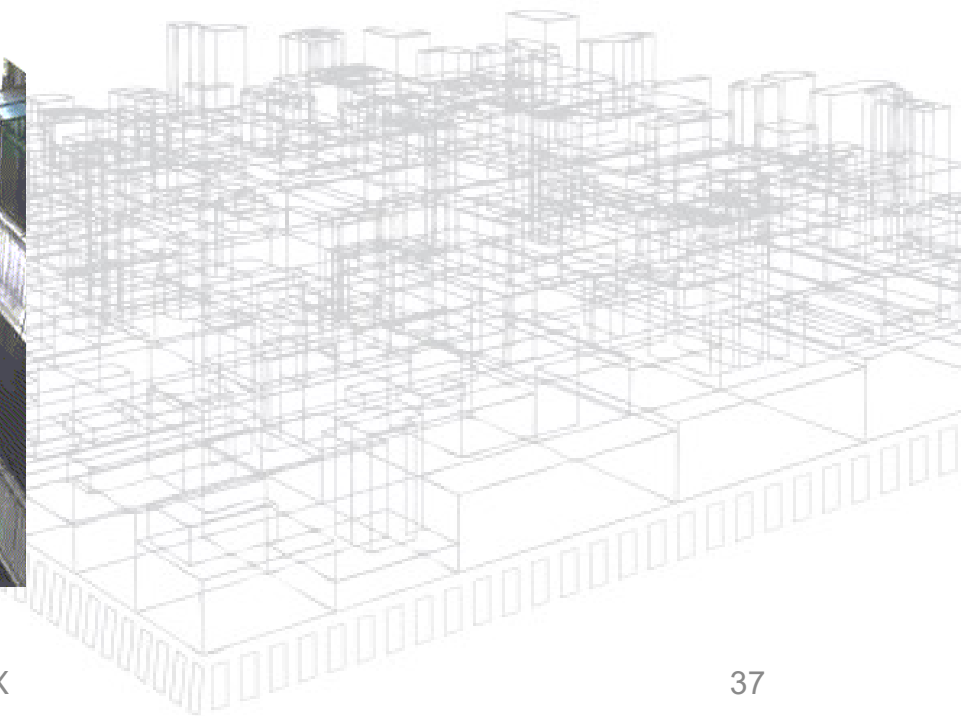
- Different fan (impeller) types have differing characteristic (performance) curves.



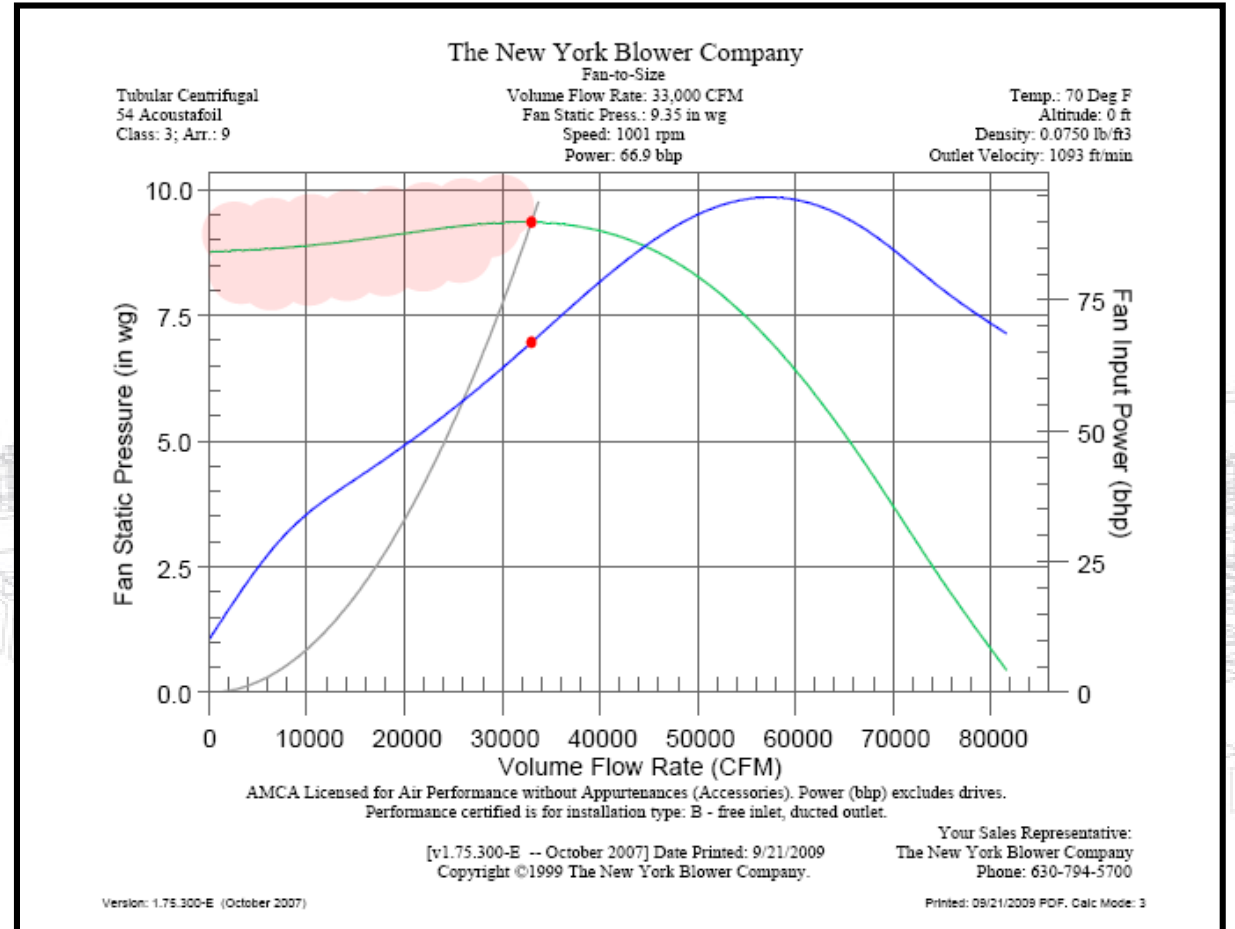
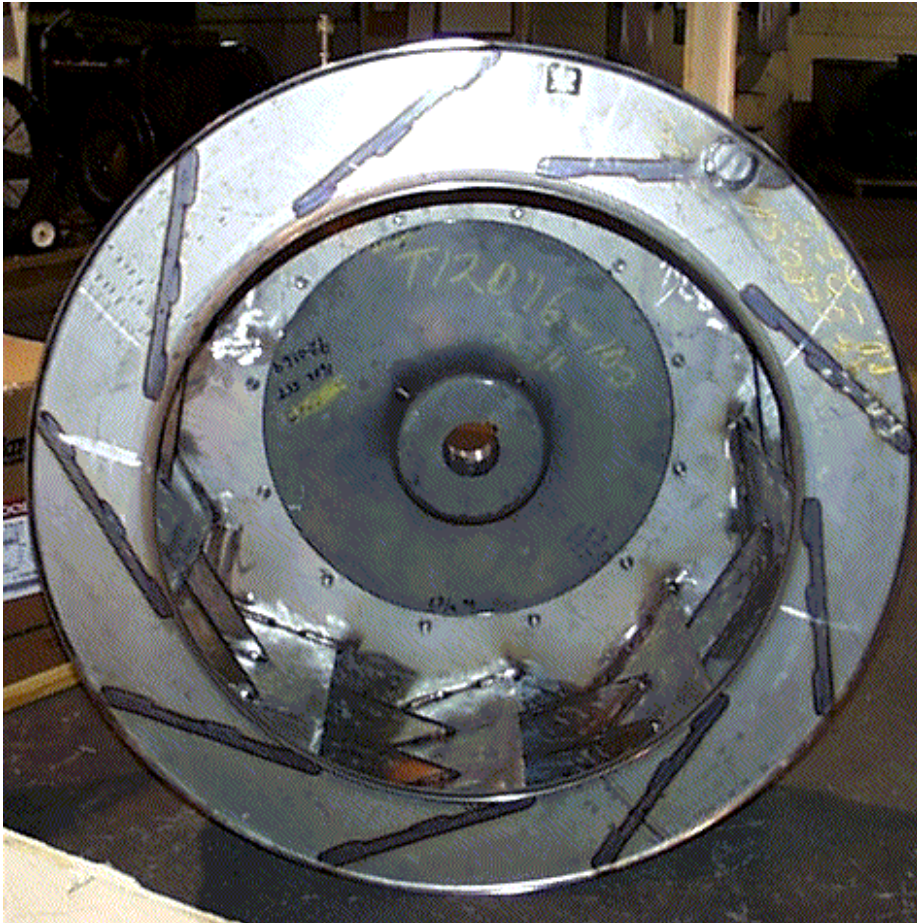
Radial



