

Moving Air Quietly:

Operate the H/C appliance at its sweet spot
Keep Ms. Smith happy: Heat/cool her individual
rooms properly

Why is this important:

Gov't. & Utility programs come and go, Ms.
Smith (our customer) still pays our rent.



**AIRCO DELUXE HI-BOY
GAS FURNACE**

AIRCO DELUXE HI-BOY gas furnaces are specially designed by our engineering department to occupy a minimum amount of floor space. At the same time, they deliver a remarkable amount of heat, due to efficient planning and precise construction.

Like all AIRCO GAS FURNACES, these units are built to deliver the highest possible amount of heat that the fuel can produce. And they are designed for extra long life and quiet operation. The heat-exchanger, for instance, is the most rugged type in its class known to the industry. AIRCO automatic controls are the finest available. The heavy steel casing is two-tone baked automobile enamel finish, thoroughly insulated against heat and sound transmission.

AIRCO gas units incorporate all leading safety features . . . Fully automatic 100% Safety Shut-Off controls are standard on all units.

 CSA & CGA approved
 A Western Canadian Product

 teca

Manufactured by AIRCO PRODUCTS LTD., Vancouver, B.C.

Problems for Ms Smith:

- Immediate
 - Excessive air noise
 - Short filter life, before equipment shutdown
- Equipment
 - Failure, Compressor & power venter motors
- Utility Costs (in case of gas furnace)
 - Electric waste, pushing air through ducts
 - Gas waste, not scrubbing off heat



Problems caused by:

- Hi Efficiency HVAC appliances move **more** air, surprise-surprise!
- Manufacturers have **shrunk** appliance sizes
- Ceiling space restricted for trunk ducts, little partition wall space to run duct between levels
- Ignorance that bad fittings, more often than undersized duct, choke air flow.



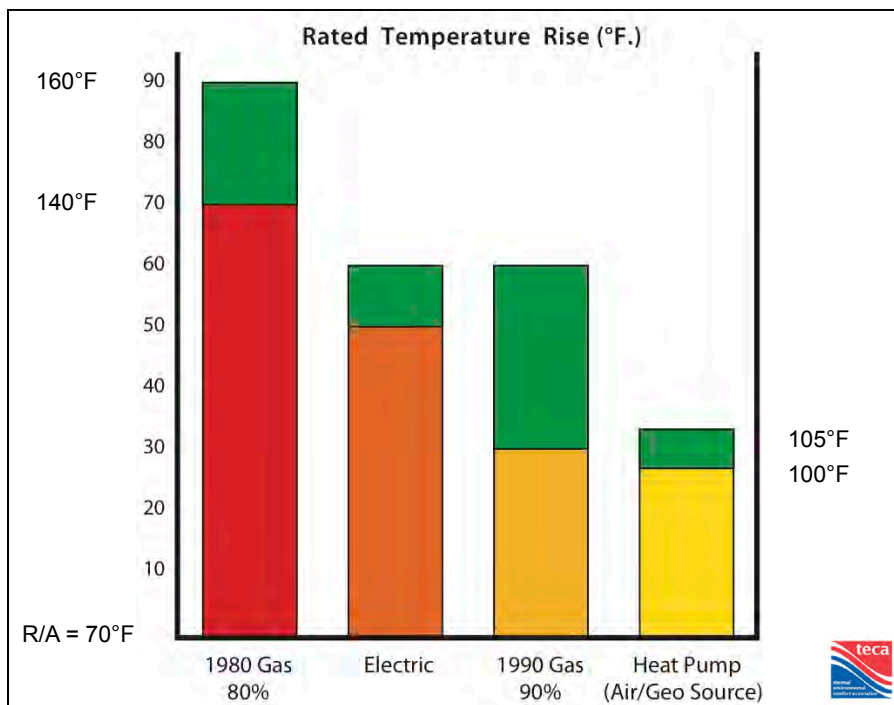
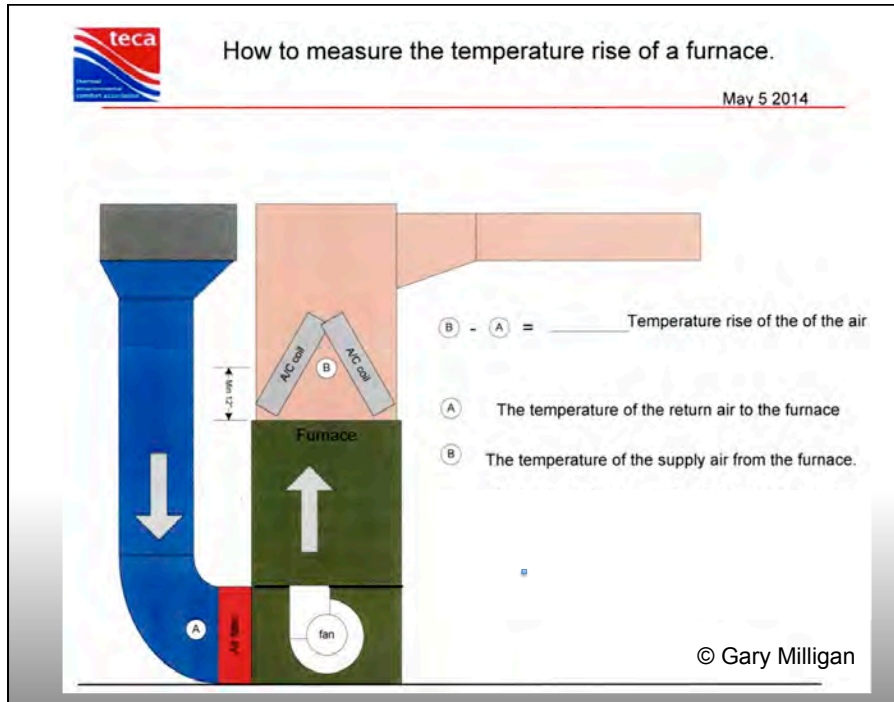
The Standard basement installation of 'Hi-Boy' (upflow) Nat. Gas Furnace installation.

