Welcome

Green HVAC Ductwork Done Right!

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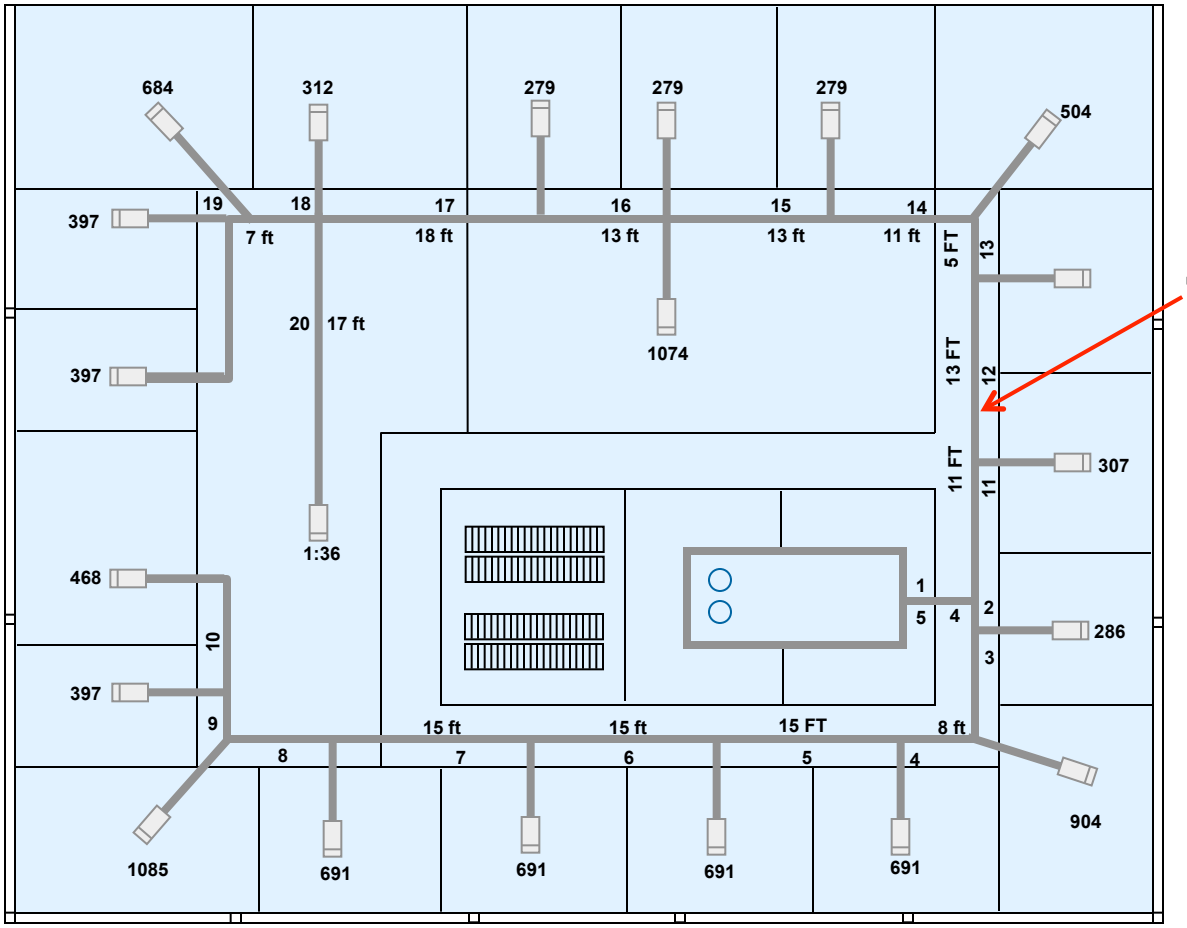
High Velocity Duct Design Tips:

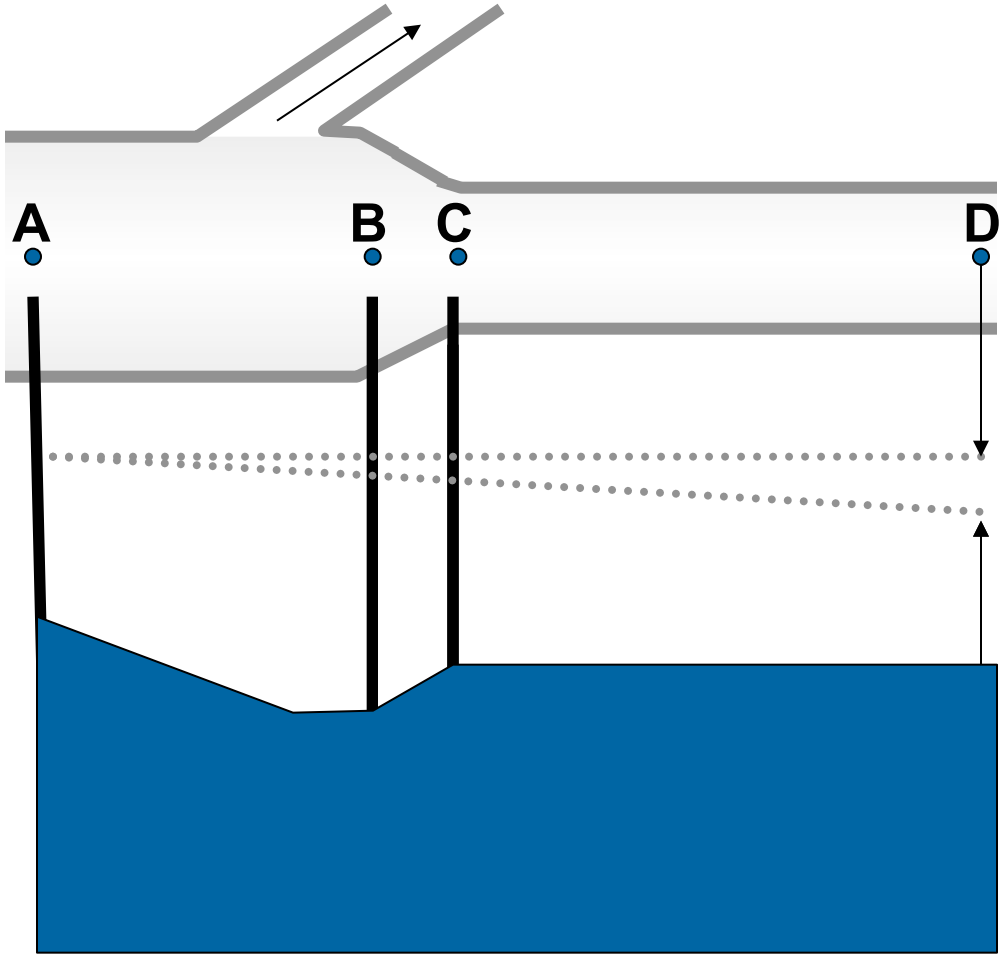
- Fundamentals of High Velocity, Static Regain, Duct Design
- Key Advantages
- Do's
- Don'ts
- Biggest Misconceptions
- Best Rooftop Acoustics Idea
- Real World Examples
- In Summary

Duct Layout



Trunk Ducts

Fundamentals of Static Regain



$Tp = Vp + Sp - h_f$

h_f

SP

VP

Limitation of Type of Ductwork

Rectangular -- No

Round -- Yes

Why?

Recommended and Maximum Duct Velocities for Low Velocity Systems (rectangular duct)

Table 6 ASHRAE Handbook, 1972, page 481

	Recommended velocities, fpm		
Designation	**Residences**	**Schools, theaters, public buildings**	**Industrial buildings**
Main ducts[b]	700-900	1000-1300	1200-1800
Branch ducts[b]	600	600-900	800-1000
Branch risers[b]	500	600-700	800

$$Vp = (fpm/4005)^2$$

Recommended and Maximum Duct Velocities for High Velocity Systems (round duct)

Table 7 ASHRAE Handbook, 1972, page 481

Recommended maximum duct velocities for high-velocity systems

CFM carried by the duct	Maximum FPM
60,000 to 40,000	6,000
40,000 to 25,000	5,000
25,000 to 15,000	4,500
15,000 to 10,000	4,000
10,000 to 6,000	3,500
6,000 to 3,000	3,000
3,000 to 1,000	2,500

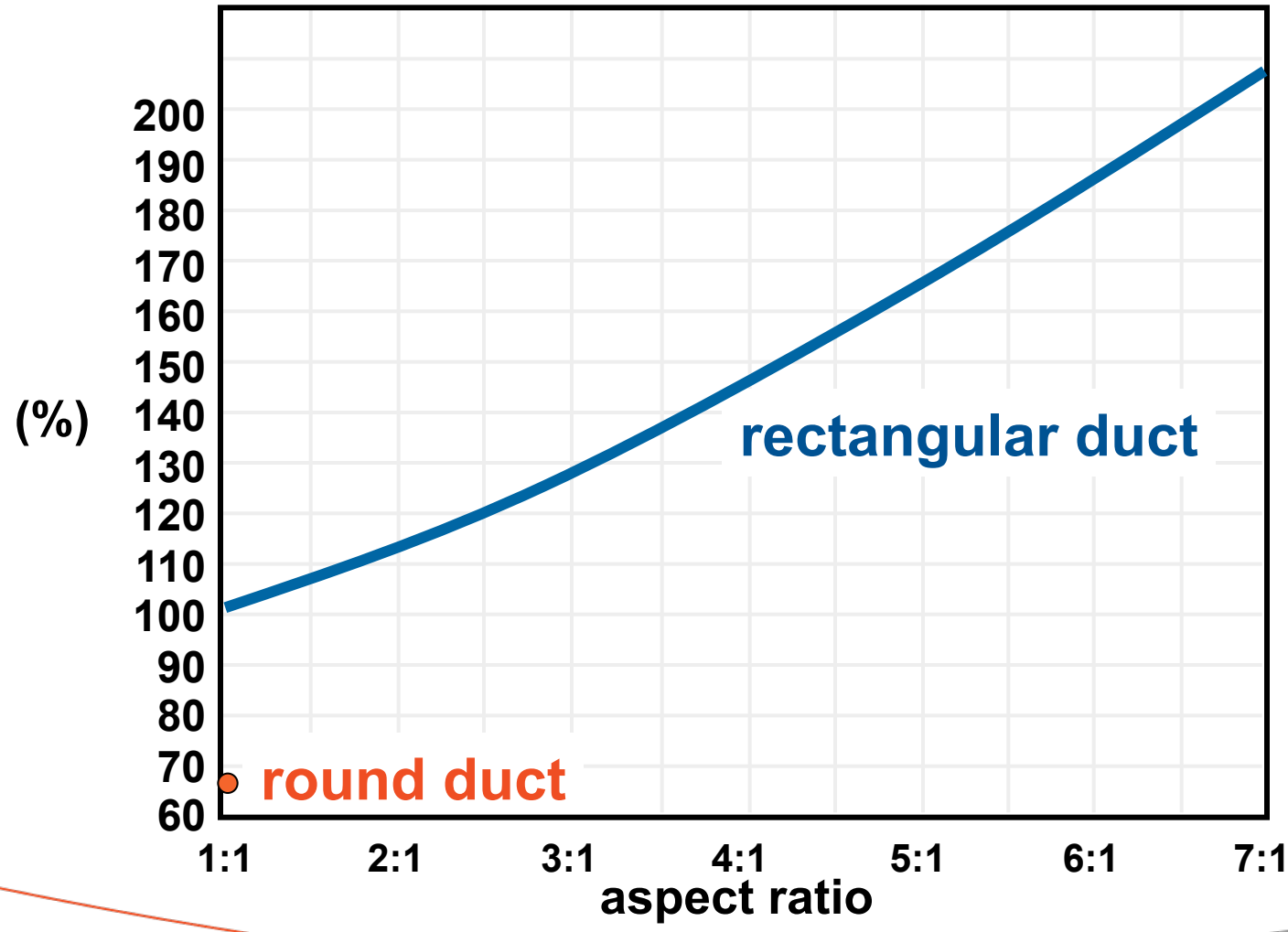
Key Advantages:

- Lower cost
- Lower duct heat pick up
- Less duct leakage
- Less space

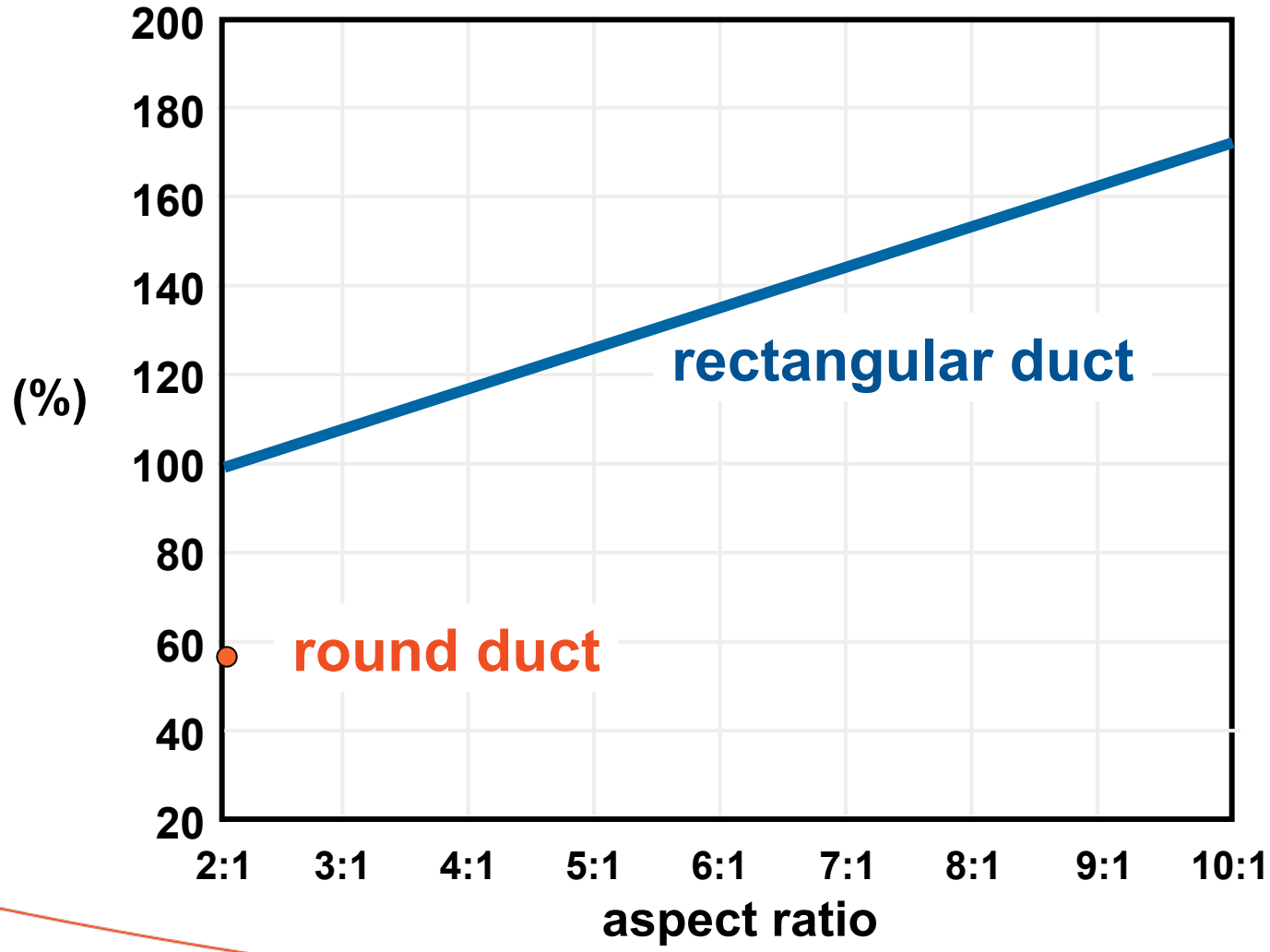
$0.25-$1.00/sq.ft. Installed Cost Savings

- Rectangular Duct 0.5#/sq.ft.
- Rectangular Duct $3.00 - $3.50/sq.ft.
- High Velocity Static Regain Round Duct 0.25#/sq.ft. (50% less)
- Round Duct $2.00 - $2.50/sq.ft.
- Saving of at least $0.25 to $1.00/sq.ft. ($100 to $400/ton)

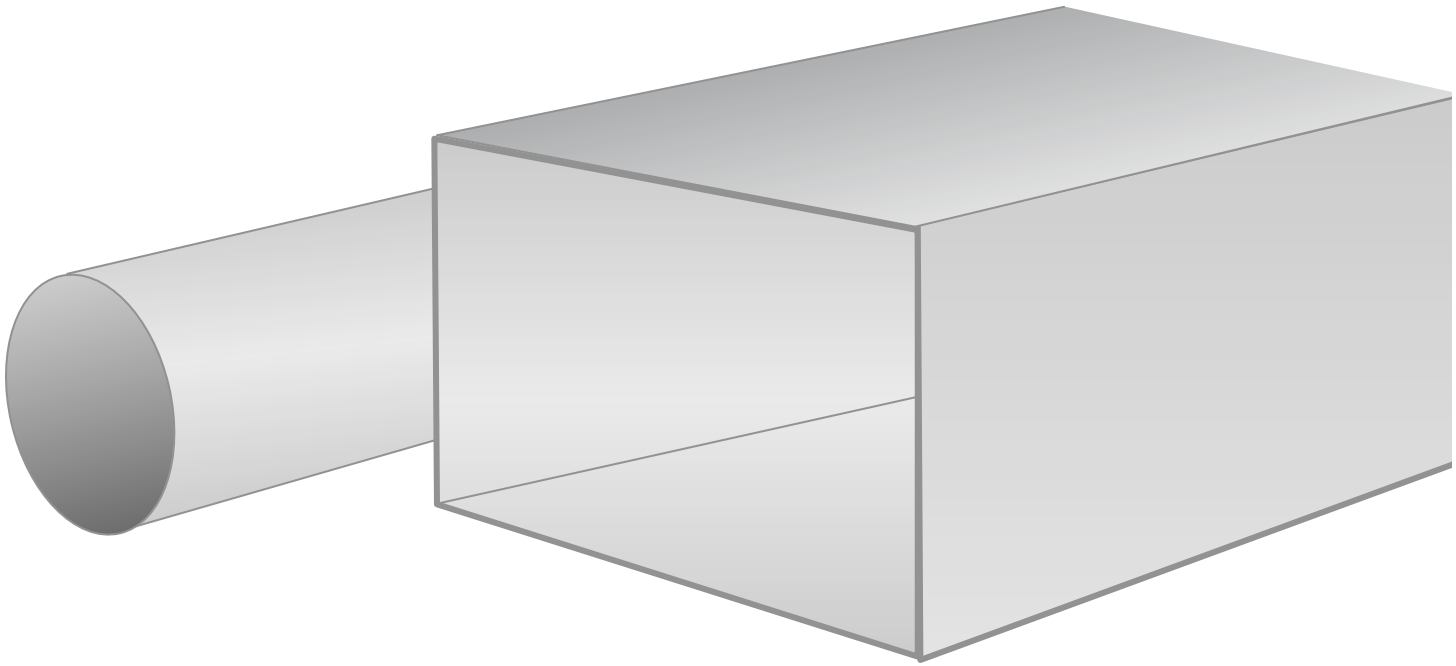
Relative Installed Cost vs. Aspect Ratio



Duct Heat Gain vs. Aspect Ratio



Duct Heat Pickup



Duct Leakage:

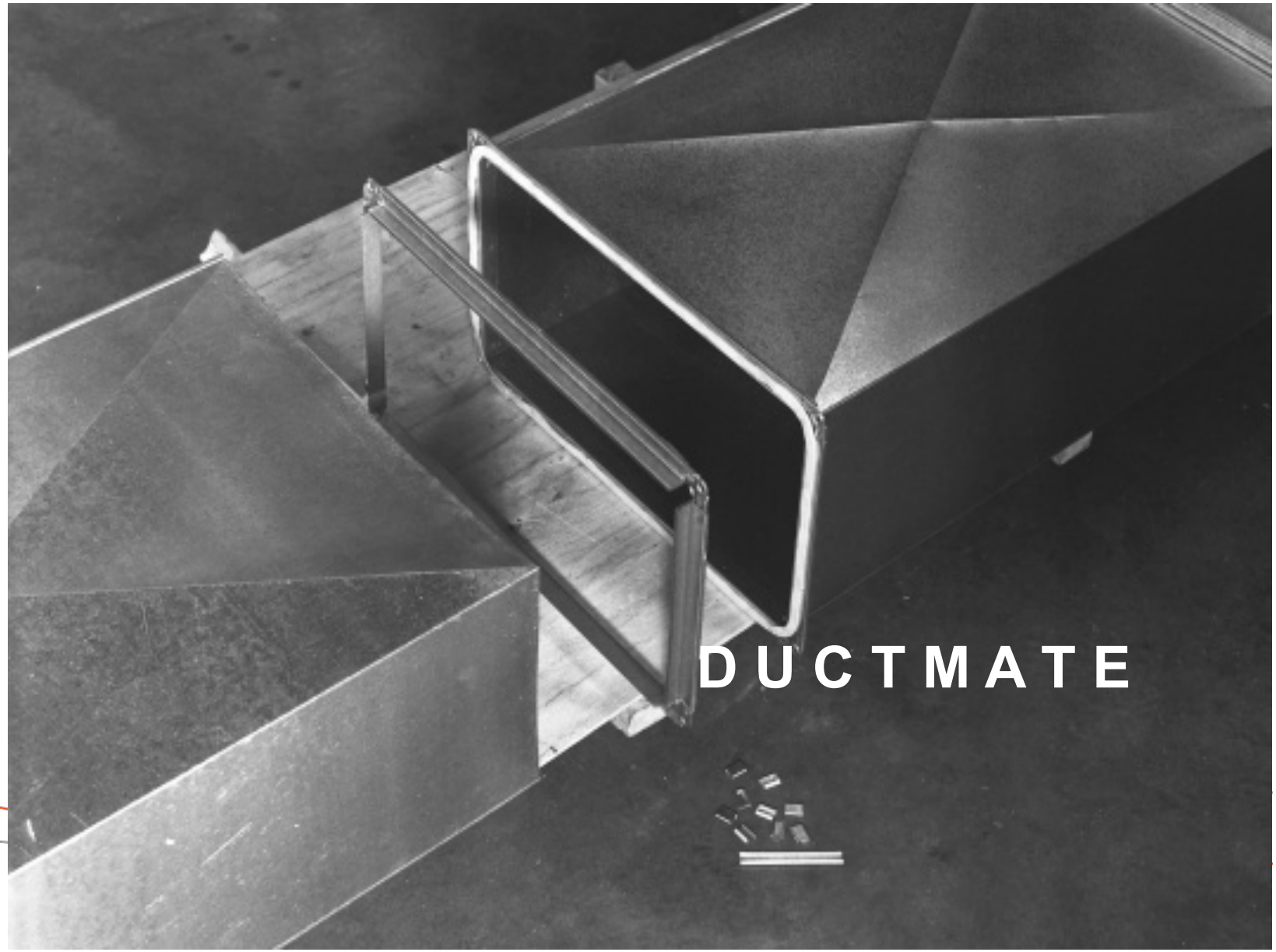
Leakage:

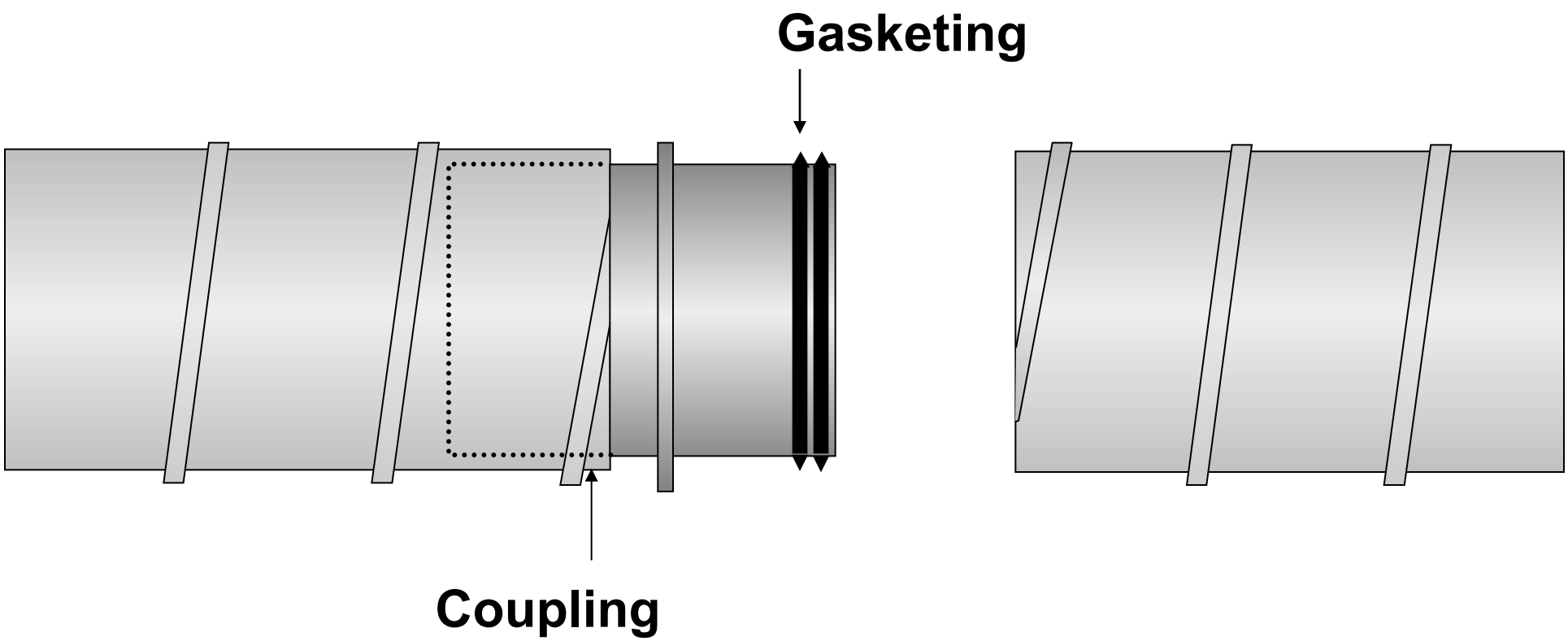
- **Rectangular Duct**
  - **traditionally hard to get below 10 percent**
  - **today it's hard to get below 3%.**
- **Round Duct – can get below 1 percent**

Fan BHP:

- $(CFM_2/CFM_1)^3 = BHP_2/BHP_1$
- $(110/101)^3$ = 29% increase in fan brake horsepower
- $(103/101)^3$ = 6% increase in fan brake horsepower

TRANE




Gasketing
Coupling

Why is leakage so important?

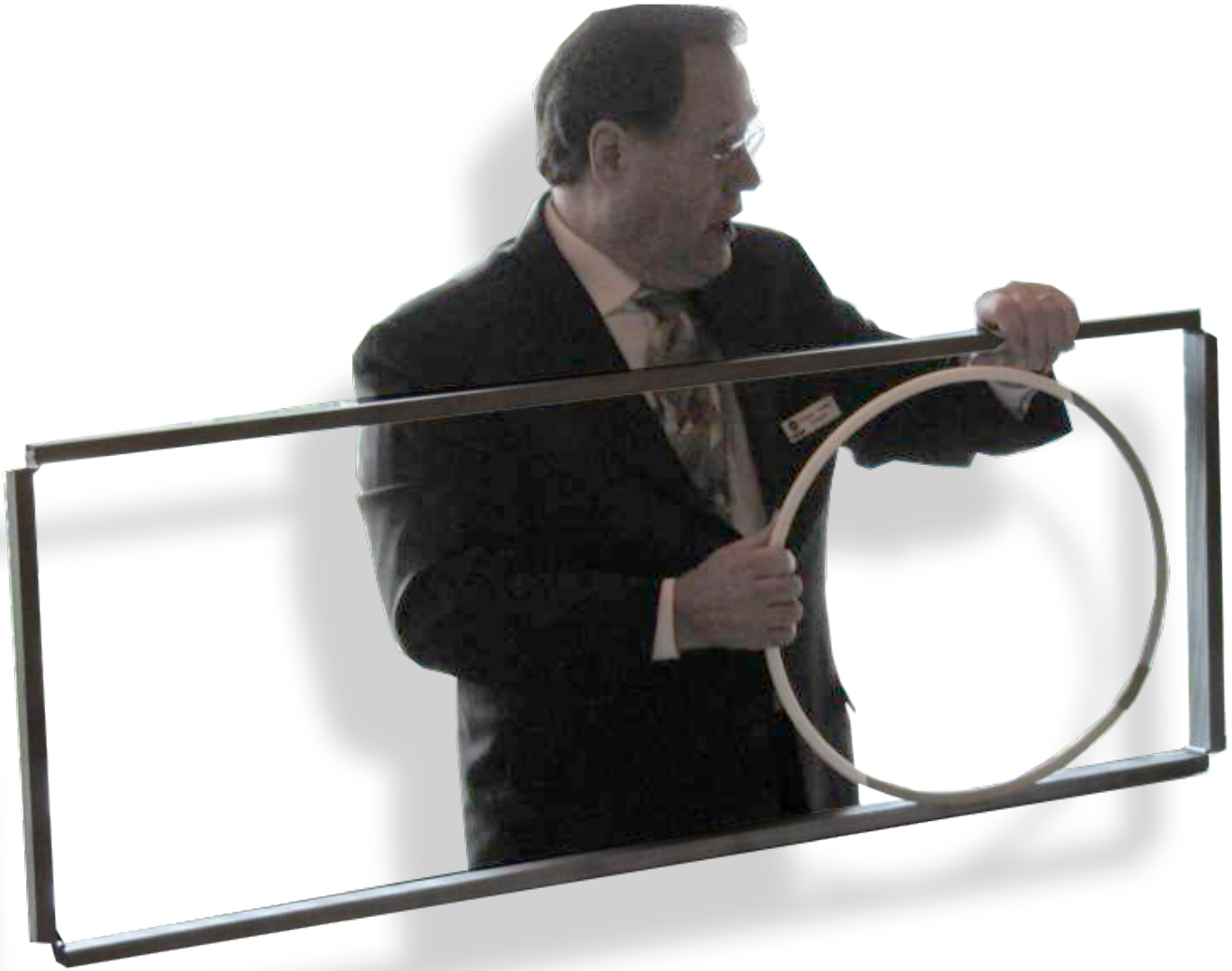
Top faults causing energy inefficiencies in commercial buildings (Top 13 of 100+ faults identified)*

	National Energy Waste (Quads, primary/year)	Electricity equivalent (BkWh/year)	Cost ($billion/year)
Duct leakage	0.3	28.6	2.9
HVAC left on when space unoccupied	0.2	19.0	1.9
Lights left on when space unoccupied	0.18	17.1	1.7
Airflow not balanced	0.07	6.7	0.7
Improper refrigerant charge	0.07	6.7	0.7
Dampers not working properly	0.055	5.2	0.5
Insufficient evaporator airflow	0.035	3.3	0.3
Improper controls setup / commissioning	0.023	2.2	0.2
Control component failure or degradation	0.023	2.2	0.2
Software programming errors	0.012	1.1	0.1
Improper controls hardware installation	0.01	1.0	0.1
Air-cooled condenser fouling	0.008	0.8	0.1
Valve leakage	0.007	0.7	0.1
Total (central estimate)	1.0	94.6	9.6
Total (range)	0.34-1.8	32.4-171.4	3.3-17.3

Adapted from Roth et al. (2005) assuming 10,500 BTU/kWh, and $0.10/kWh

*Source: Study Done by Lawrence Berkeley National Laboratory for the Department of Energy

Less Space



Biggest Misconception

I can't use round duct because it won't fit!