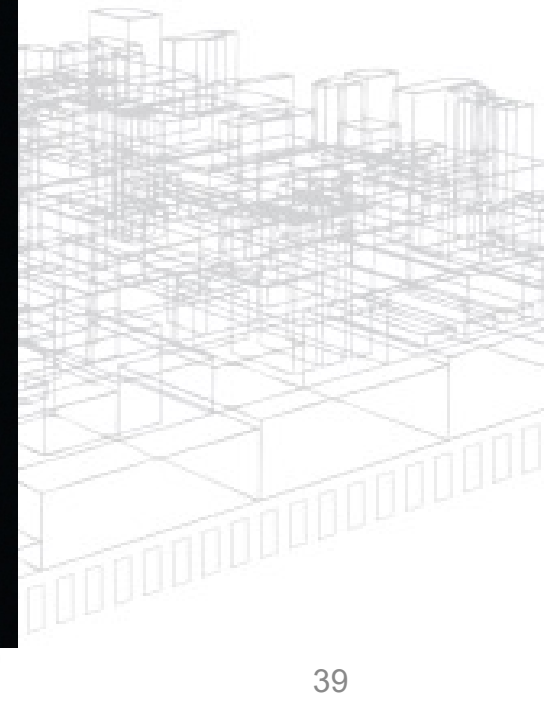
Radial



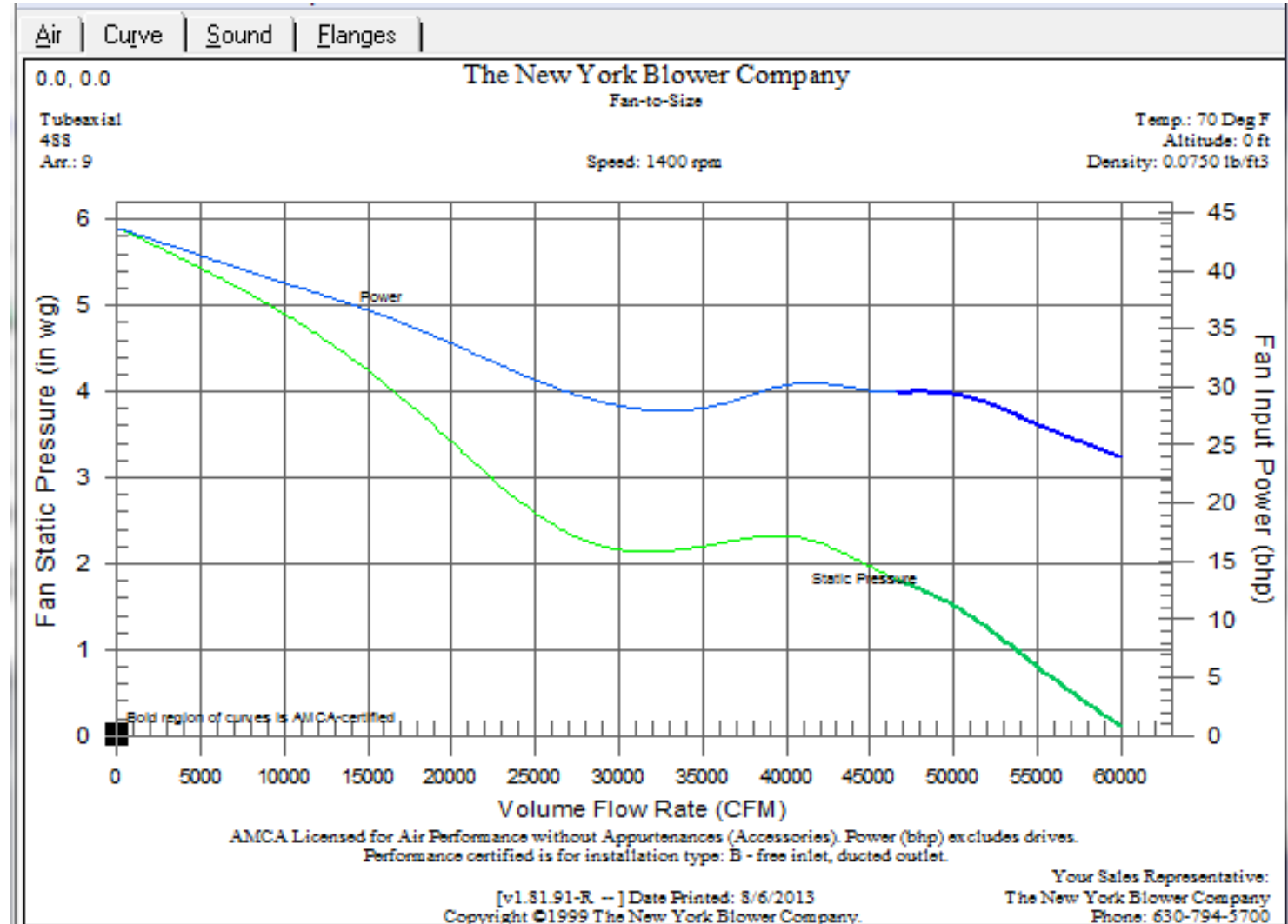
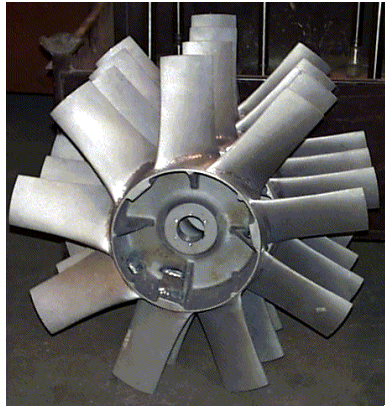
Backward Inclined