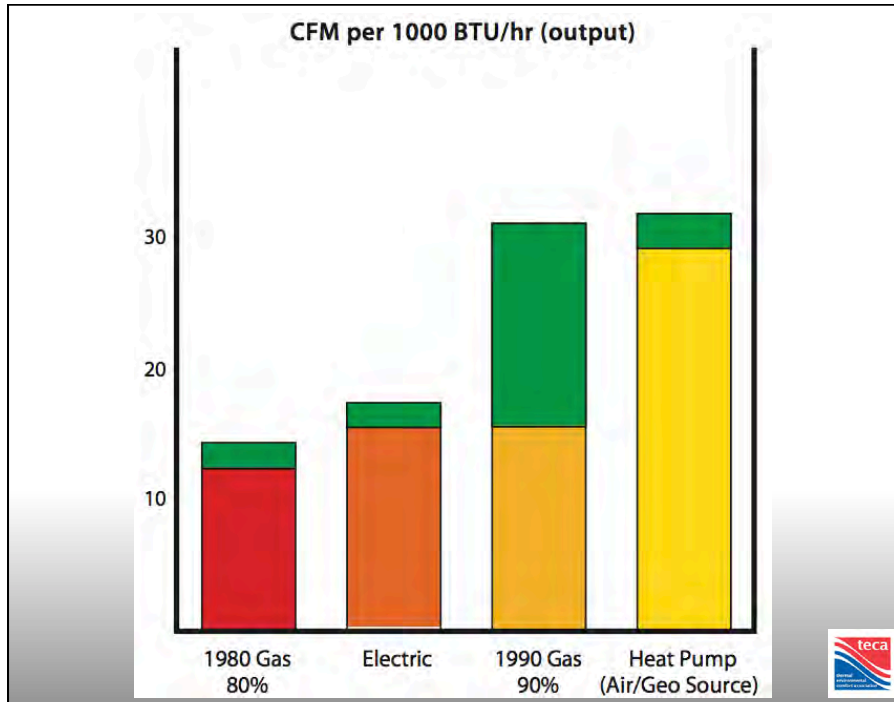
Gary Milligan taking a motor current reading.



1 cubic foot weighs 1/10 lb.
(almost)







Standard Vs Hi Efficiency Nat. Gas Furnace

Airco Furnace
 Standard Efficiency 80%
 In: 85K BTU/hr
 Out: 68 K BTU/hr

Air Circulation Required
 730 cfm @ 85°F
 Recommended ESP
 .15" W.C.

Lennox
 High Efficiency 95%
 In: 70K BTU/hr
 Out: 67.9K BTU/hr

Air Circulation Required
 1257 cfm @ 50°F
 Recommended ESP
 .30" W.C.

Note: Same cabinet size goes up to 135 BTU/hr.

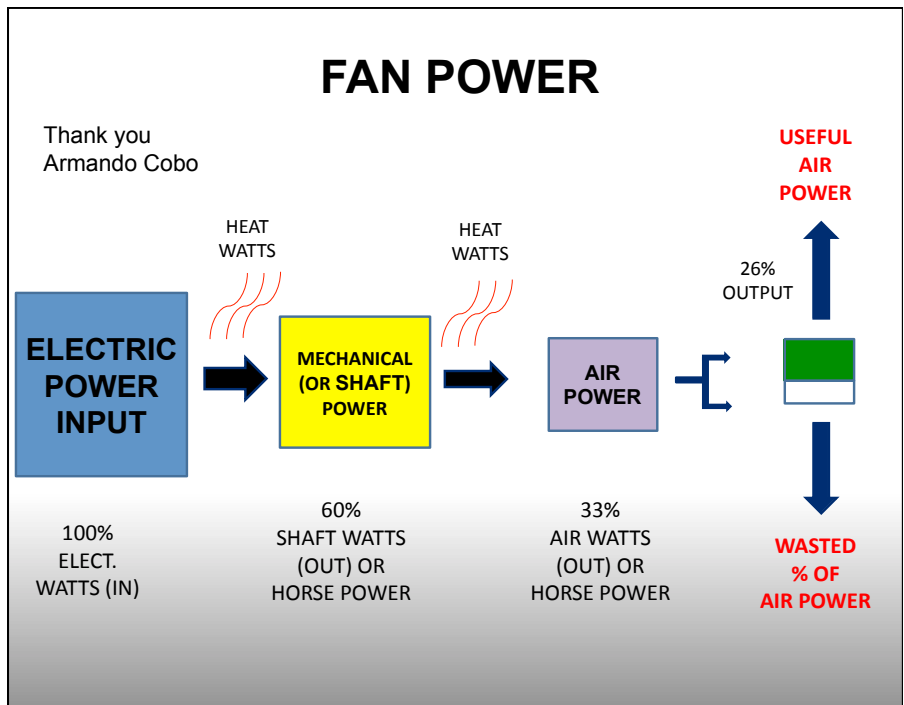
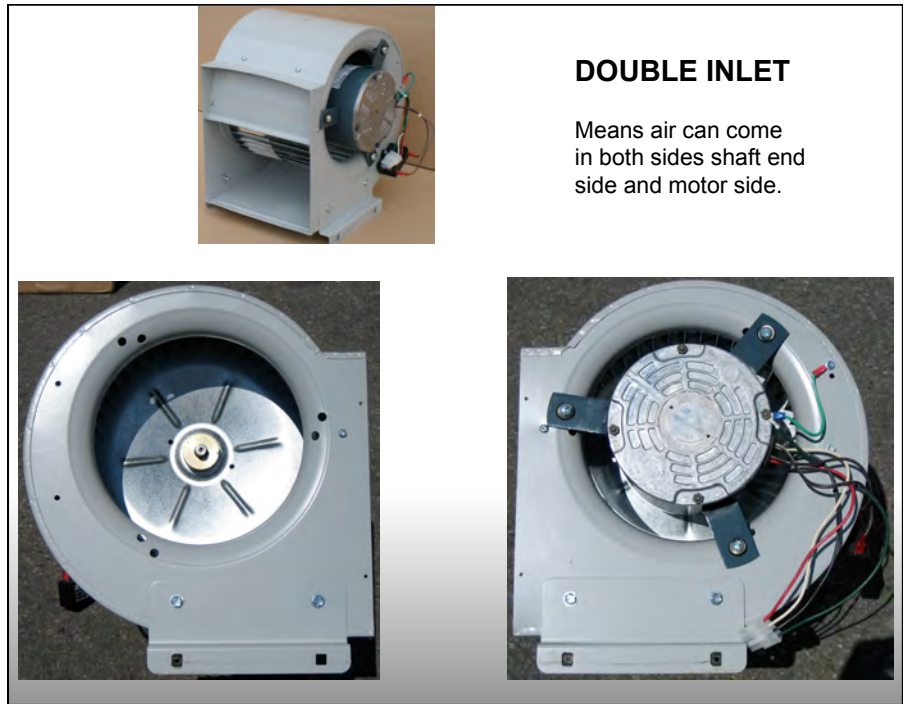
CHANGE:
 For same output,
 air flow increases
 by **+72%**