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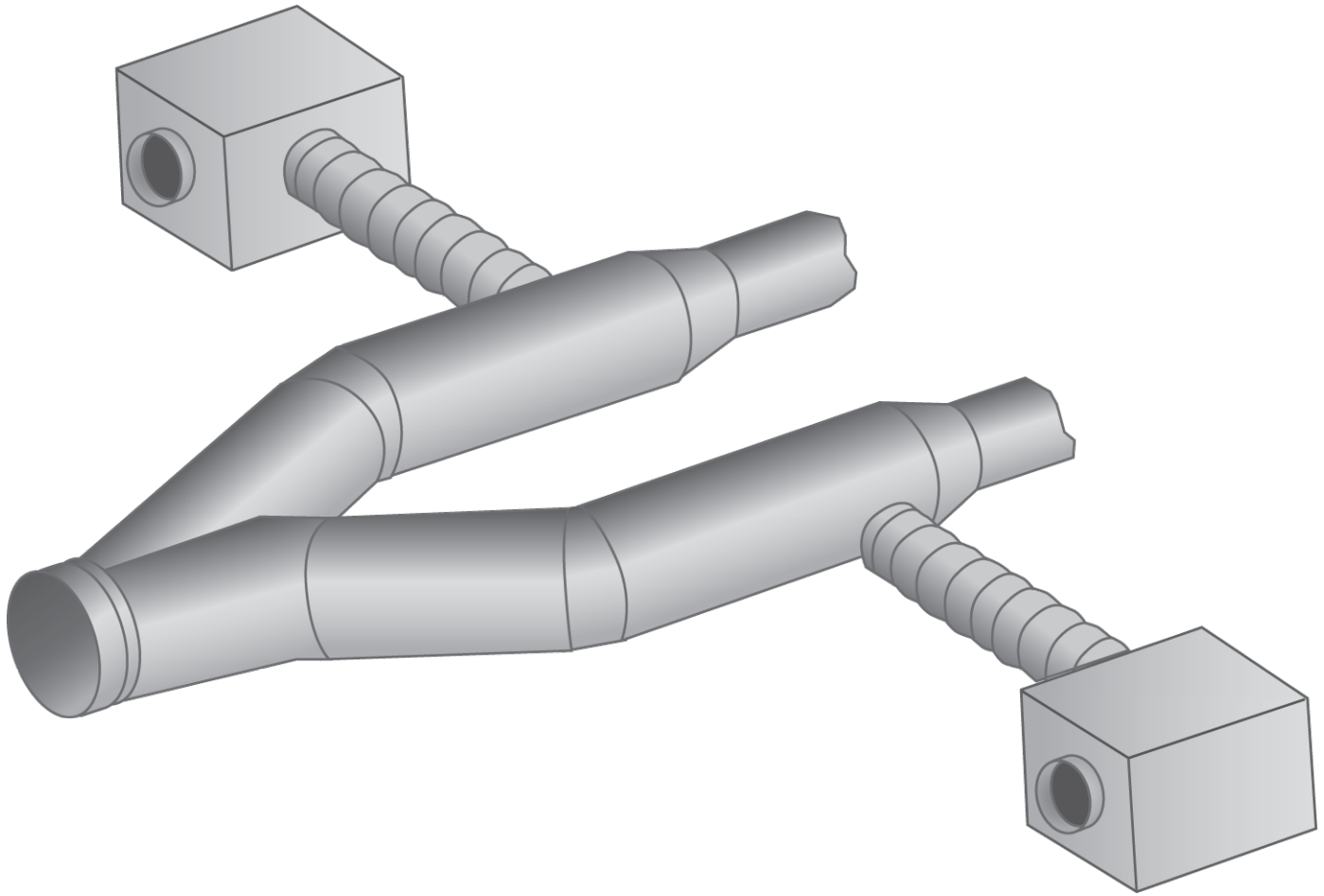
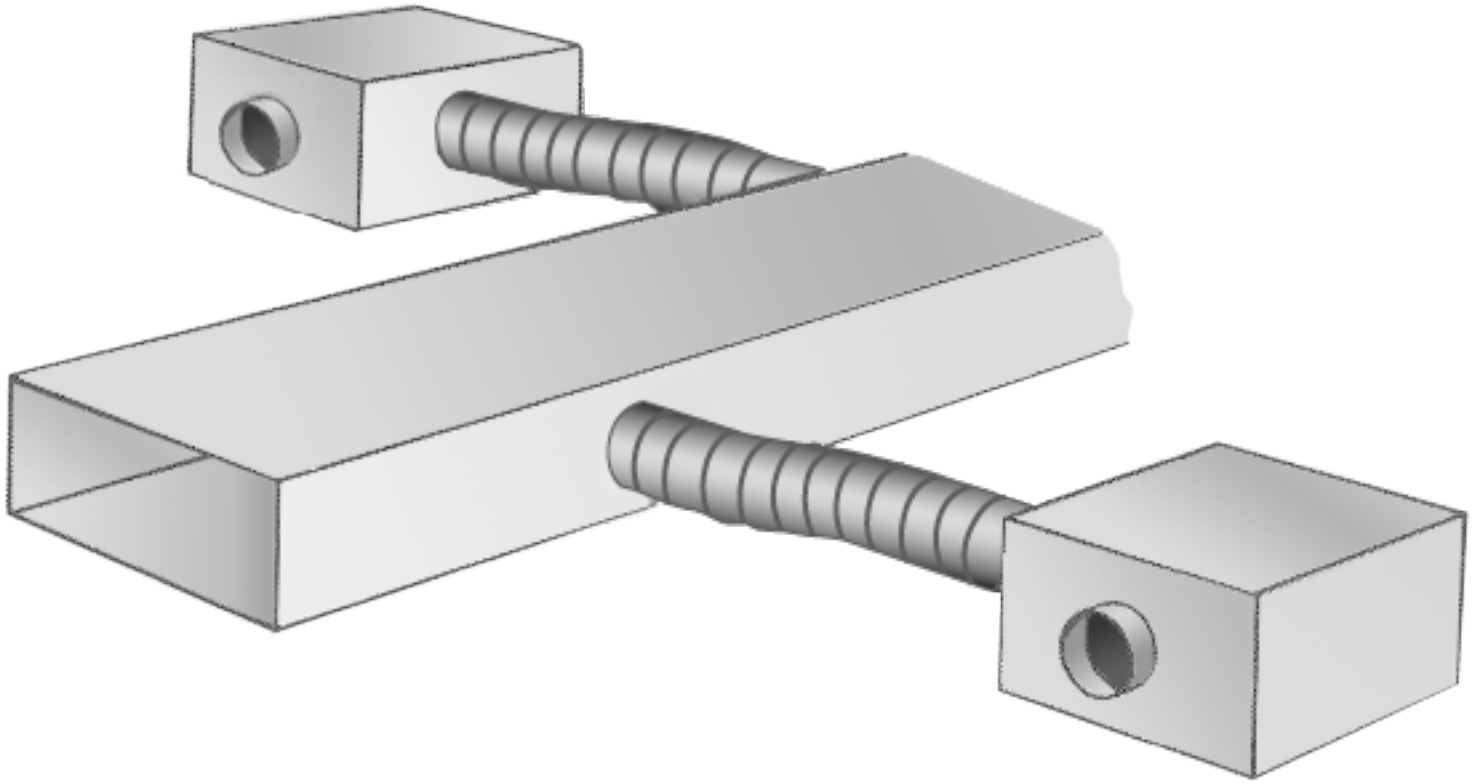
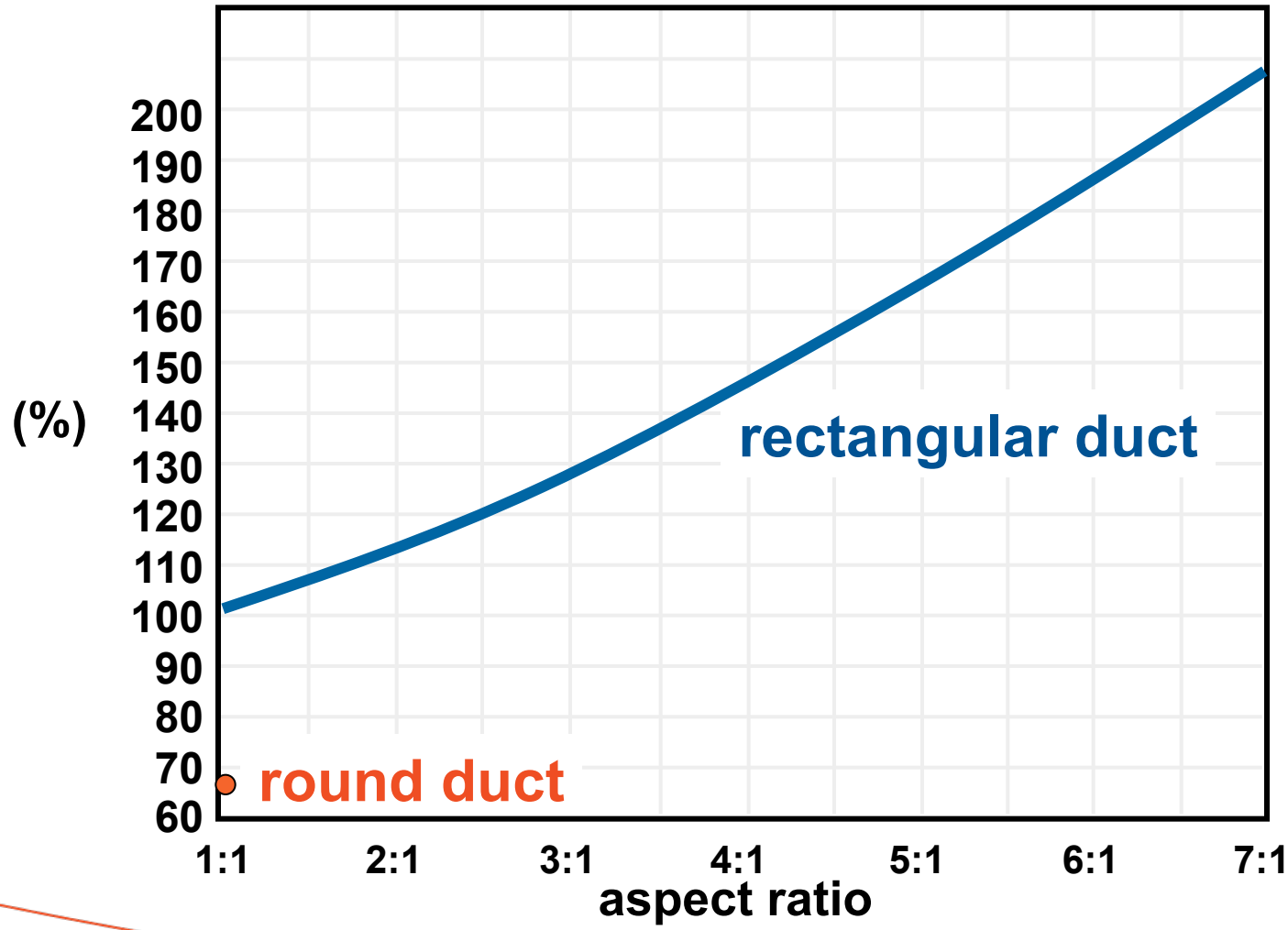
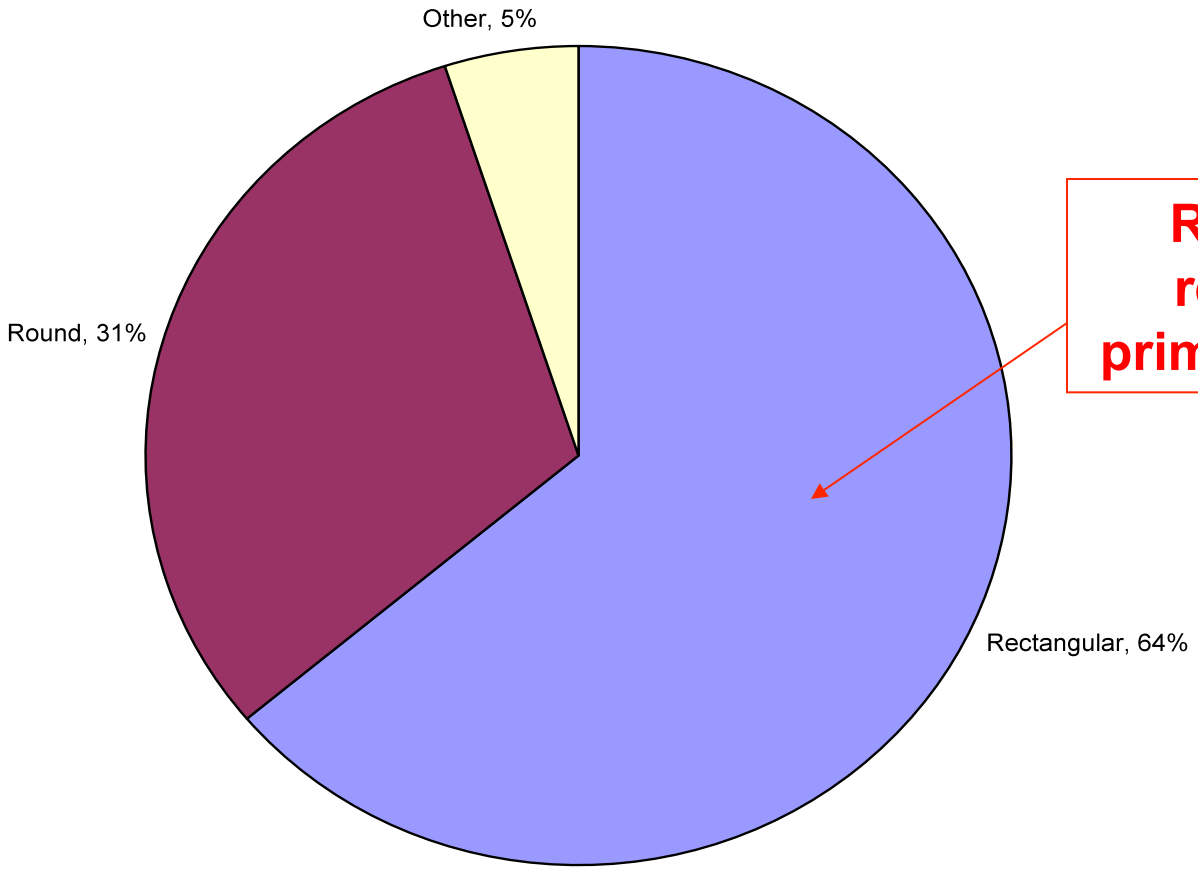




Relative Installed Cost vs. Aspect Ratio



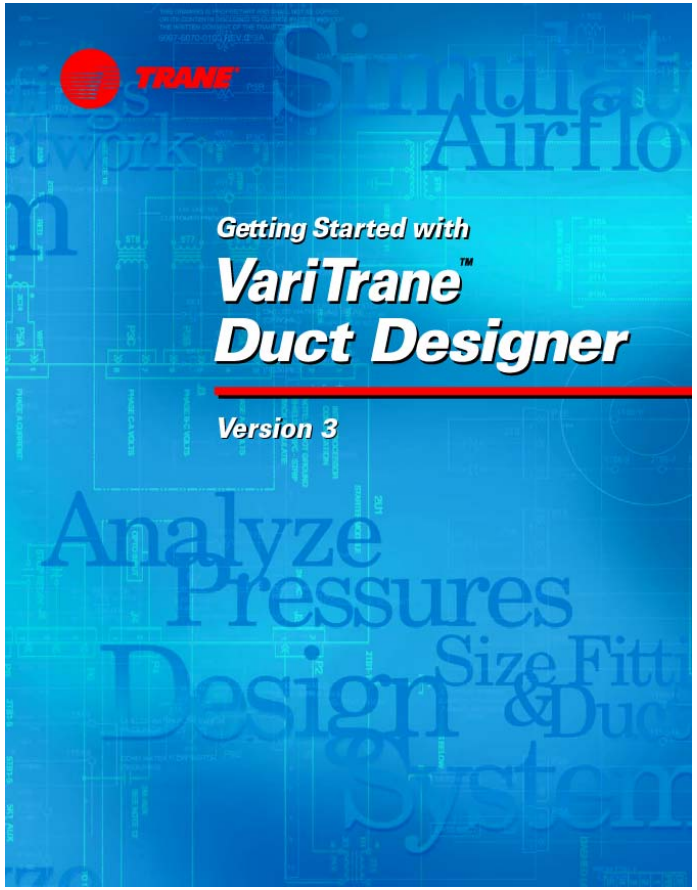
U.S. Market



Rectangular remains the primary ductwork

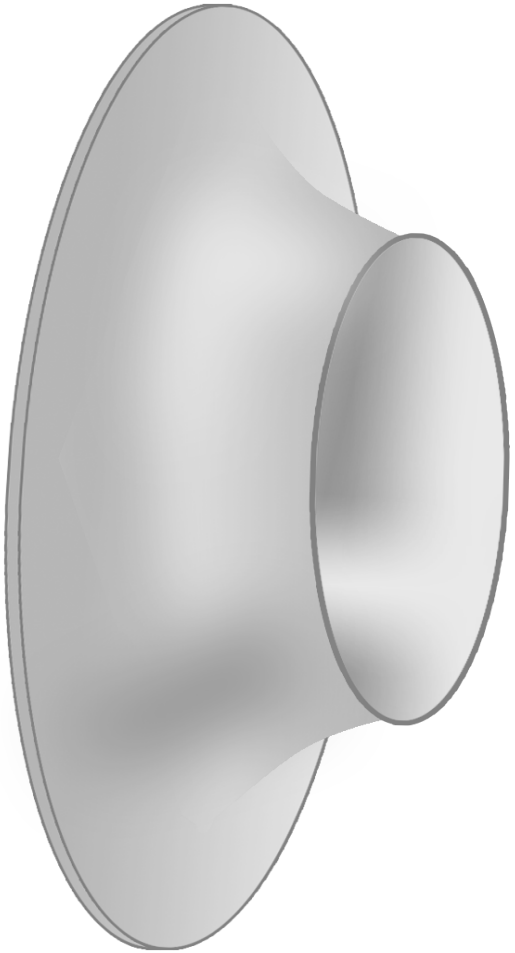
Trane Ductulator

Whereas, High Velocity, Static Regain, Round Duct Requires a Computerized Program