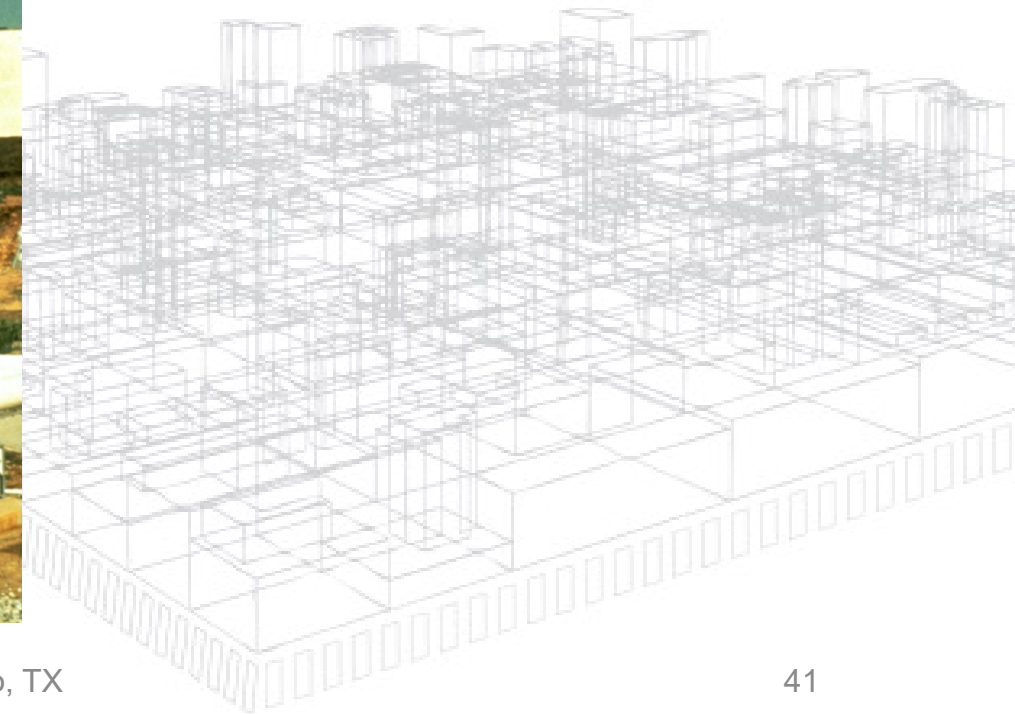
Backward Inclined



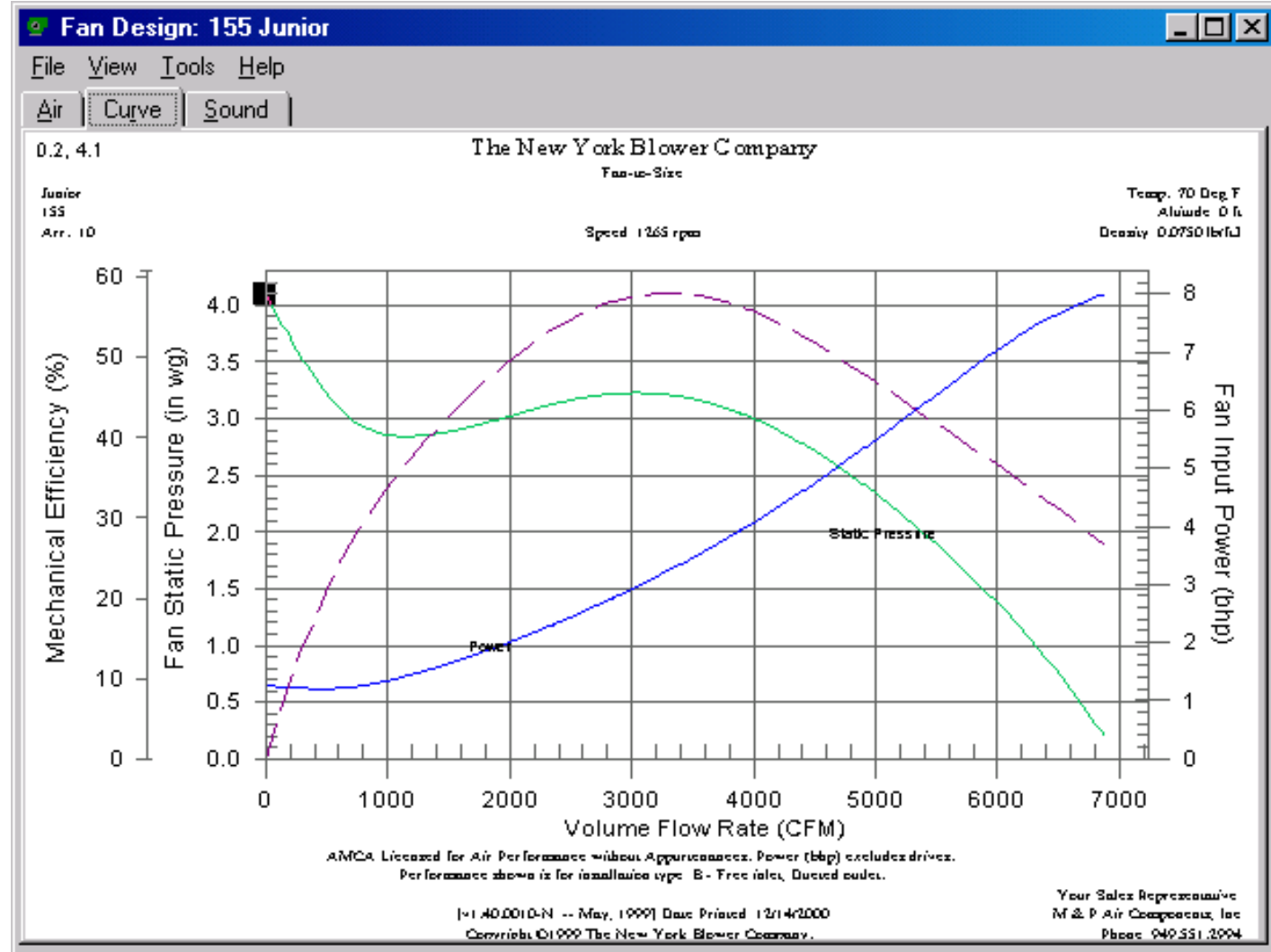
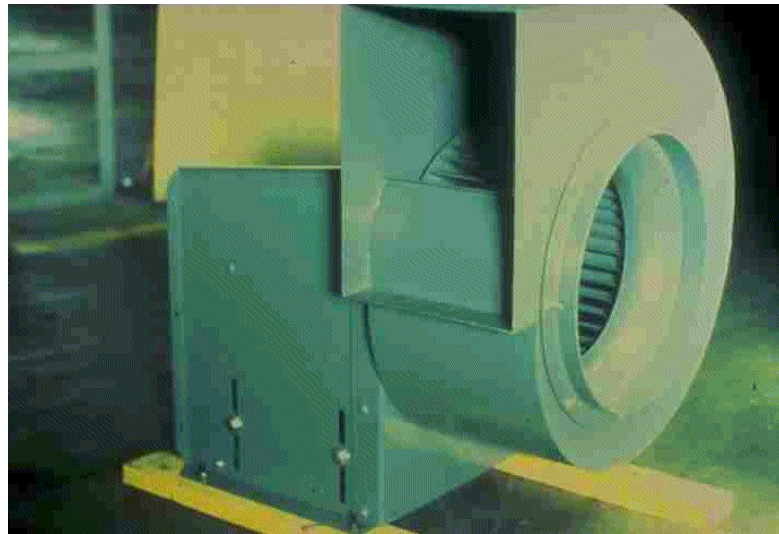
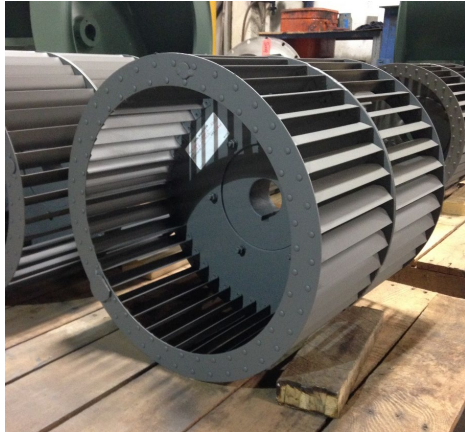
Axial



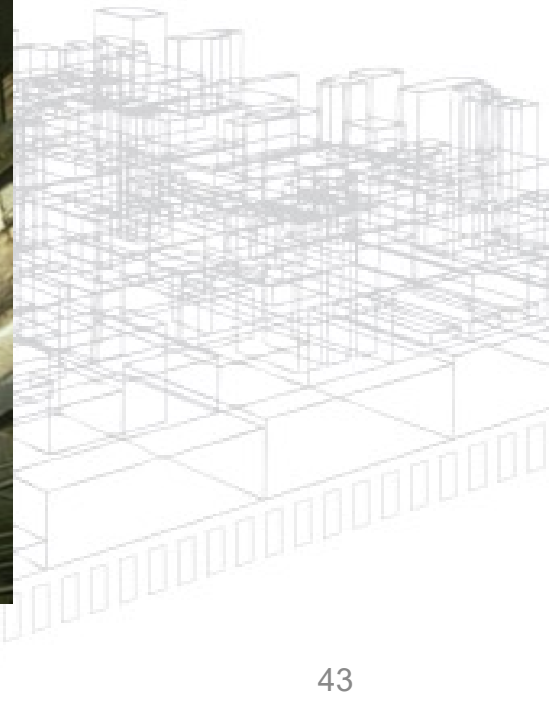
Axial



Forward Curve



Forward Curve

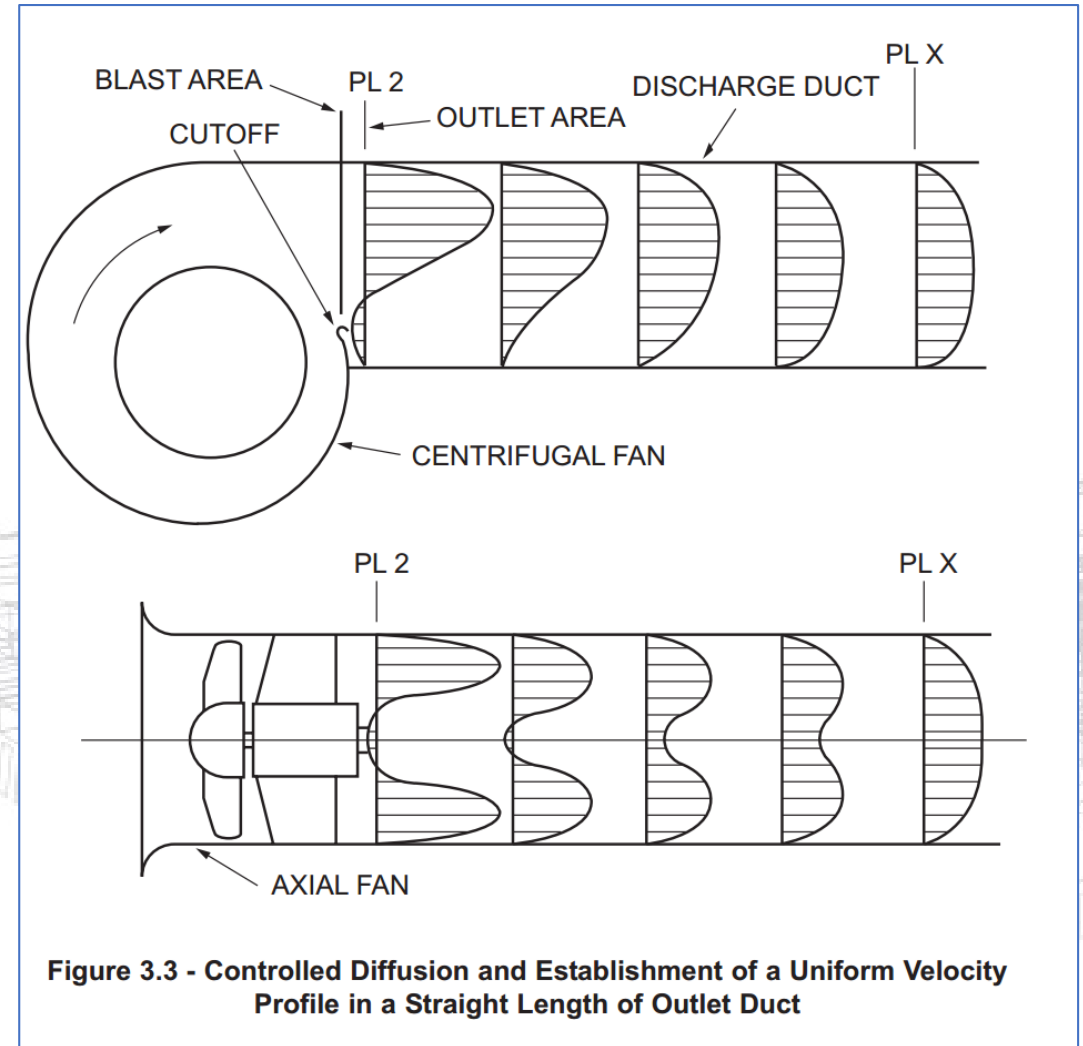
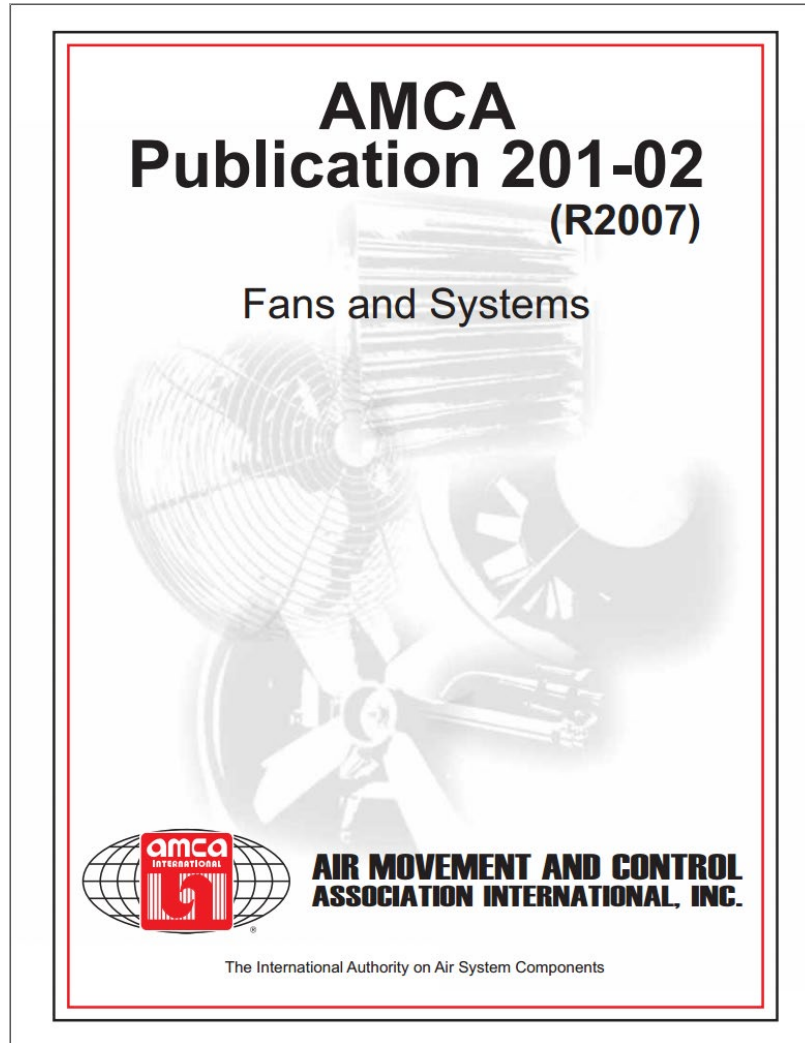