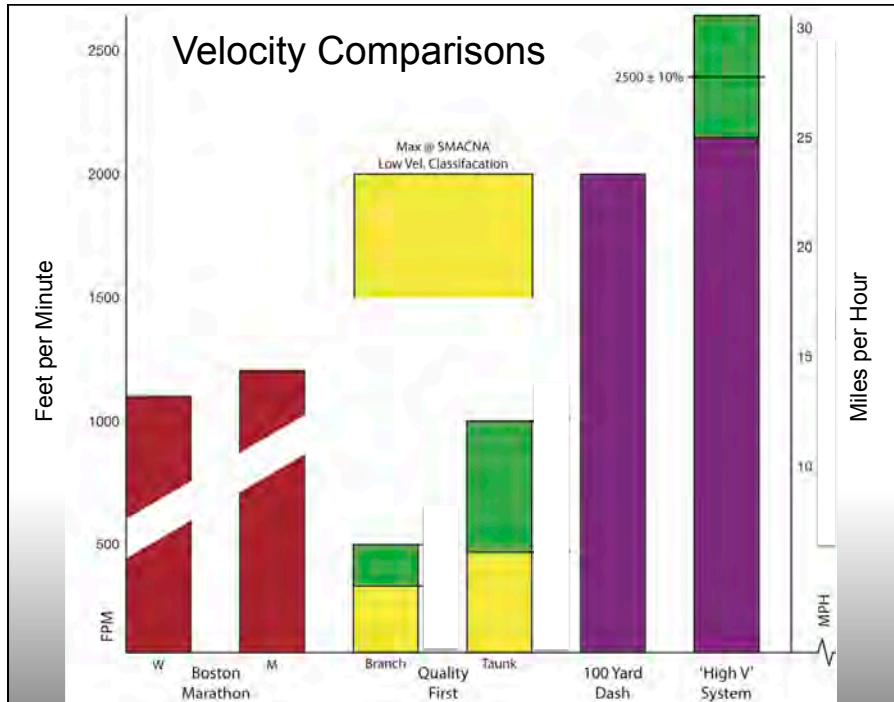
Result of Direct Changeout, Summary (after matching BTU/hr output)

Standard Efficiency	High Efficiency	Difference:
Airco 80% (std) Output 68 K B/h	Lennox 95% Output 67.9K B/h	
Air flow @ 85°F 730 CFM	Air flow @ 50°F 1257 CFM	+72%
ESP recommended .15" W.C.	ESP result* .44" W.C.	+213%
Fan Motor HP 1/6 (.166)	Fan Motor HP .85	+412%

*Very low ESP was achieved on initial installation; No allowance for A/C or filters included.

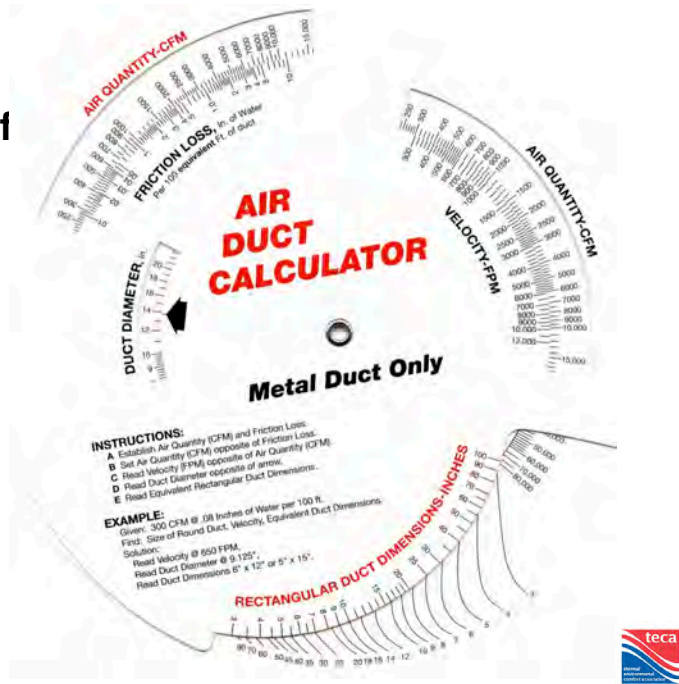




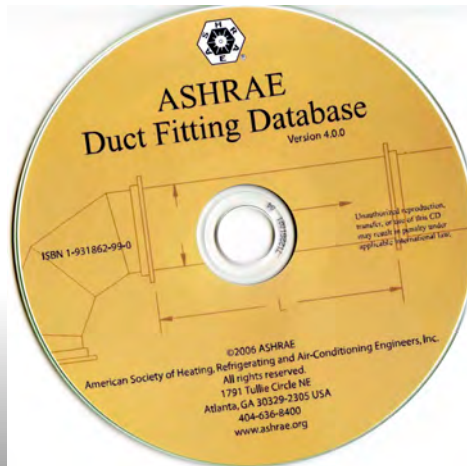


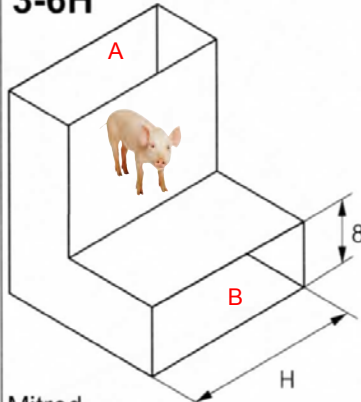
Friction Loss per 100 feet of straight duct.