Do’s

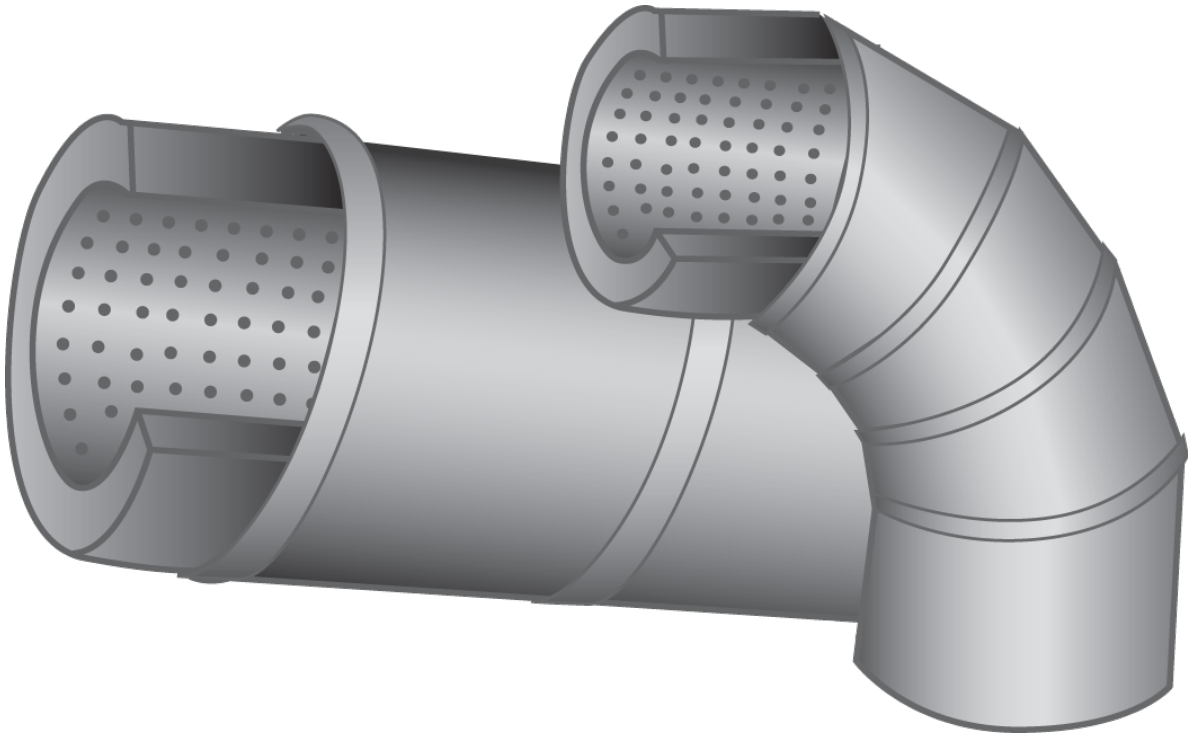
Bellmouth Fitting



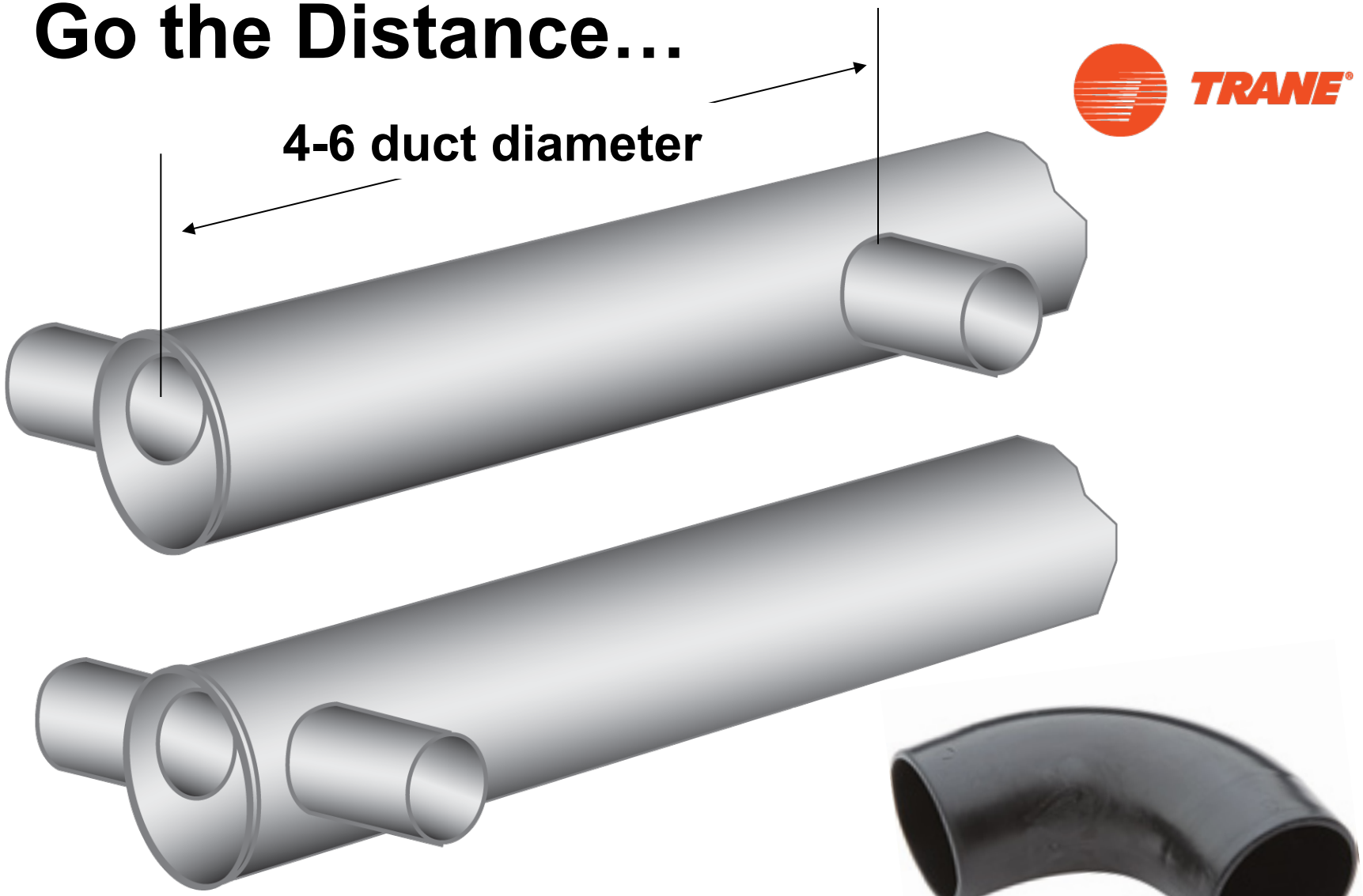

2003 10 15

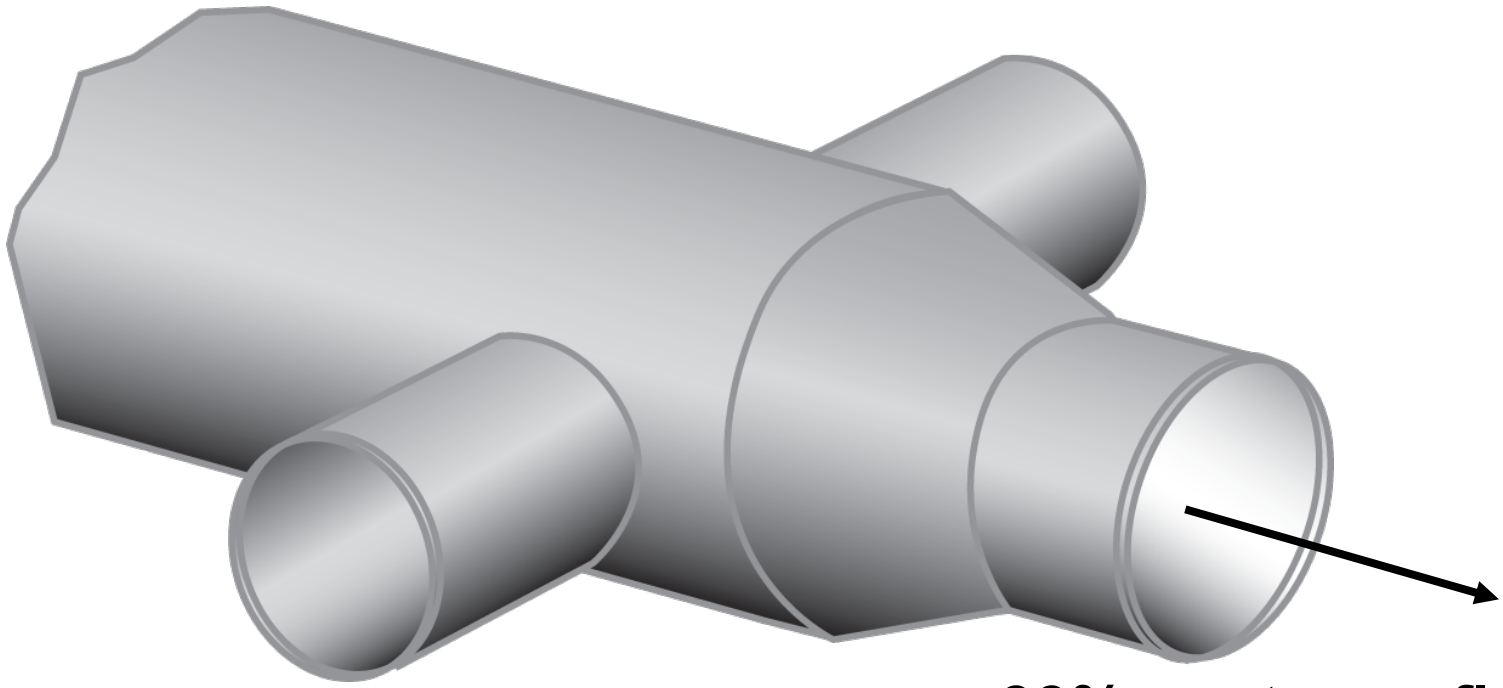

2003 10 15

Attenuated Duct



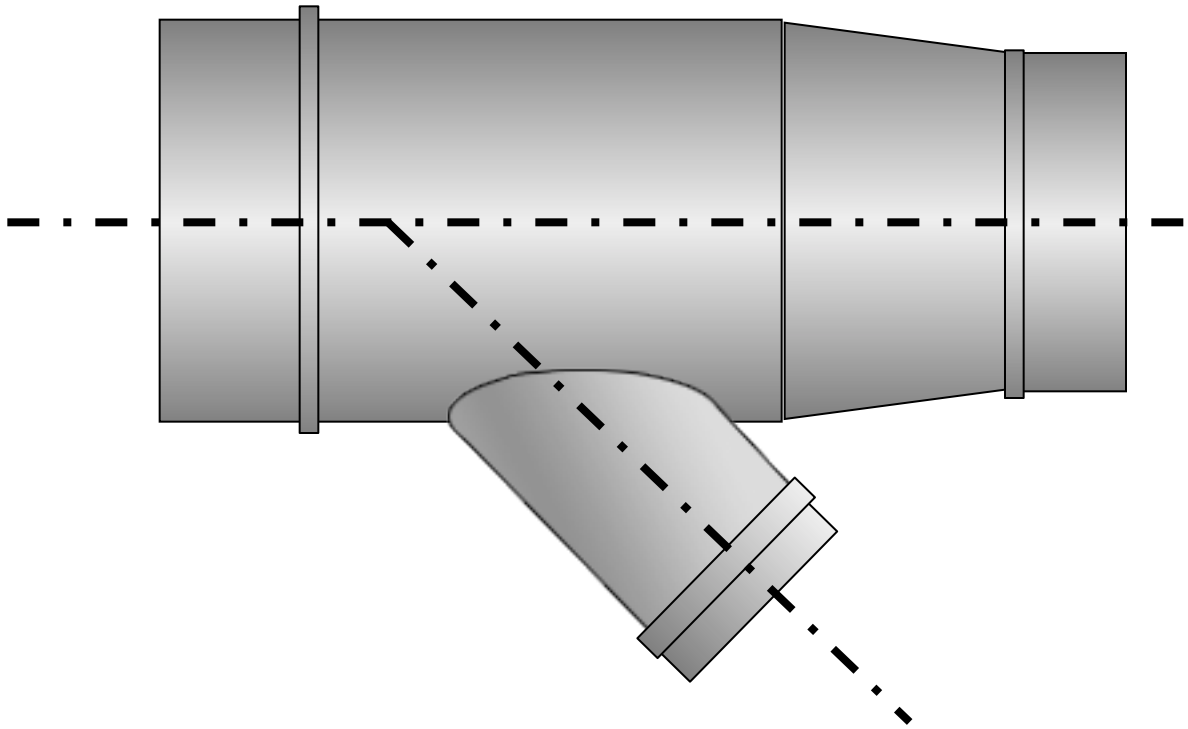
Go the Distance…



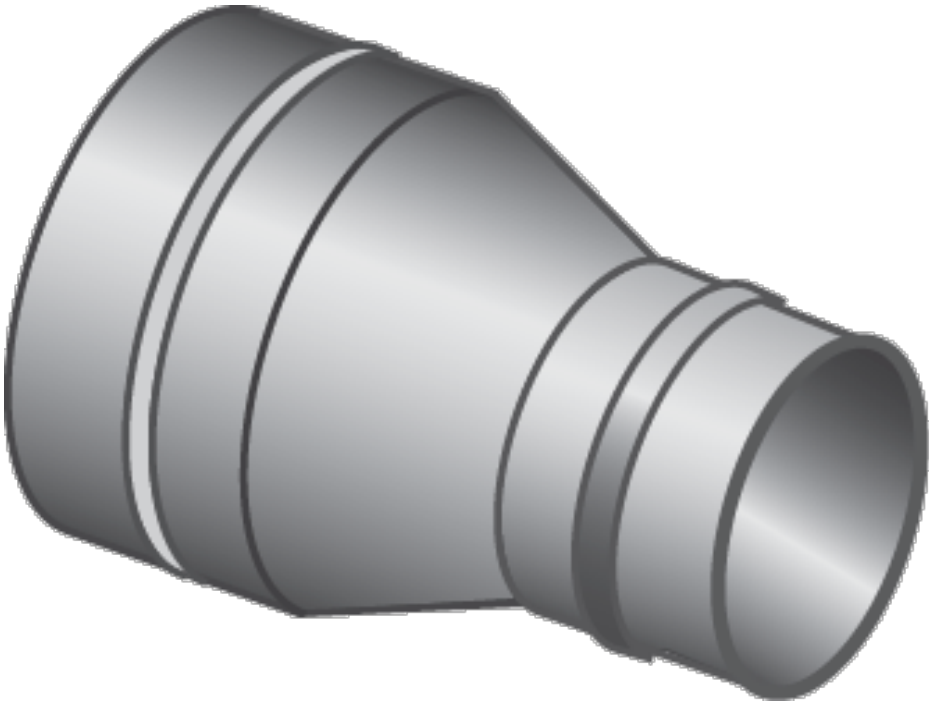


33% upstream flow

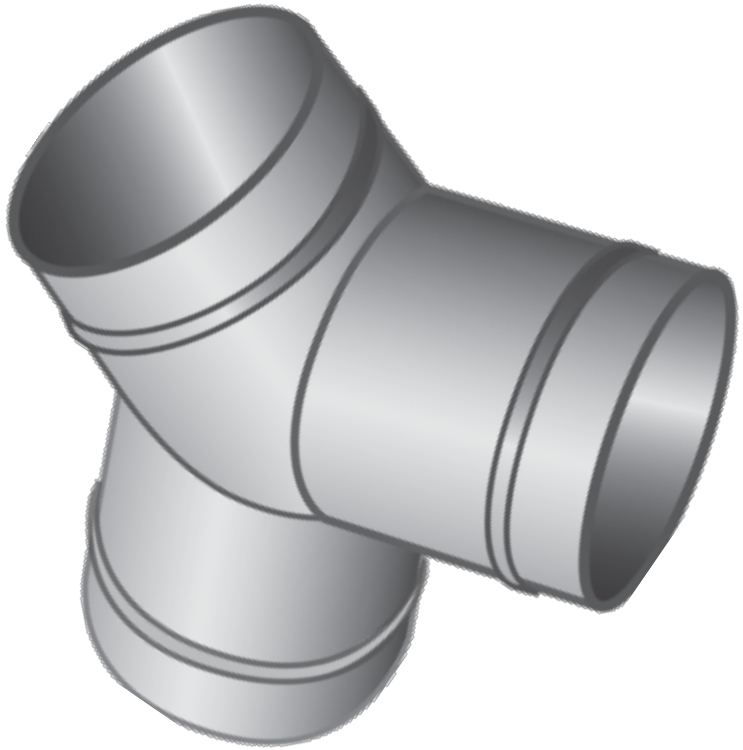
Fitting Efficiency



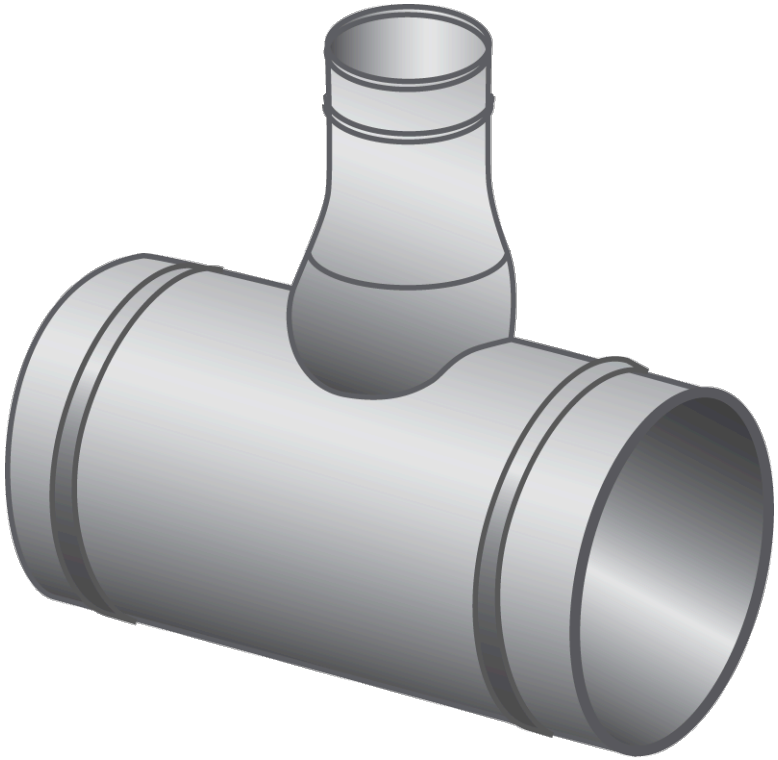
Reducer Fitting

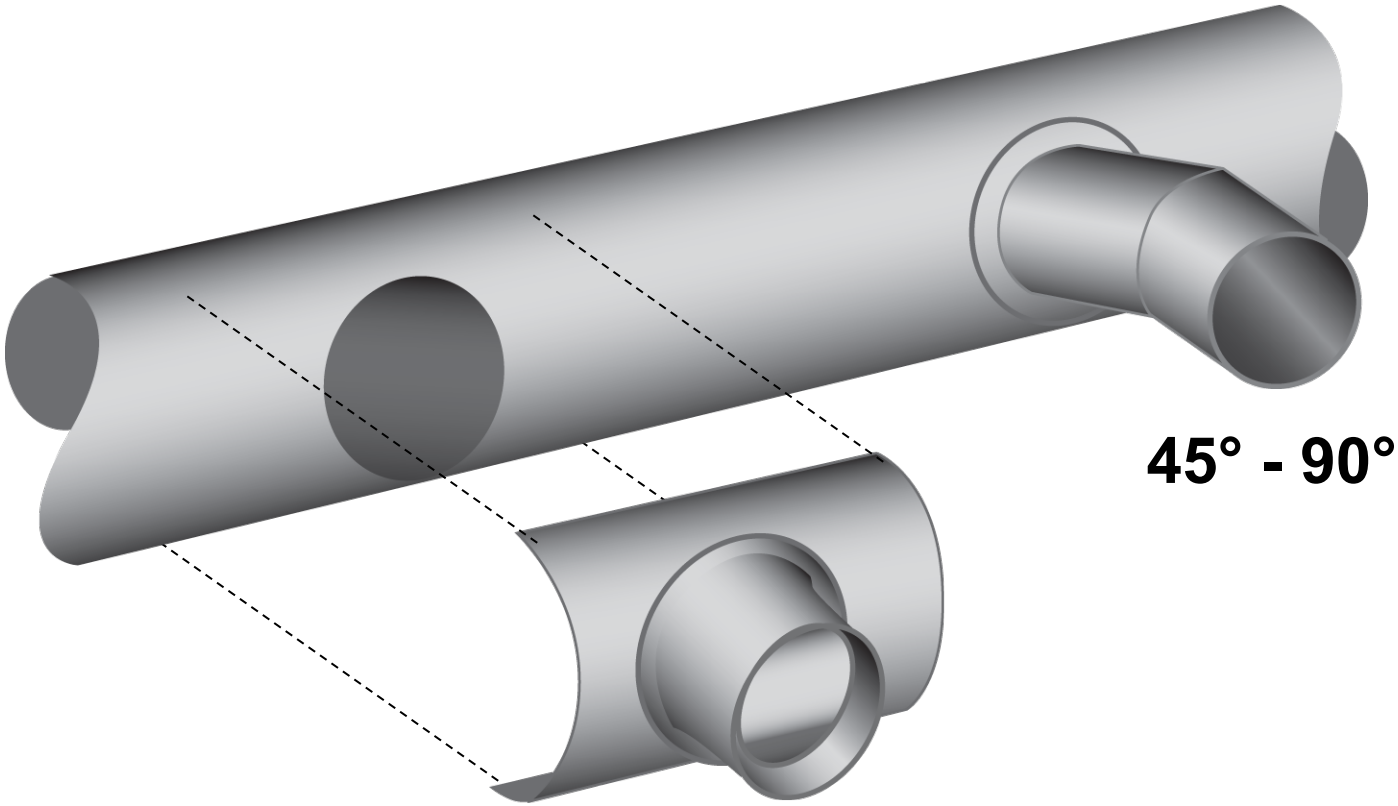