System Effects

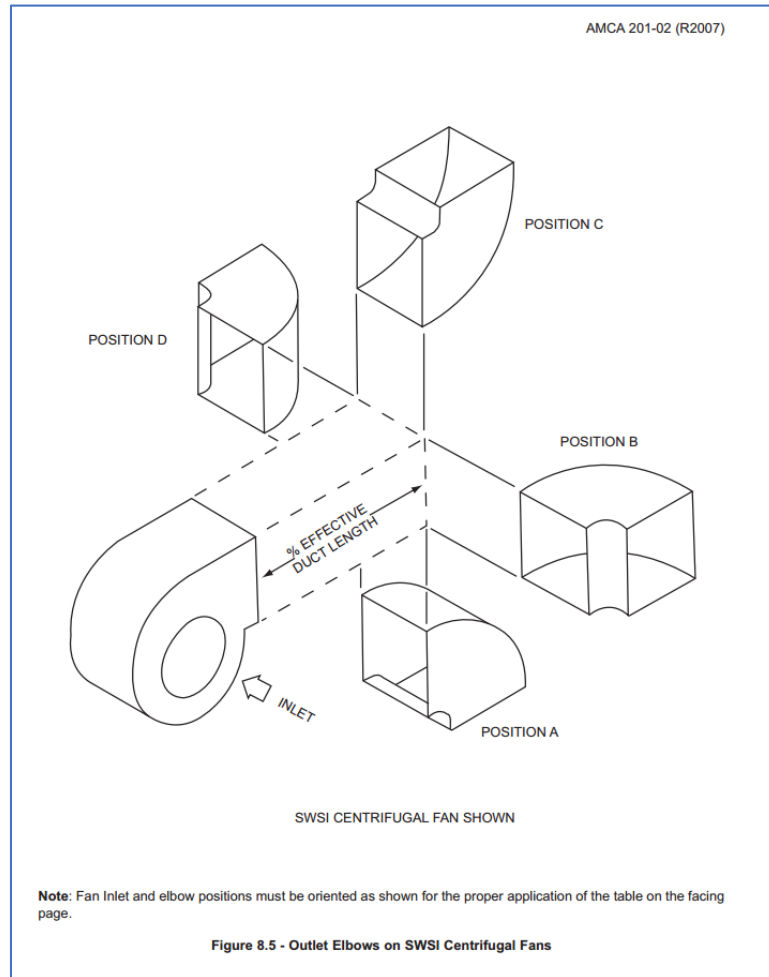
- Laboratory Environment
- Specified (AMCA) Configurations
- Inlet and outlet conditions specified...why?
...to *minimize system effect*



System Effects



System Effects



AMCA 201-02 (R2007)

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	NO System Effect Factor
	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	NO System Effect Factor
	B	N-O	O-P	Q	S-T	
	C	M-N	N	O-P	R-S	
	D	M-N	N	O-P	R-S	
0.6	A	Q	Q-R	S	U	NO System Effect Factor
	B	P	Q	R	T	
	C	N-O	O	Q	S	
	D	N-O	O	Q	S	
0.7	A	R-S	S	T	V	NO System Effect Factor
	B	Q-R	R-S	S-T	U-V	
	C	P	Q	R-S	T	
	D	P	Q	R-S	T	
0.8	A	S	S-T	T-U	W	NO System Effect Factor
	B	R-S	S	T	V	
	C	Q-R	R	S	U-V	
	D	Q-R	R	S	U-V	
0.9	A	T	T-U	U-V	W	NO System Effect Factor
	B	S	S-T	T-U	W	
	C	R	S	S-T	V	
	D	R	S	S-T	V	
1.0	A	T	T-U	U-V	W	NO System Effect Factor
	B	S-T	T	U	W	
	C	R-S	S	T	V	
	D	R-S	S	T	V	

SYSTEM EFFECT CURVES FOR SWSI FANS

DETERMINE SEF BY USING FIGURES 7.1 AND 8.1

For DWDI fans determine SEF using the curve for SWSI fans. Then, apply the appropriate multiplier from the tabulation below

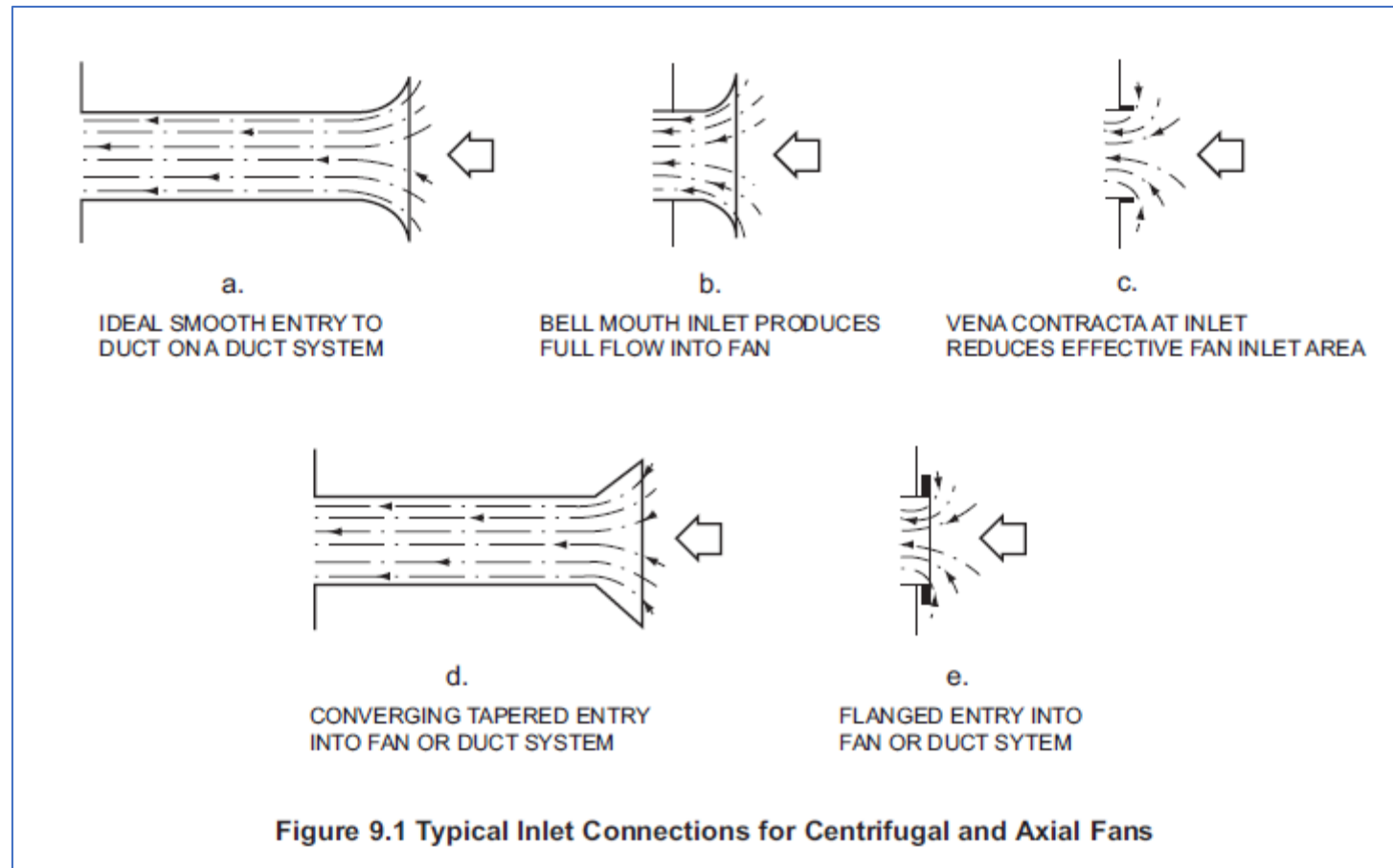
MULTIPLIERS FOR DWDI FANS

ELBOW POSITION A = $\Delta P \times 1.00$
 ELBOW POSITION B = $\Delta P \times 1.25$
 ELBOW POSITION C = $\Delta P \times 1.00$
 ELBOW POSITION D = $\Delta P \times 0.85$