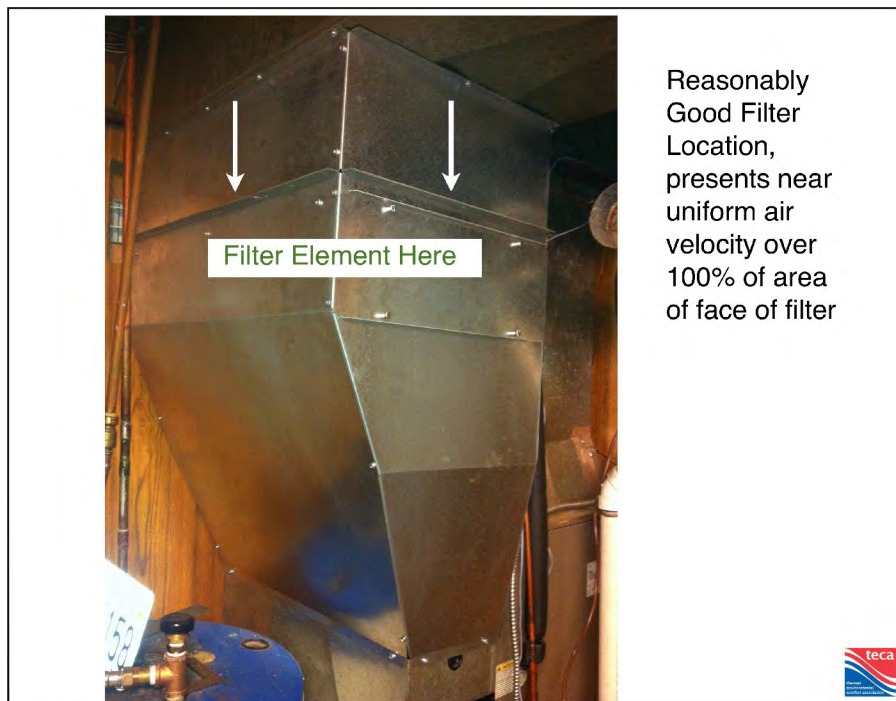
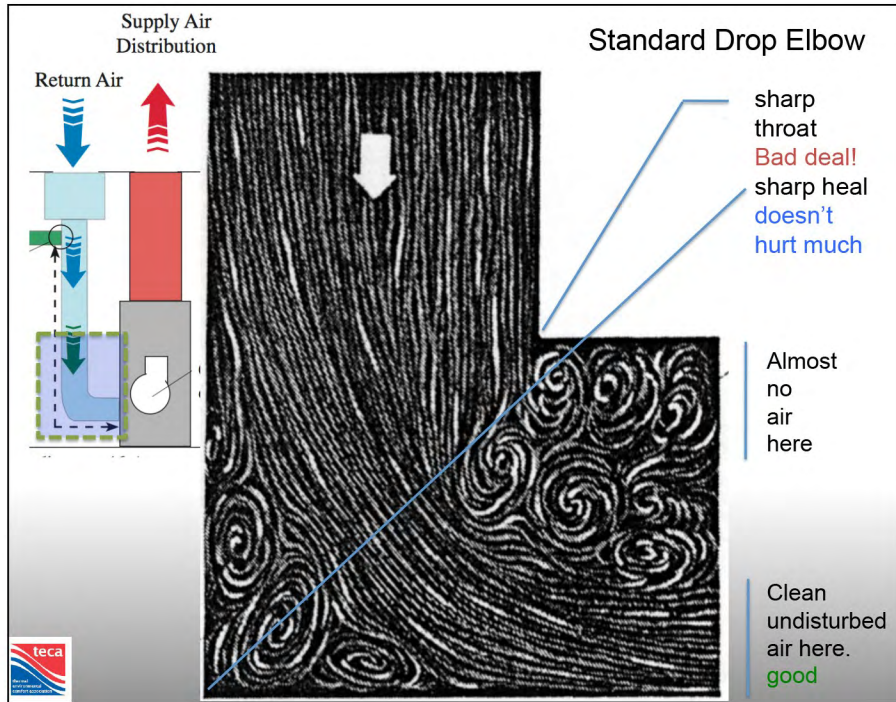
Ps: Have you ever seen 100 straight feet of duct in any house???

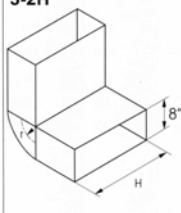
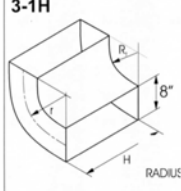
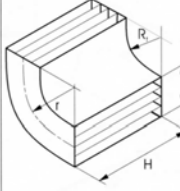


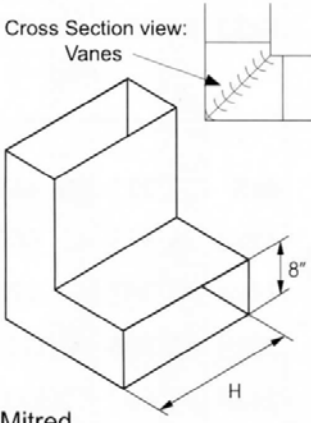
Eli Howard SMACNA/ASHRAE chair tech committee