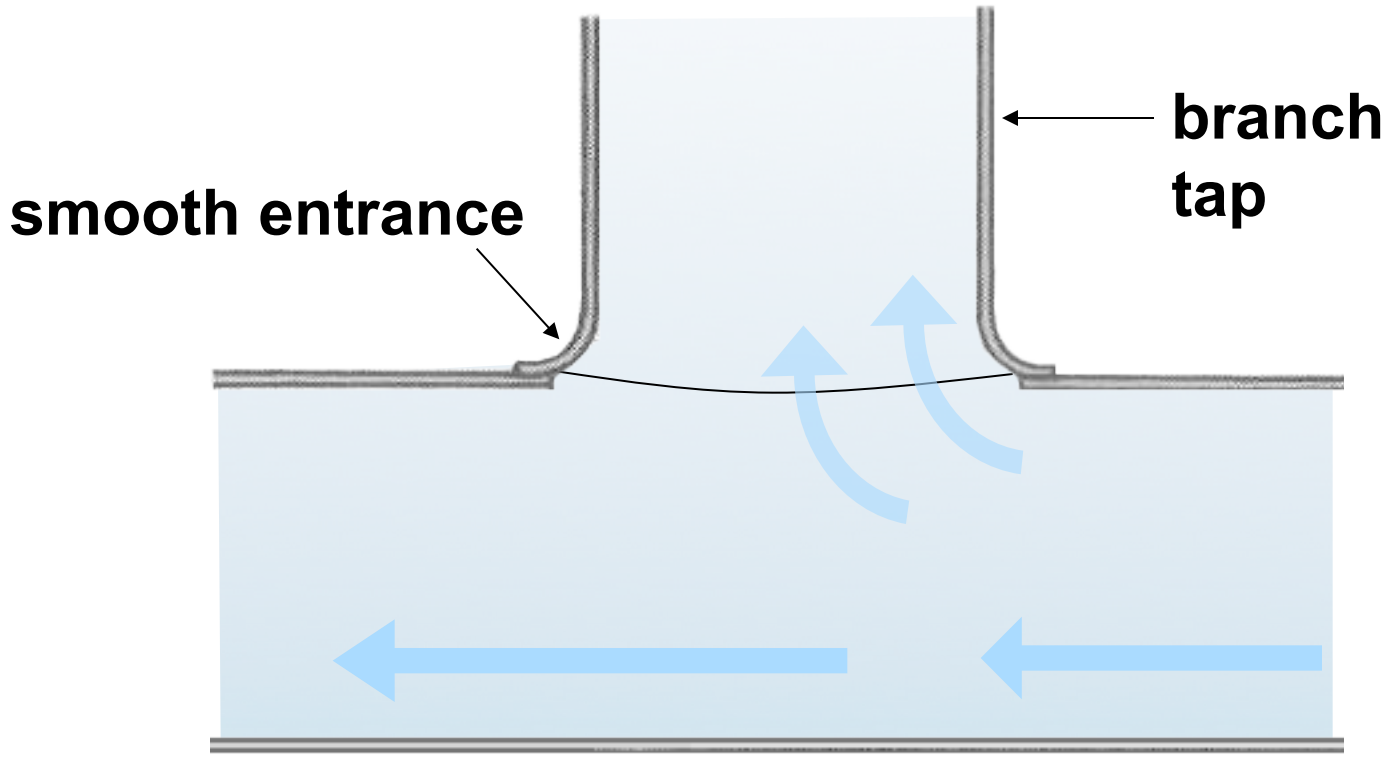
Y Fitting



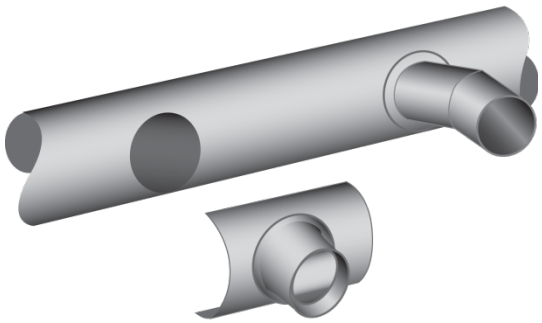
Well-Rounded, 90-Degree Tee

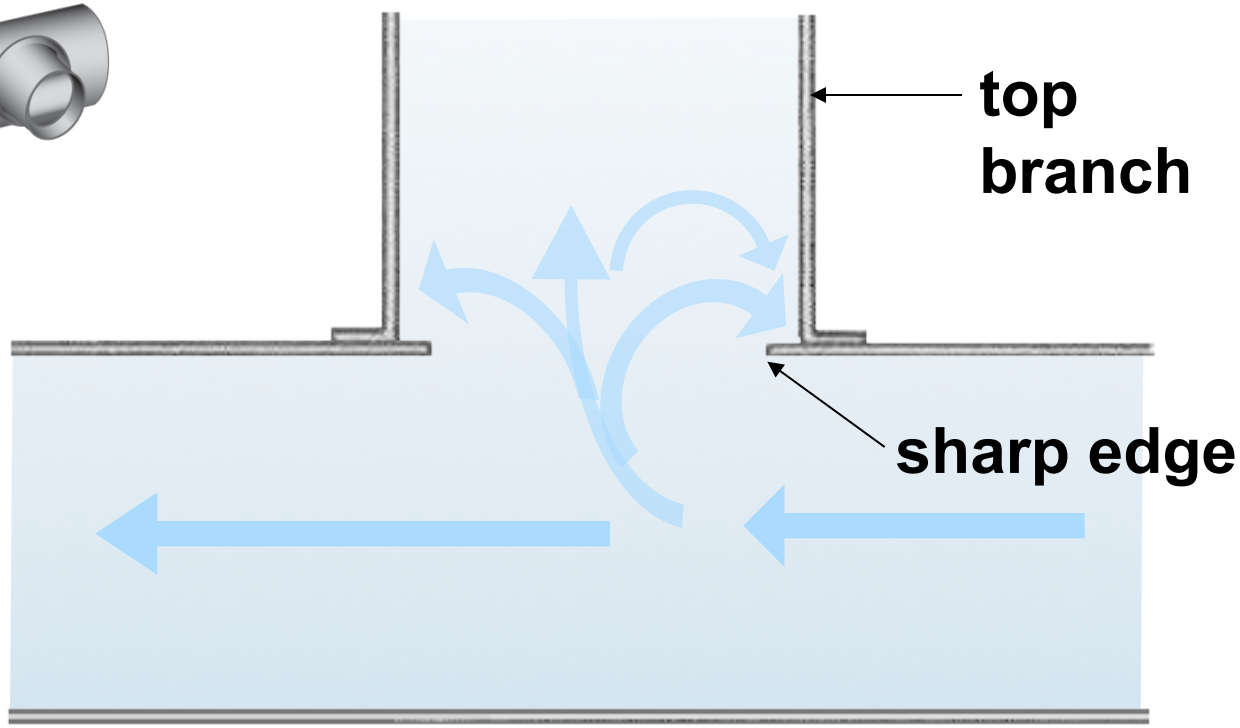



45° - 90°
90°

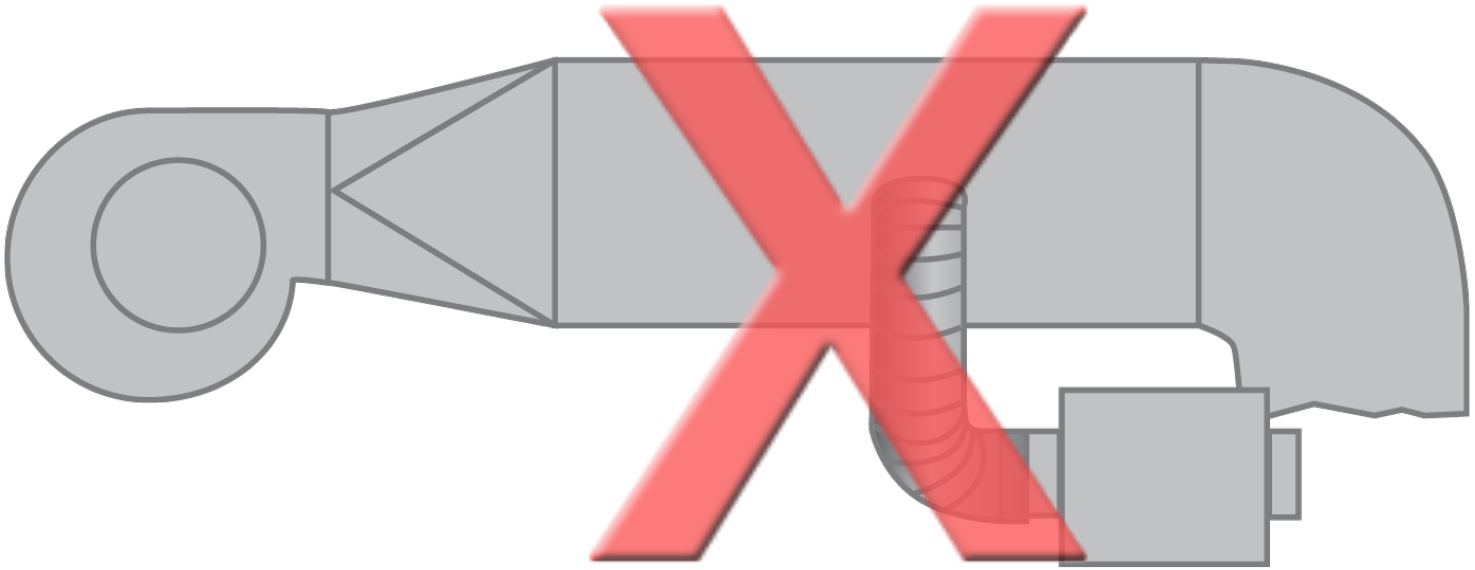

smooth entrance
branch
tap

Don’ts

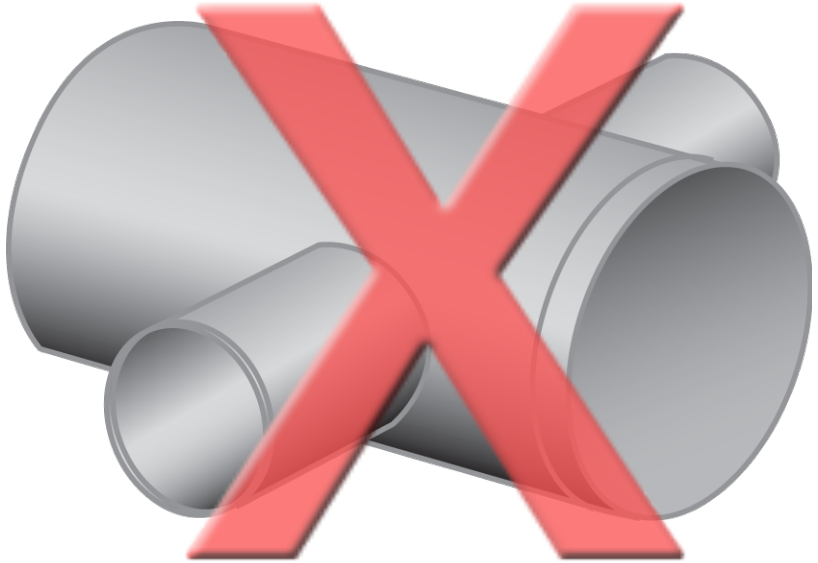



top
branch
sharp edge

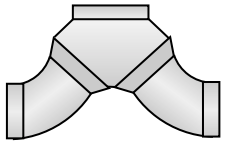
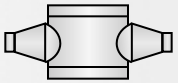
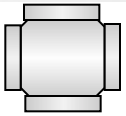
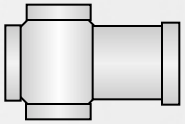
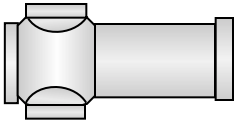
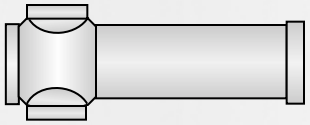
VAV Box Too Close to the Fan



Capped Cross Fitting



Divided Flow Fittings

Fitting		Loss Coefficient (2)
Y-2 plus 45 elbows		**0.22**
Capped cross with conical tabs		**5.0**
Capped cross		**5.0**
Capped cross with 1” cushion head		**5.4**
Capped cross with 2” cushion head		**6.0**
Capped cross with 3” cushion head		**6.4**