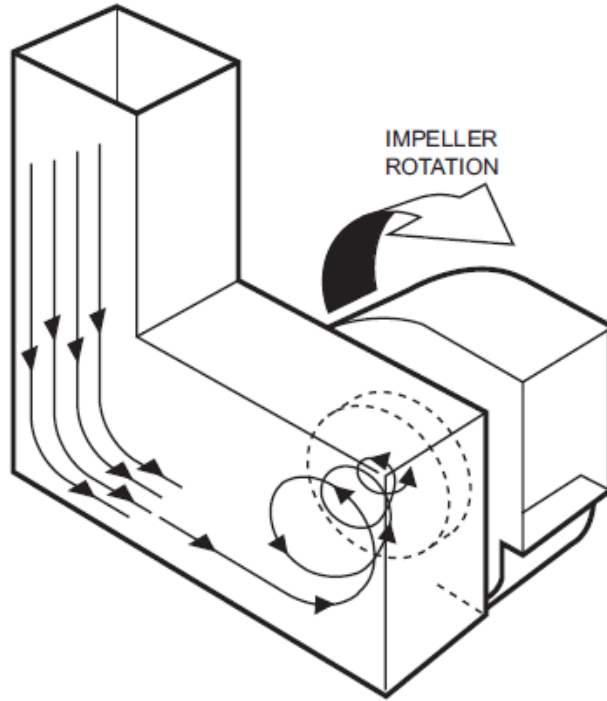
Figure 8.5 - Outlet Elbows on SWSI Centrifugal Fans

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System Effects



System Effects



COUNTER-ROTATING SWIRL

Figure 9.7 - Example of a Forced Inlet Vortex

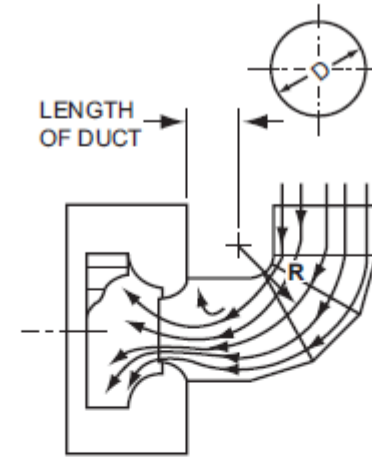


Figure 9.3A - Non-Uniform Airflow Into a Fan Inlet Induced by a 90°, 3-Piece Section Elbow-- No Turning Vanes

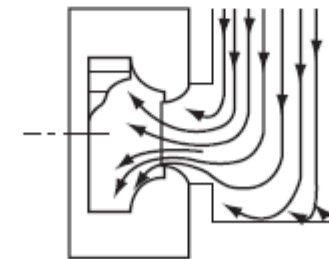


Figure 9.3B - Non-Uniform Airflow Induced Into Fan Inlet by a Rectangular Inlet Duct