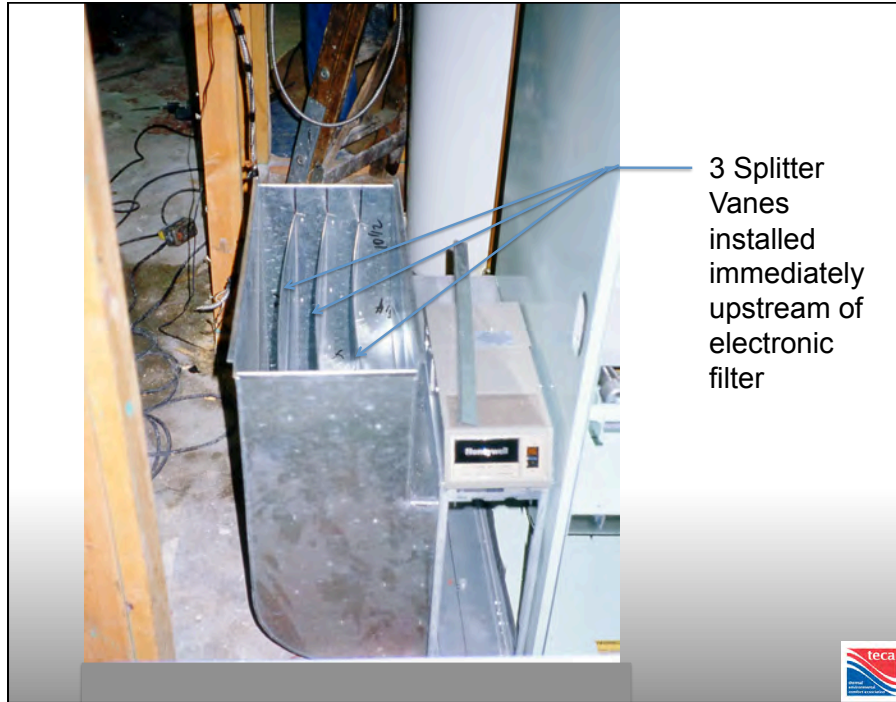


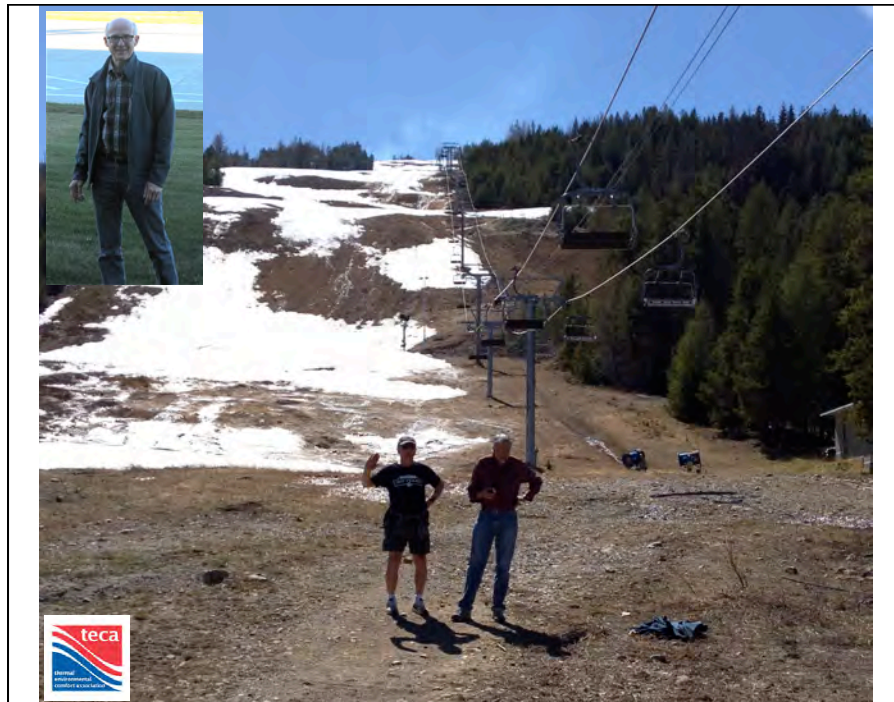
Elbow Fitting	WxH in	Velocity (fpm)	
		500	1000
3-6H  Mitred Sharp Heel & Throat No Vanes	8x8	36	444
	8x12	43	667
	8x14	45	778
	8x20	49	1111
	8x24	49	1333
	8x32	50	1778
			Le ft



3-2H 		<table border="1"> <thead> <tr> <th>WxH</th> <th>Velocity (fpm)</th> </tr> <tr> <th>in</th> <th>1000 Le CFM ft</th> </tr> </thead> <tbody> <tr><td>8x8</td><td>36 444</td></tr> <tr><td>8x12</td><td>40 667</td></tr> <tr><td>8x14</td><td>42 778</td></tr> <tr><td>8x20</td><td>47 1111</td></tr> <tr><td>8x24</td><td>50 1333</td></tr> <tr><td>8x32</td><td>57 1778</td></tr> </tbody> </table>	WxH	Velocity (fpm)	in	1000 Le CFM ft	8x8	36 444	8x12	40 667	8x14	42 778	8x20	47 1111	8x24	50 1333	8x32	57 1778
WxH	Velocity (fpm)																	
in	1000 Le CFM ft																	
8x8	36 444																	
8x12	40 667																	
8x14	42 778																	
8x20	47 1111																	
8x24	50 1333																	
8x32	57 1778																	
Elbow Fitting R_t Throat Radius r Centreline Radius r/W Radius Ratio		<table border="1"> <thead> <tr> <th>WxH</th> <th>Velocity (fpm)</th> </tr> <tr> <th>in</th> <th>1000 Le CFM ft</th> </tr> </thead> <tbody> <tr><td>8x8</td><td>13 444</td></tr> <tr><td>8x12</td><td>14 667</td></tr> <tr><td>8x14</td><td>16 778</td></tr> <tr><td>8x20</td><td>18 1111</td></tr> <tr><td>8x24</td><td>19 1333</td></tr> <tr><td>8x32</td><td>21 1778</td></tr> </tbody> </table>	WxH	Velocity (fpm)	in	1000 Le CFM ft	8x8	13 444	8x12	14 667	8x14	16 778	8x20	18 1111	8x24	19 1333	8x32	21 1778
WxH	Velocity (fpm)																	
in	1000 Le CFM ft																	
8x8	13 444																	
8x12	14 667																	
8x14	16 778																	
8x20	18 1111																	
8x24	19 1333																	
8x32	21 1778																	
3-1H 		<table border="1"> <thead> <tr> <th>WxH</th> <th>Velocity (fpm)</th> </tr> <tr> <th>in</th> <th>1000 Le CFM ft</th> </tr> </thead> <tbody> <tr><td>8x8</td><td>6 444</td></tr> <tr><td>8x12</td><td>6 667</td></tr> <tr><td>8x14</td><td>7 778</td></tr> <tr><td>8x20</td><td>8 1111</td></tr> <tr><td>8x24</td><td>8 1333</td></tr> <tr><td>8x32</td><td>9 1778</td></tr> </tbody> </table>	WxH	Velocity (fpm)	in	1000 Le CFM ft	8x8	6 444	8x12	6 667	8x14	7 778	8x20	8 1111	8x24	8 1333	8x32	9 1778
WxH	Velocity (fpm)																	
in	1000 Le CFM ft																	
8x8	6 444																	
8x12	6 667																	
8x14	7 778																	
8x20	8 1111																	
8x24	8 1333																	
8x32	9 1778																	
3-5H 		<table border="1"> <thead> <tr> <th>WxH</th> <th>Velocity (fpm)</th> </tr> <tr> <th>in</th> <th>1000 Le CFM ft</th> </tr> </thead> <tbody> <tr><td>8x8</td><td>1 444</td></tr> <tr><td>8x12</td><td>1 667</td></tr> <tr><td>8x14</td><td>1 778</td></tr> <tr><td>8x20</td><td>1 1111</td></tr> <tr><td>8x24</td><td>1 1333</td></tr> <tr><td>8x32</td><td>1 1778</td></tr> </tbody> </table>	WxH	Velocity (fpm)	in	1000 Le CFM ft	8x8	1 444	8x12	1 667	8x14	1 778	8x20	1 1111	8x24	1 1333	8x32	1 1778
WxH	Velocity (fpm)																	
in	1000 Le CFM ft																	
8x8	1 444																	
8x12	1 667																	
8x14	1 778																	
8x20	1 1111																	
8x24	1 1333																	
8x32	1 1778																	