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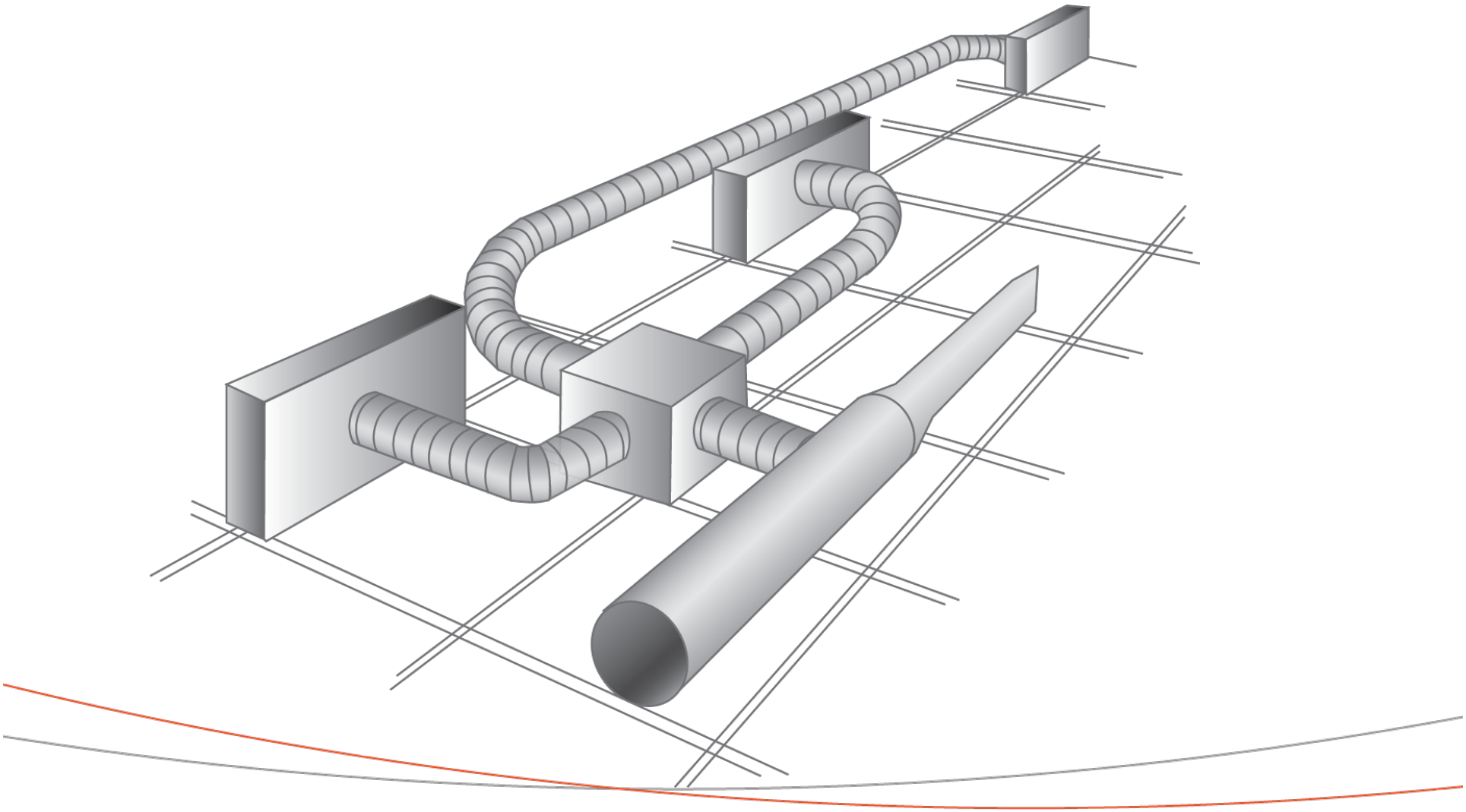
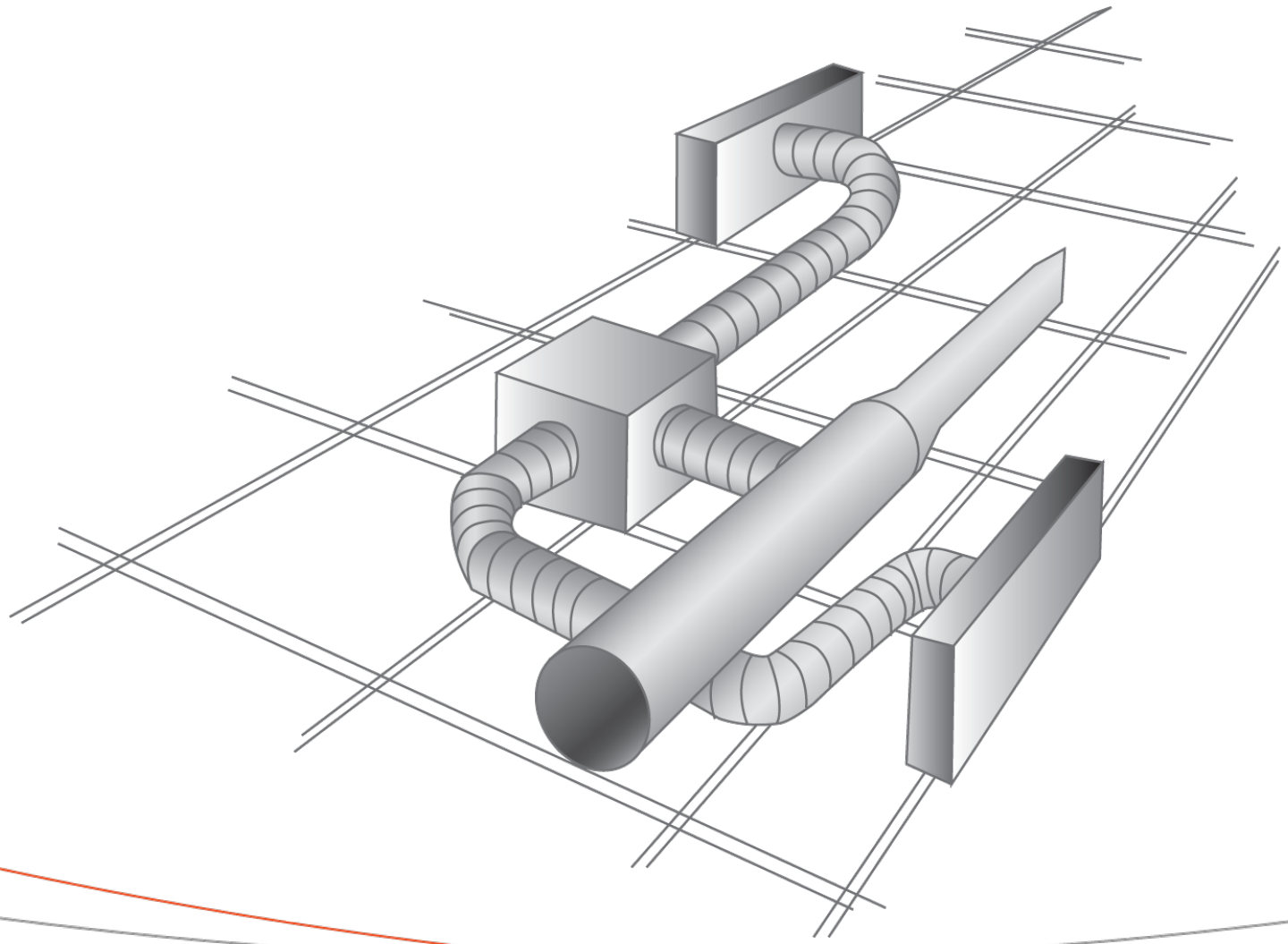




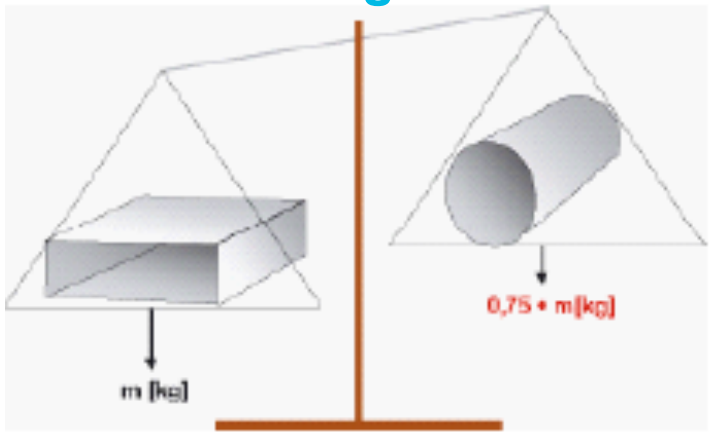
Rooftop Sound Attenuation

"Sound transmission below 250 Hz via duct breakout is often a major acoustical limitation for many rooftop installations. Excessive low-frequency noise associated with fan noise and air turbulence in the region of the discharge section of the fan and the first duct elbow results in duct rumble, which is difficult to attenuate. This problem is often worsened by the presence of a high-aspect-ratio duct at the discharge section of the fan. Rectangular ducts with duct lagging are often ineffective in reducing duct breakout noise. Using either a single- or dual-wall round duct with a radiused elbow coming off the discharge section of the fan can reduce duct breakout. If space does not allow for the use of a single duct, the duct can be split into several parallel round ducts".

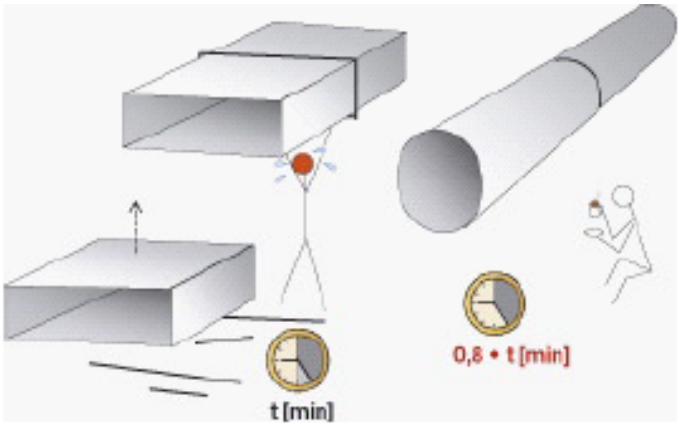
2003 ASHRAE Applications Manual, p. 47.7

In Summary...

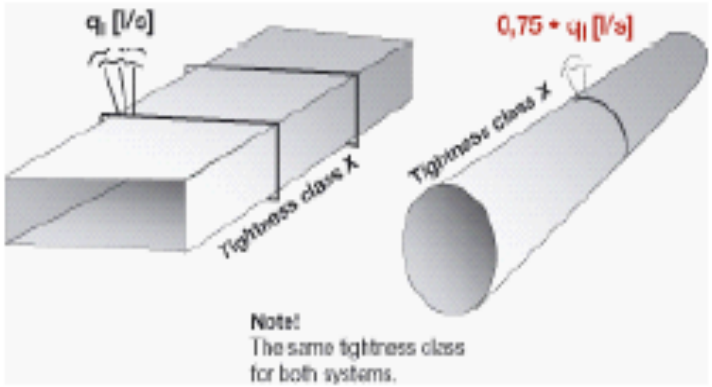
Lower weight 25+%



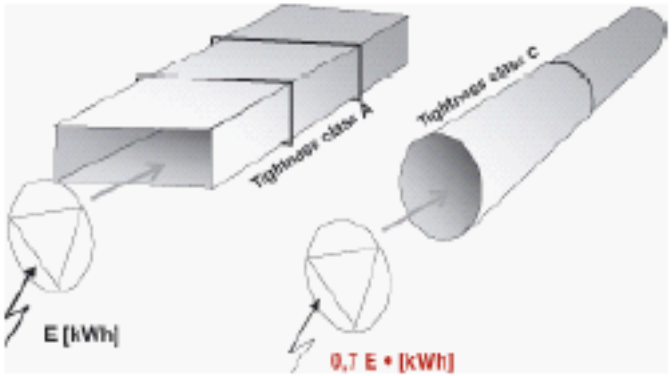
Shorter installation hours 30+%



Lower air leakage 2–10+%



Lower fan energy use 6-30+%



Experience

- Air to every box – quietly
- Plus $0.25 to $1.00/sq.ft. ($100 to $400/ton) savings

JOHN V REINTS, PE

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630-327-5425 or jvrpellc@msn.com

30 Years of Designing High Velocity, Static Regain, Round Duct Systems

Thank You

Green HVAC Duct Design Done Right!

45°F air versus 55°F air

6 Real World Examples

2012 Ductwork Comparison for Rectangular versus Static regain

HVAC contractor project location	Project (ft^2)	Project (tons)	Supply (CFM)	installed						
				Rect. (lbs)	Spiral (lbs)	Rect. cost ($)	Spiral cost ($)	Savings ($)	Savings (%)	Savings ($/ton)
Pewaukee, WI	42,400	70	25,500	9,103	5,165	$47,094	$36,768	$10,326	22%	$148
Fort Worth, TX	12,000	40	15,000	3,504	2,090	$14,936	$13,169	$1,767	12%	$44
Atlanta, GA	21,000	55	19,500	6,000	2,600	$42,635	$21,305	$21,330	50%	$388
St. Louis, MO	98,000	240	80,000	32,533	19,804	$169,391	$115,479	$53,912	32%	$225
Orlando, FL	25,870	60	22,000	13,600	6,548	$117,078	$64,259	$52,819	45%	$880
Chicago, IL	23,000	60	20,100	6,320	2,455	$37,920	$17,185	$20,735	55%	$346
Average (6)	37,045	88	30,350	11,843	6,444	$71,509	$44,694	$26,815	**37%**	**$306**

Conclusion:

Cut the lbs in half and save a lot on labor while delivering a quieter air delivery system.