System Effects

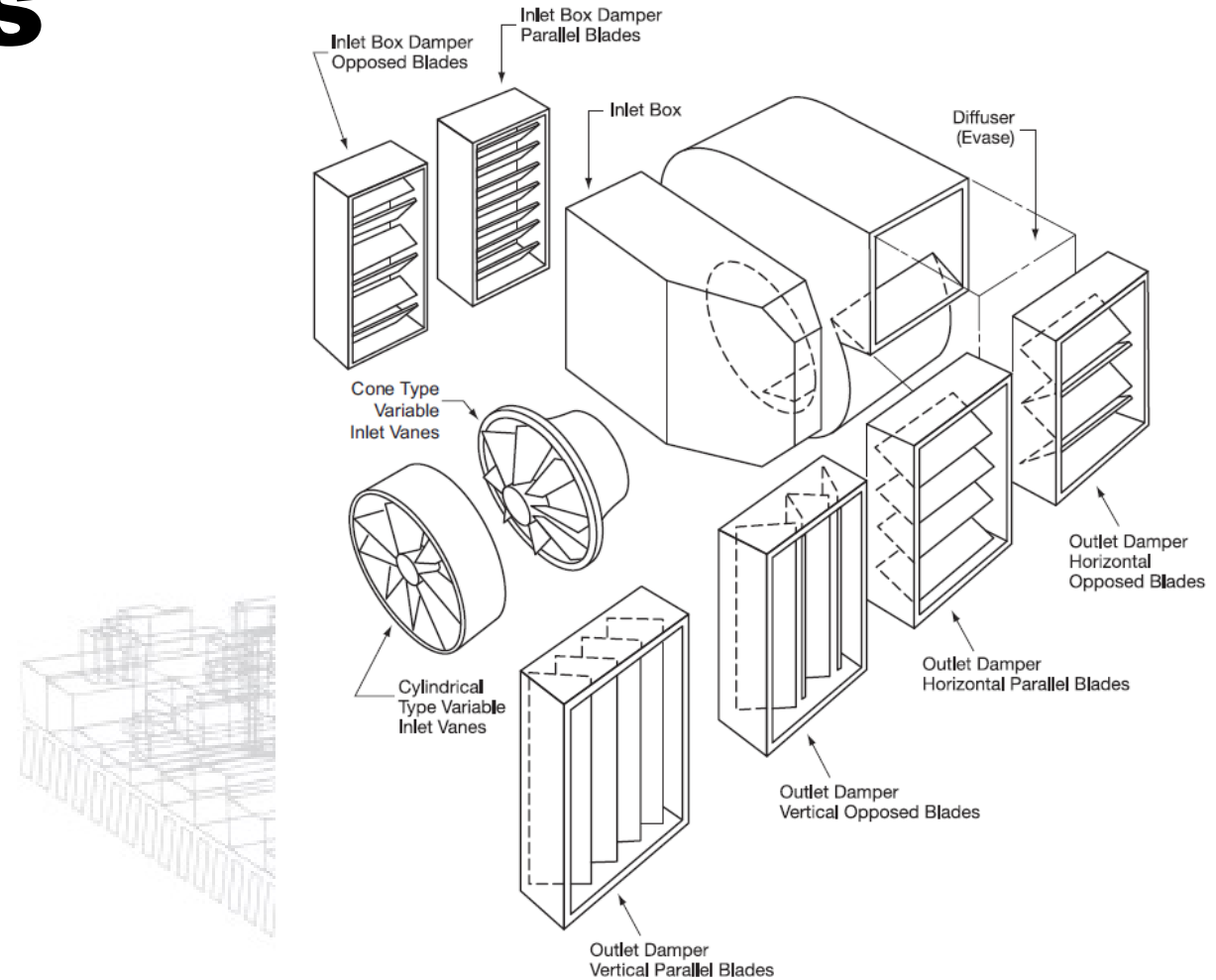
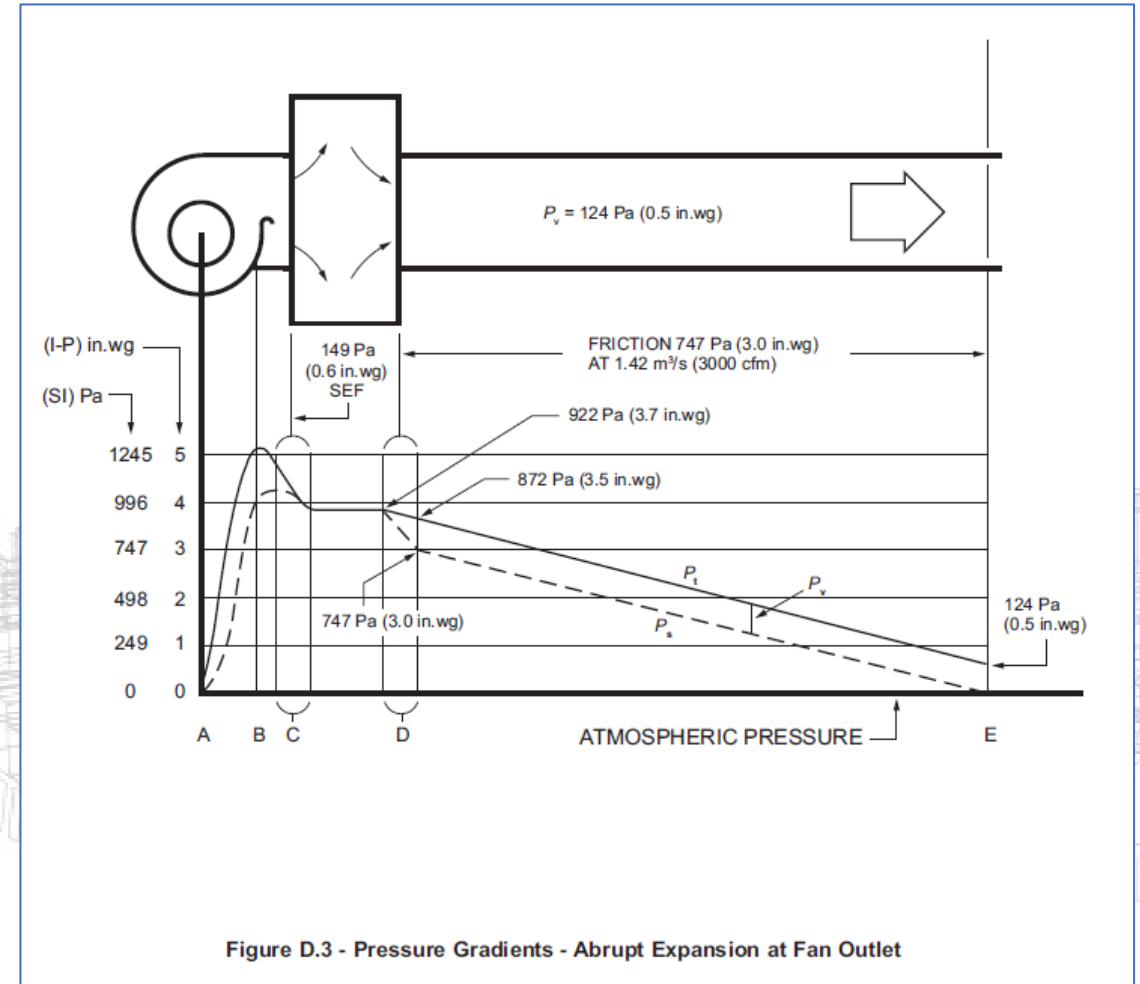
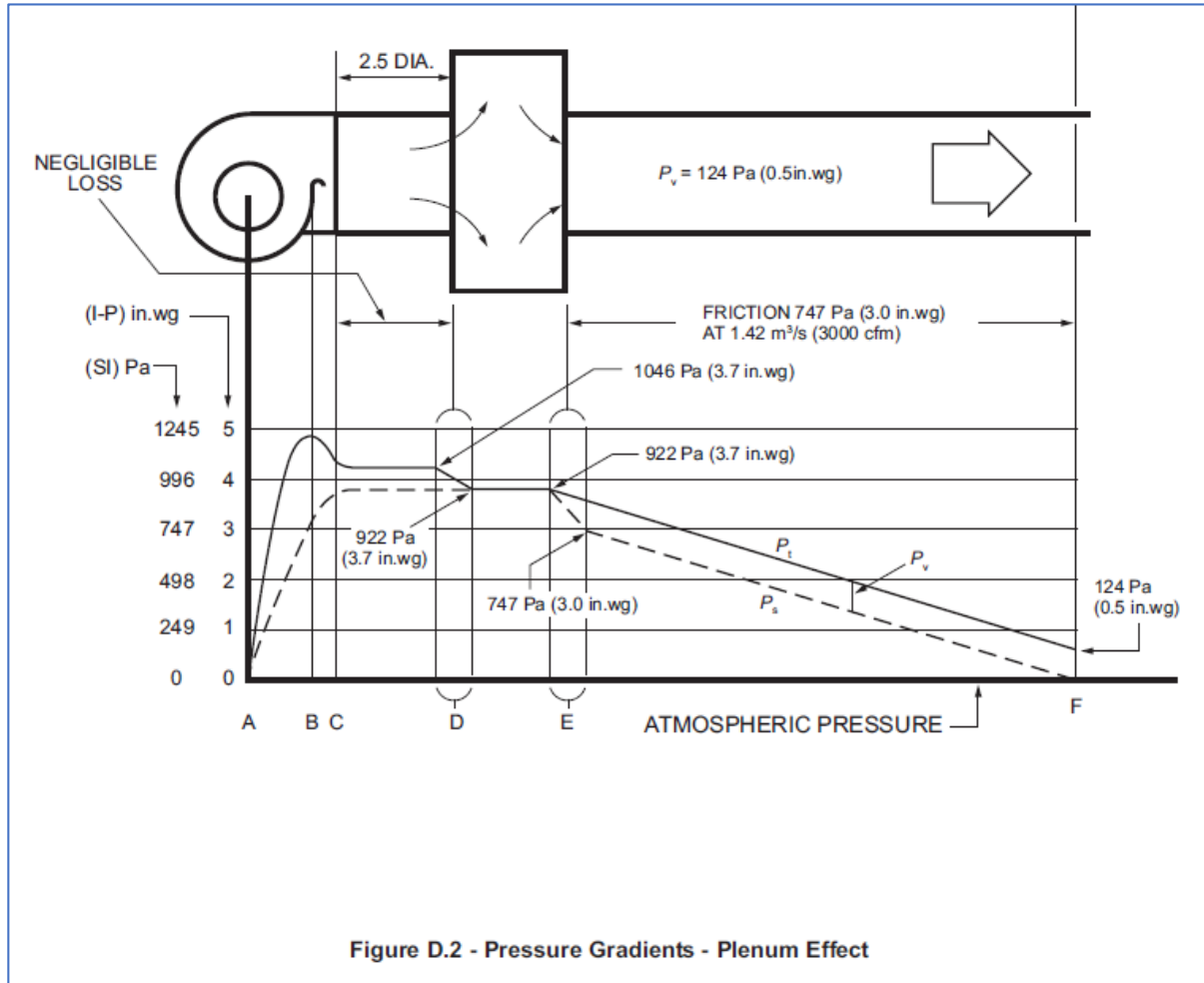
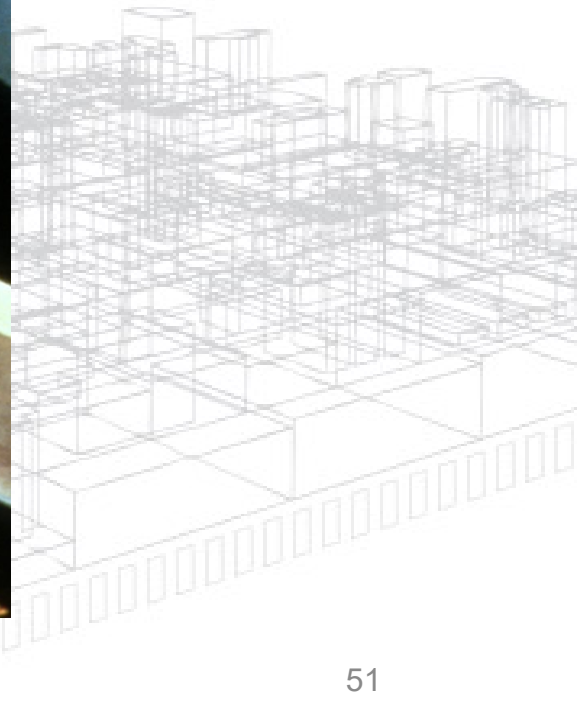
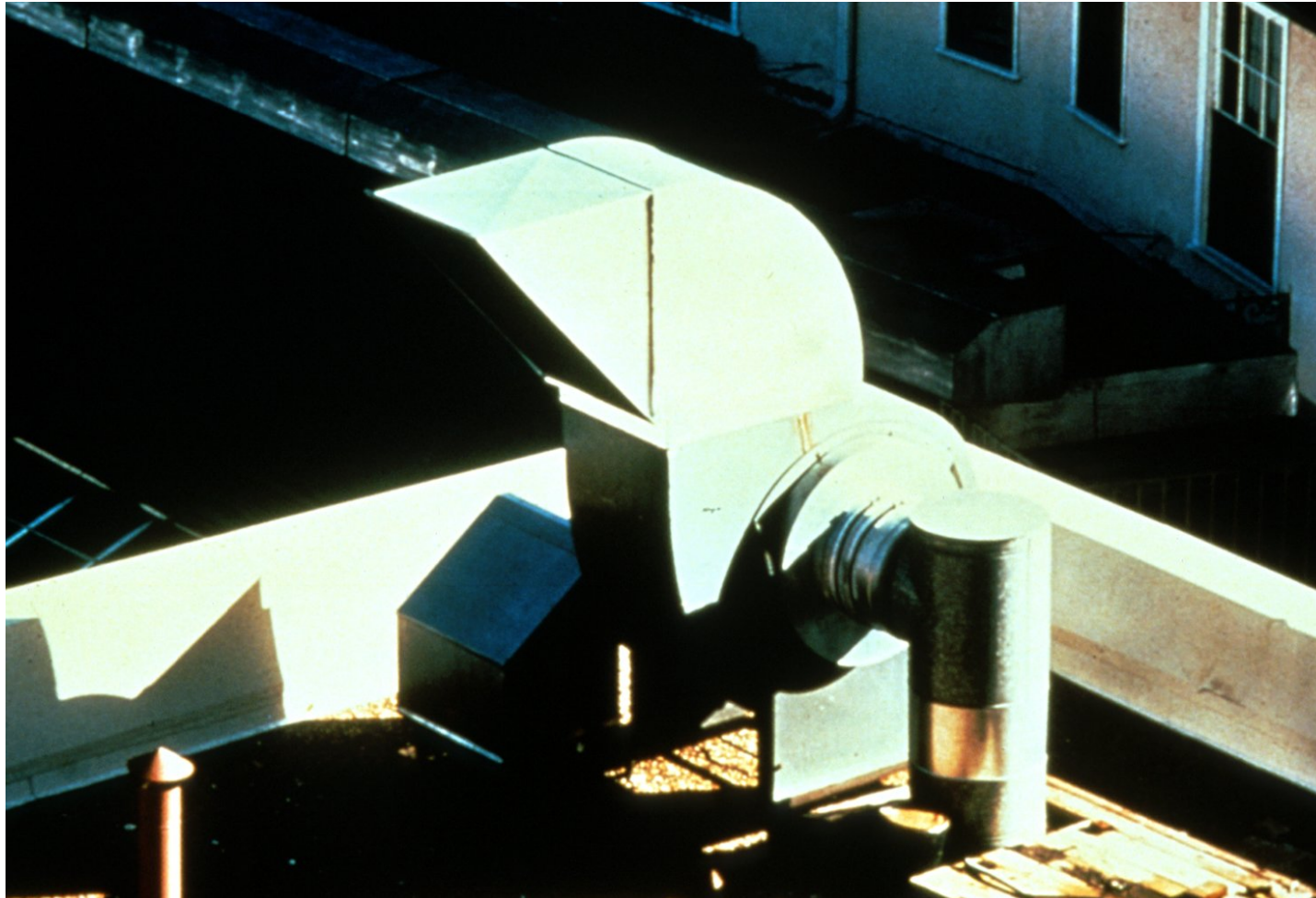