Elbow Fitting R_t Throat Radius r Centreline Radius r/W Radius Ratio		<table border="1"> <thead> <tr> <th>WxH</th> <th>Velocity (fpm)</th> </tr> <tr> <th>in</th> <th>1000 Le CFM ft</th> </tr> </thead> <tbody> <tr><td>8x8</td><td>3 444</td></tr> <tr><td>8x12</td><td>4 667</td></tr> <tr><td>8x14</td><td>4 778</td></tr> <tr><td>8x20</td><td>5 1111</td></tr> <tr><td>8x24</td><td>6 1333</td></tr> <tr><td>8x32</td><td>6 1778</td></tr> </tbody> </table>	WxH	Velocity (fpm)	in	1000 Le CFM ft	8x8	3 444	8x12	4 667	8x14	4 778	8x20	5 1111	8x24	6 1333	8x32	6 1778
WxH	Velocity (fpm)																	
in	1000 Le CFM ft																	
8x8	3 444																	
8x12	4 667																	
8x14	4 778																	
8x20	5 1111																	
8x24	6 1333																	
8x32	6 1778																	
3-9H Cross Section view: Vanes 		<p>88% lower than without T.V.s</p>																
Mitred Single Thickness Vane 1 1/2" Spacing																		





Branch Issues:

Symptom:

- Ms. Smith has hot (in summer) rooms

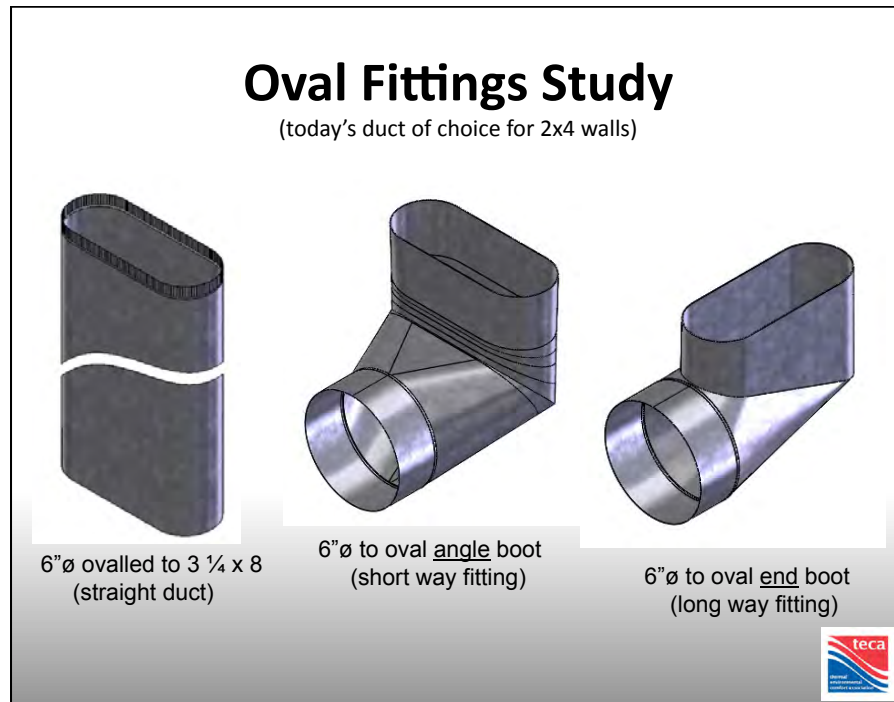
Problem:

- Branch Ducts undersized
- Branch ducts too long
- Branch duct full of 'fittings'
- No interior wall space
- Can't use exterior walls

Note:

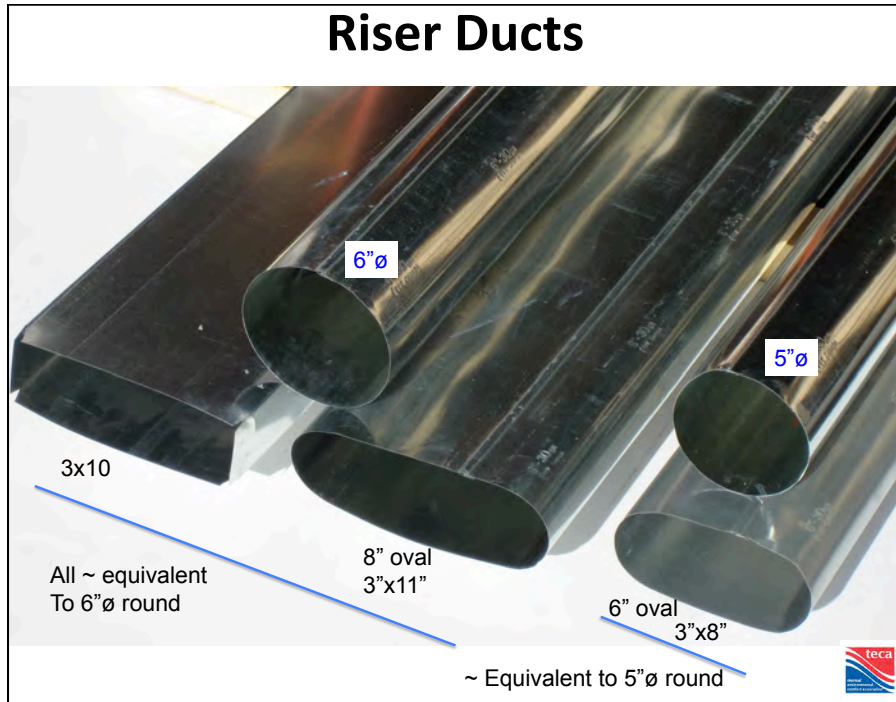
- Equipment by and large doesn't care

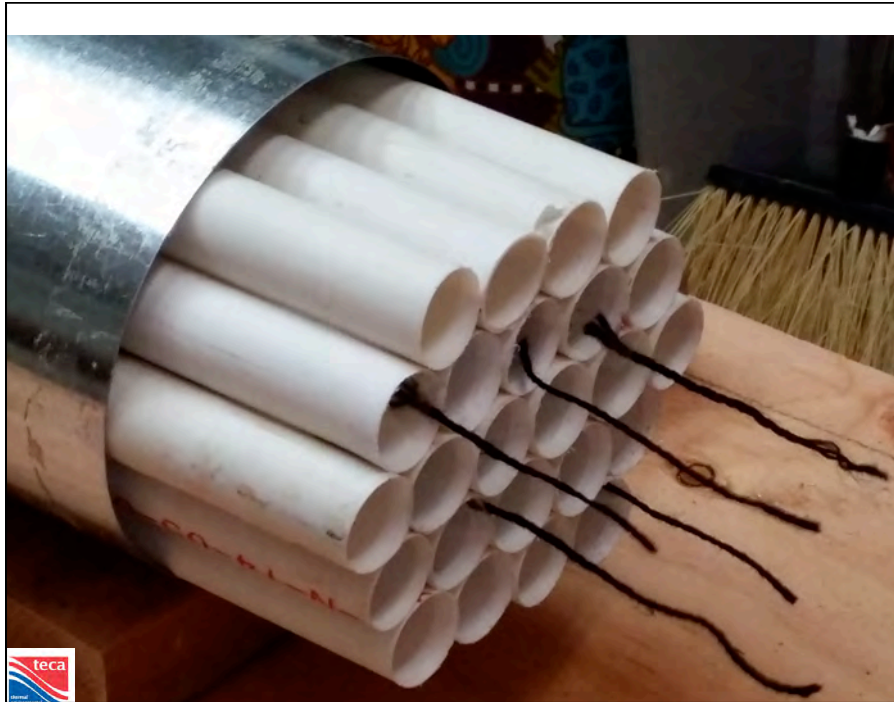




Oval Fitting People

- Mr. Gary Milligan HVAC Contractor/A Fitter
- Mr. Steve Savage TQ Sheet Metal/contractor
- Tony Nardi TQ Sheet Metal/wholesaler
- Lauris Krisch P.Eng. Sheet Metal Manufacturer
- Dr. Don W. McAdam P.Eng. Heat transfer/fluid dynamics
- David Hill, Vent. Manufacturer
- Sean Allan, CET, Sheet Metal Mfg draftsman



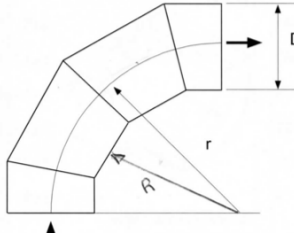
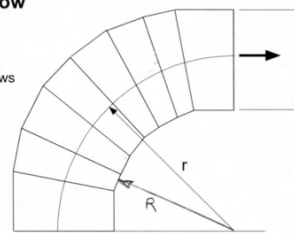



1. Base Case - Round

Fitting Size	Equivalent Length (ft)	
		Total
5" x 90° Round		31
6" x 90° Round		34

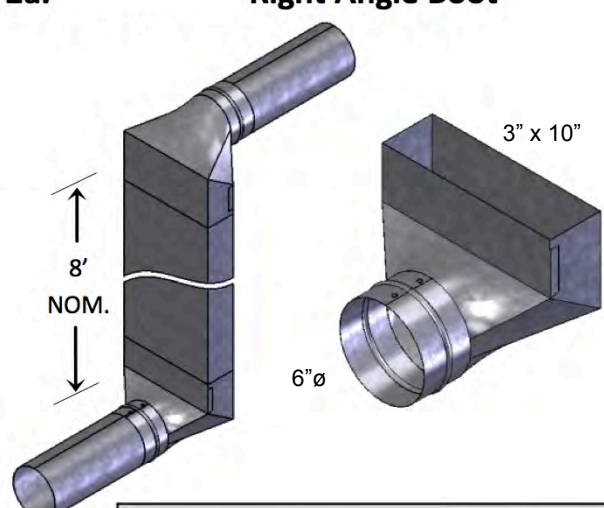
Base Case →

Equivalent Length (Le) Chart: Common Round 90° Fittings — Diameter Varies


Elbow Fitting	D in Ø	R in	Velocity (fpm)	
			Le ft	CFM
4 Piece Elbow Standard Use				
	5	2	7	68
	8	2.5	14	174
	12	3	25	392
	16	4.5	34	697
	18	5	40	883
8 Piece Elbow Long Radius Common use is two, 4-piece elbows				
	5	10	2	68
	8	16	3	174
	12	24	4	392
	16	32	5	697
	18	36	5	883