Figure 10.1 - Common Terminology for Centrifugal Fan Appurtenances

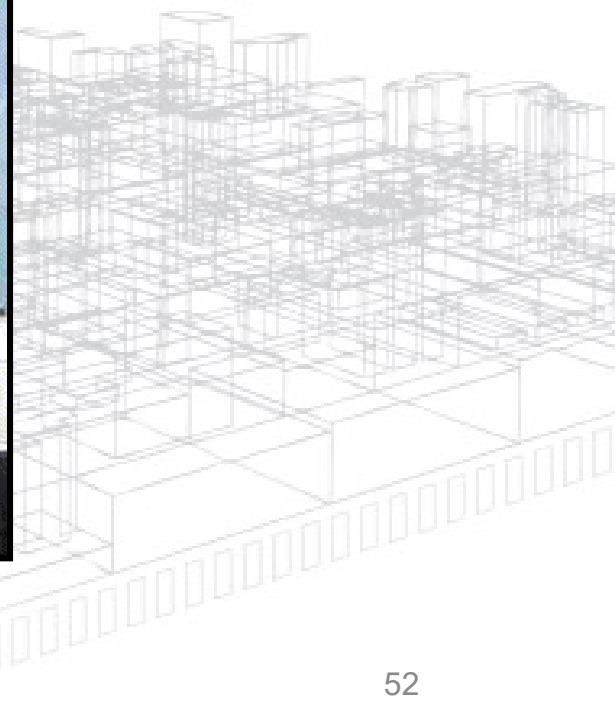
System Effects



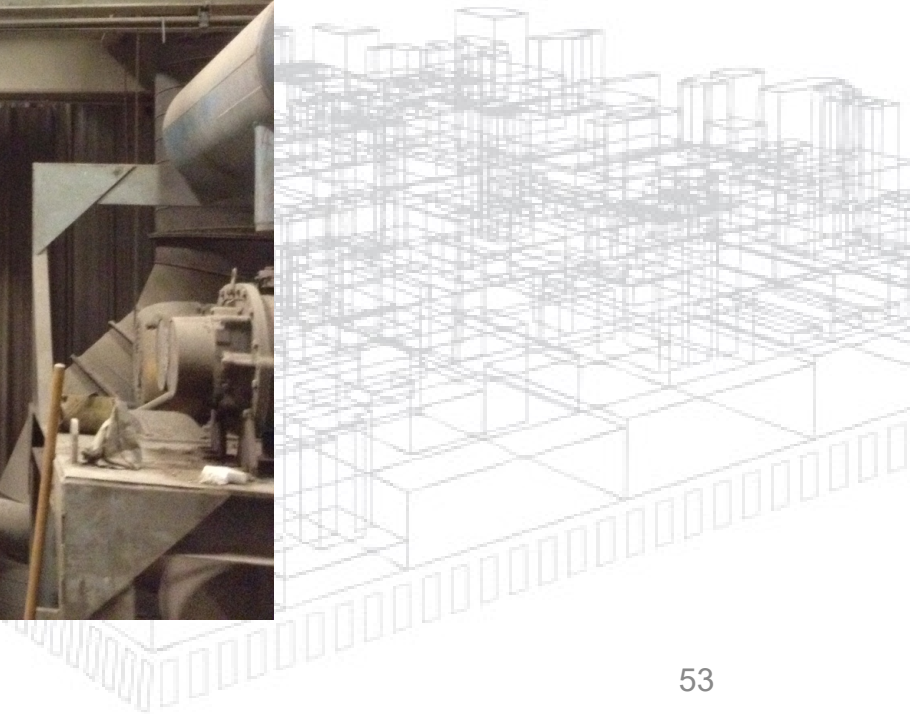
System Effects



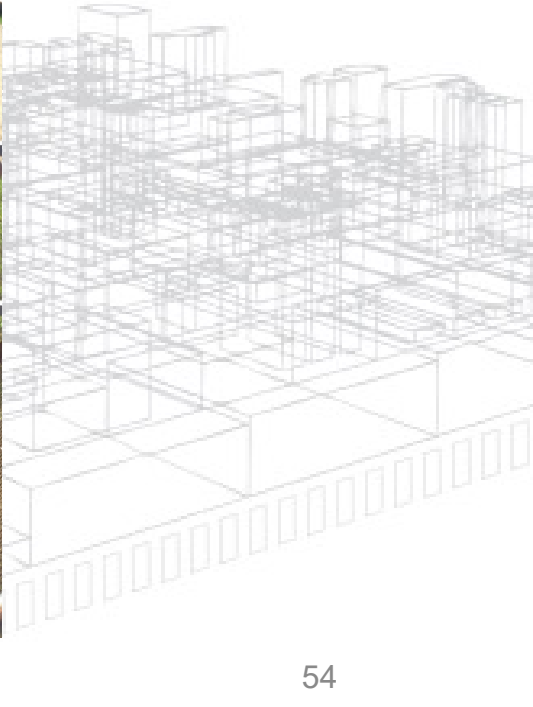
System Effects



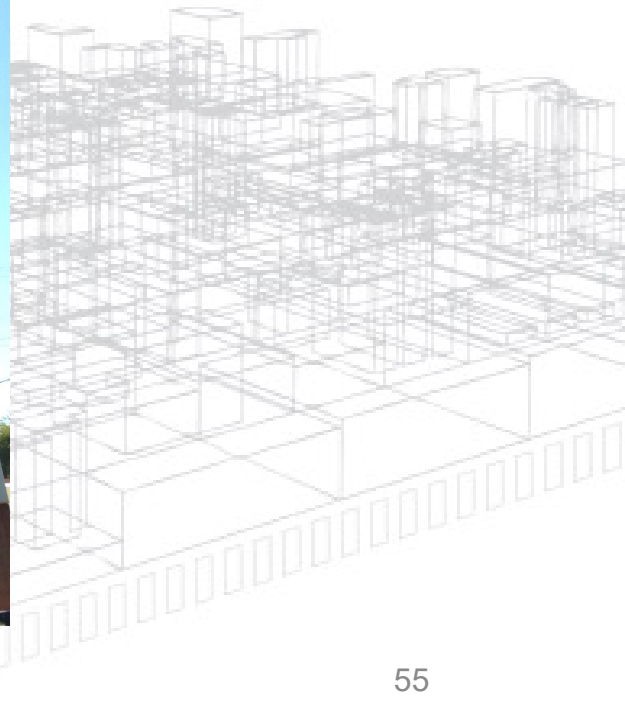
System Effects



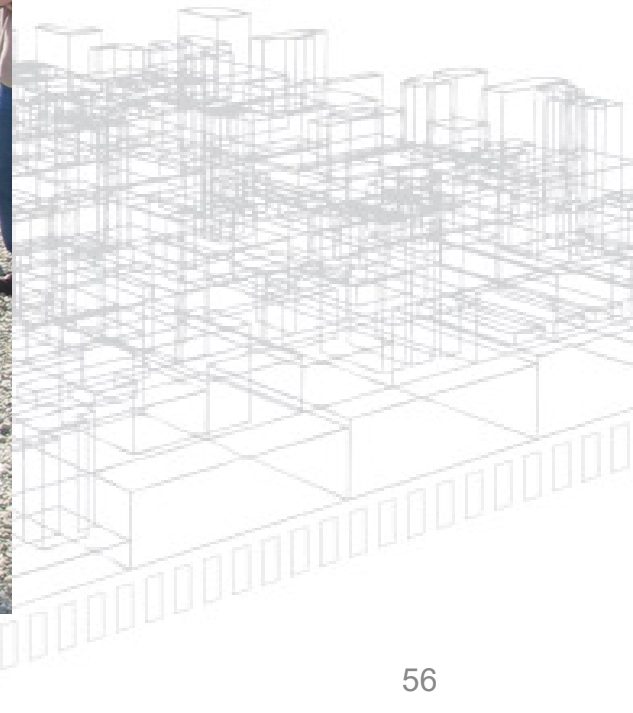
System Effects



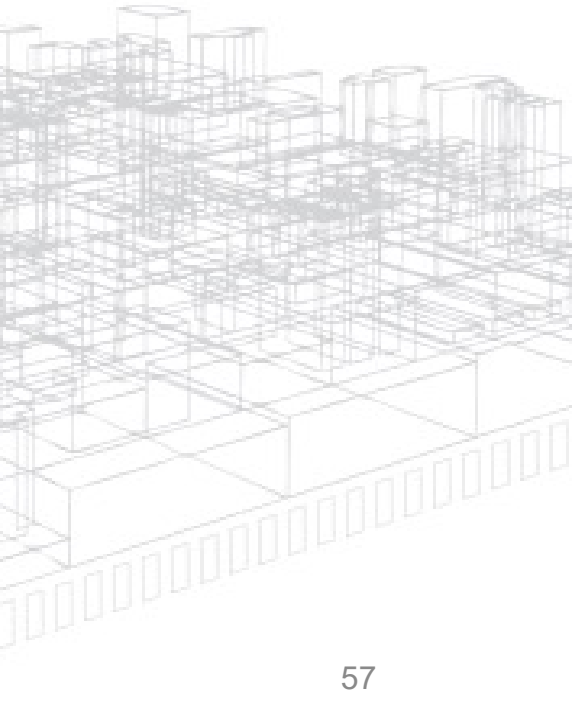
System Effects



System Effects



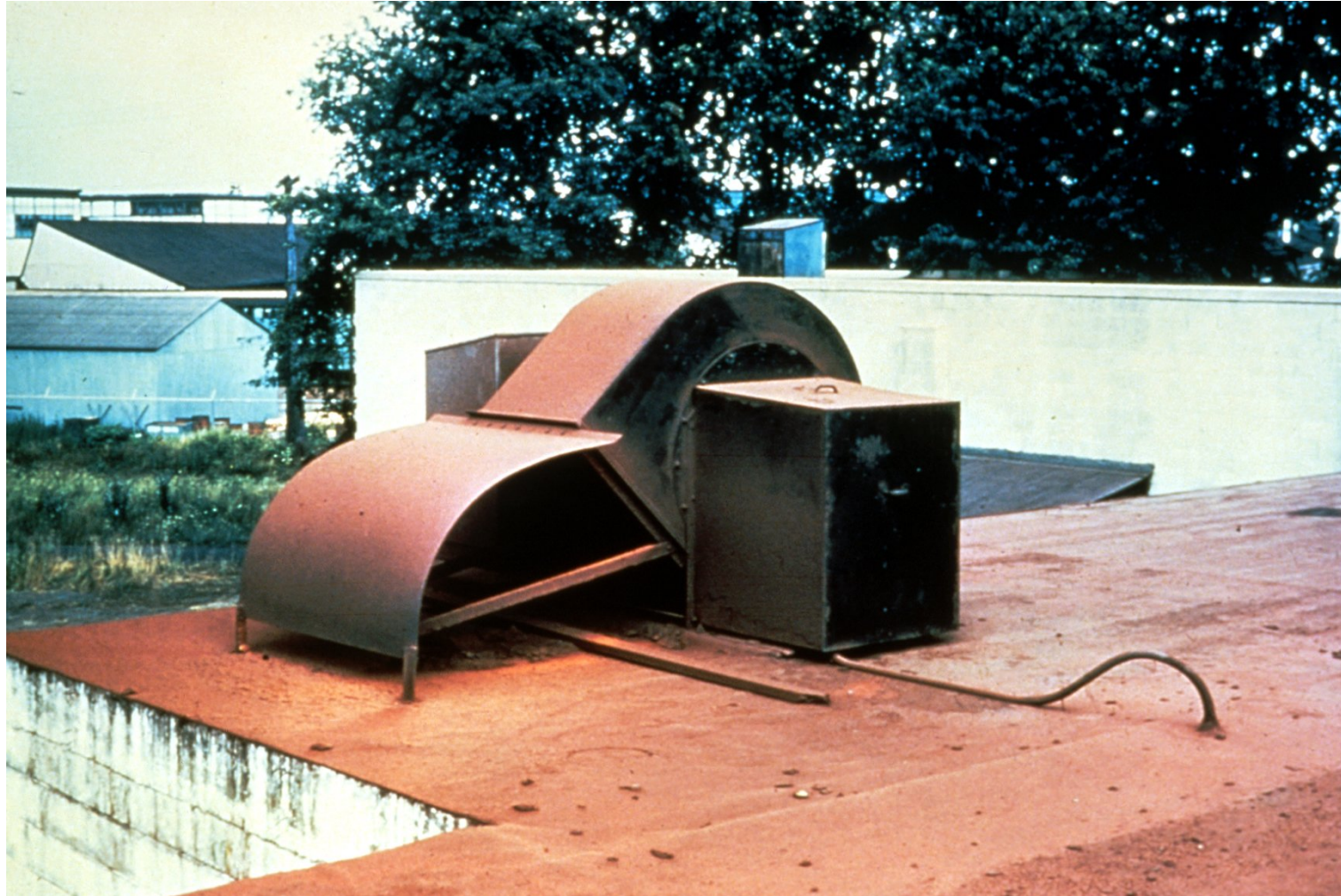
System Effects



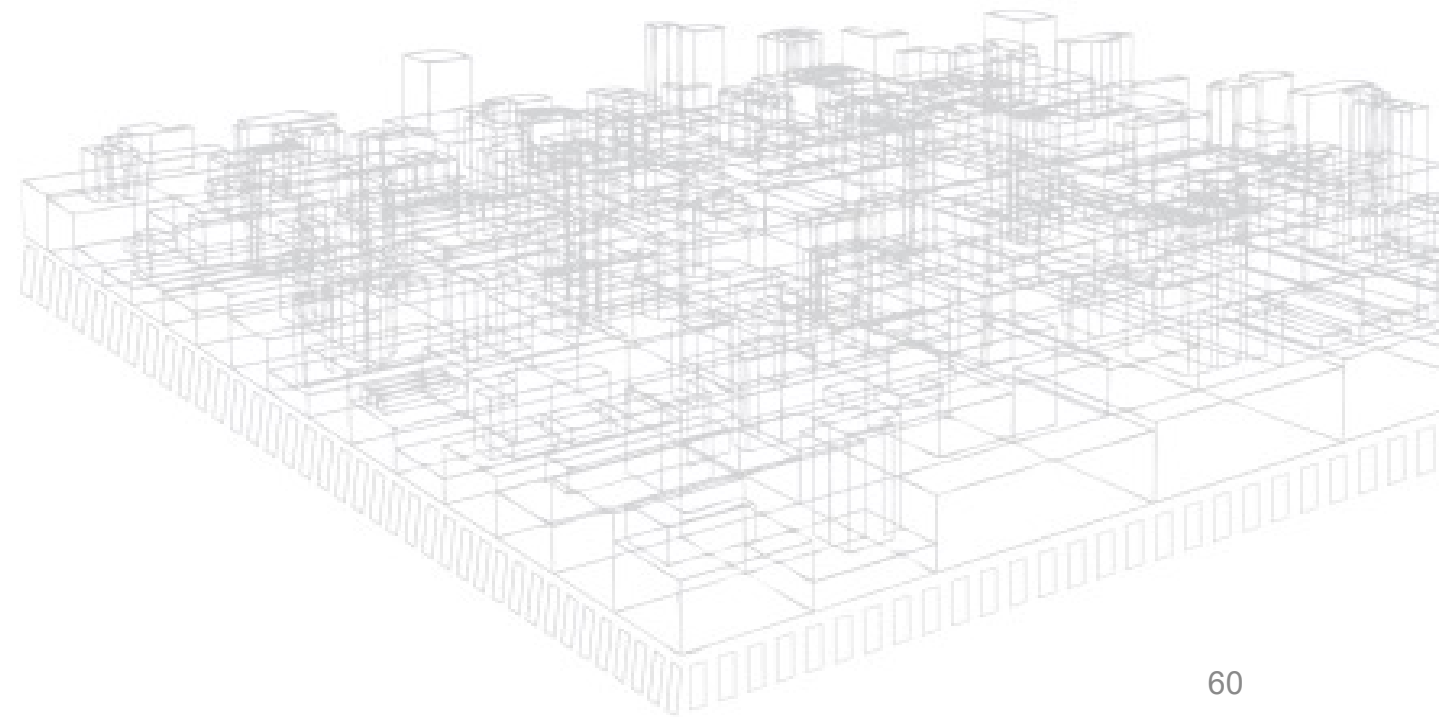
System Effects



System Effects



System Effect Demonstration



Questions?

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