2a. Right Angle Boot



Fitting Size	Equivalent Length (ft)	
		Total
6" Round – 3"x10" Rect.		41



2b. End Boot

Fitting Size	Equivalent Length (ft)	
		Total
6" Round – 3"x10" Rect.		92


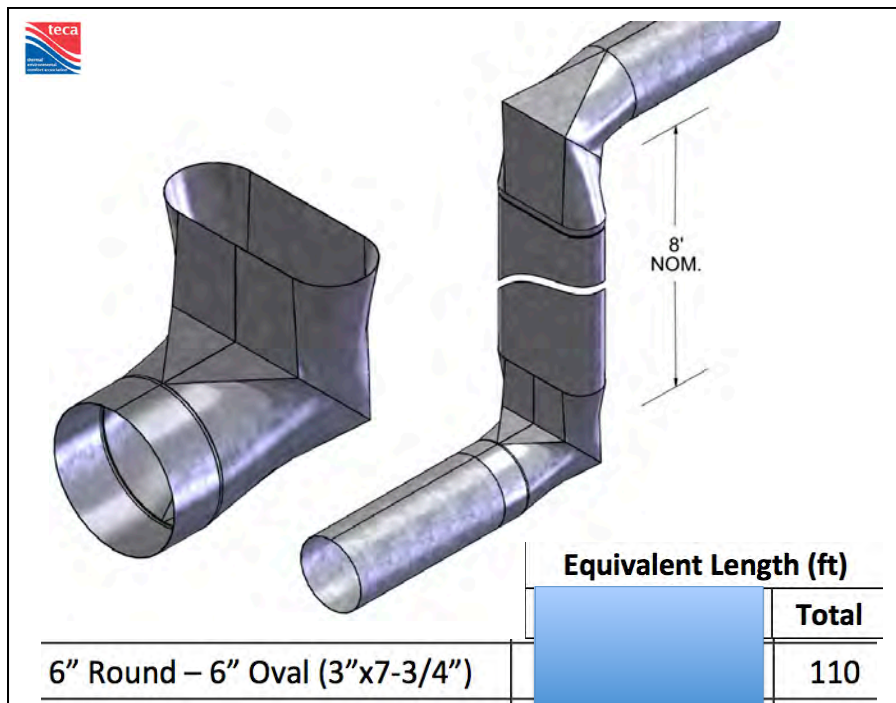


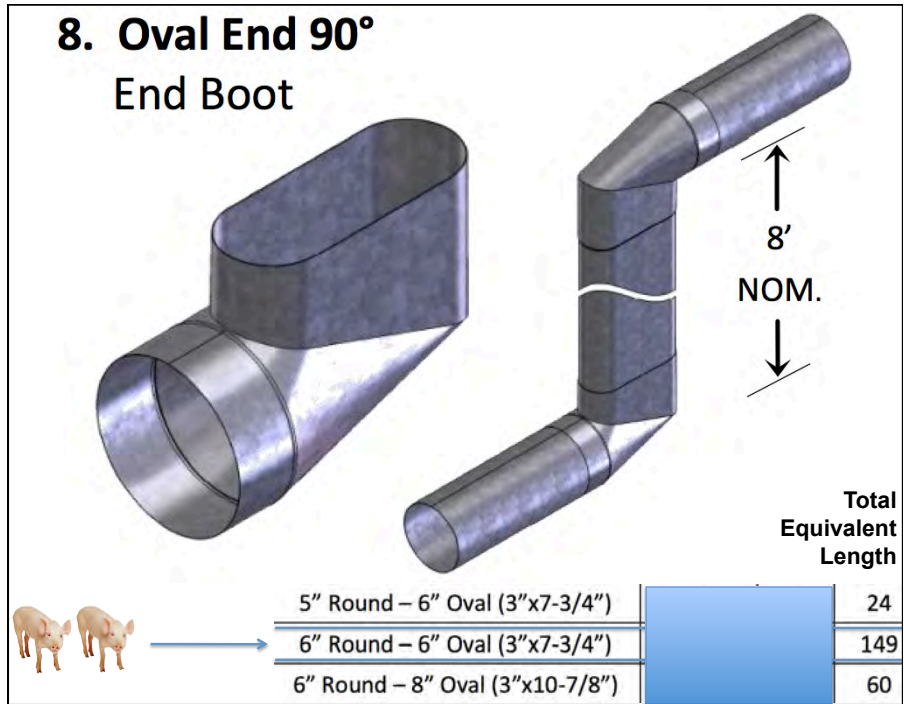
ASHRAE Fundamentals 2009

Example: 3" x 8" (nominal) flat oval all info in inches and sq. in. Apr. 3, '10

Shape (nominal size, in.)	Actual Size inch	Perimeter inch	Actual area in sq. in.	Diameter based on 'actual' area	De inch
Round 6"	6"ø	18.84	28.26	→ 6"	6.00
Flat oval 3 x 8	3 x 7.71	18.84	21.20	→ 5.20	5.02
Flat oval 3 x 8	3.25 x 7.57	18.84	22.33	5.33	5.18

De = Diameter, equivalent (if equivalent friction round duct were substituted)



(02/24/15)

OVAL FITTINGS STUDY

Fitting #	Stock #	Fitting Size	Equivalent Length (ft)			# Fittings
			Bottom	Top	Total	
1	120500	5" x 90° Round	14	17	31	0.9
	120400	6" x 90° Round	17	17	34	0.9
2	076310	6" Round - 3"x10" Rectangle	15	25	41	1.1
3	080310	6" Round - 3"x10" Rectangle	47	45	92	2.6
4	090310	6" Round - 3"x10" Rectangle	19	25	46	1.3
	095500	5" Round - 6" Oval (3"x7-3/4")	0	0	1	0.0
5	099500	6" Round - 6" Oval (3"x7-3/4")	11	7	20	0.6
	097500	5" Round - 6" Oval (3"x7-3/4")	11	18	29	0.8
6	076600	6" Round - 6" Oval (3"x7-3/4")	42	42	110	3.1
	076608	6" Round - 8" Oval (3"x10-7/8")	35	19	55	1.5
7	097500	6" Round - 6" Oval (3"x7-3/4")	37	40	77	2.2
	088000	5" Round - 6" Oval (3"x7-3/4")	16	7	24	0.7
8	098600	6" Round - 6" Oval (3"x7-3/4")	97	46	149	4.2
	098608	6" Round - 8" Oval (3"x10-7/8")	37	22	60	1.7
9	111919	6" Oval (3"x7-3/4")	52	33	85	2.4
10	111936	6" Oval (3"x7-3/4")	89	34	123	3.5

NOTES:
 *Assembly has (2x) 6" x 90° round elbow
 **Assembly has (2x) 6" Oval Straight Boots

Fitting #	Fitting Size	Total Equivalent Length in Feet
1	5" x 90° Round	31
	6" x 90° Round	34
2	6" Round - 3"x10" Rectangle	41
3	6" Round - 3"x10" Rectangle	92
4	6" Round - 3"x10" Rectangle	46
5	5" Round - 6" Oval (3"x7-3/4")	1
	6" Round - 6" Oval (3"x7-3/4")	20
6	5" Round - 6" Oval (3"x7-3/4")	29
	6" Round - 6" Oval (3"x7-3/4")	110
	6" Round - 8" Oval (3"x10-7/8")	55
7	6" Round - 6" Oval (3"x7-3/4")	77
8	5" Round - 6" Oval (3"x7-3/4")	24
	6" Round - 6" Oval (3"x7-3/4")	149
	6" Round - 8" Oval (3"x10-7/8")	60
9	6" Oval (3"x7-3/4")	85
10	6" Oval (3"x7-3/4")	123

SA Branch Run Sizing .3 In. wc ESP

Maximum CFM per Branch Run

Branch Duct Size	Max. No. of fittings per branch		
	4 ftg	6 ftg	7 ftg
4"Ø	35	30	25
5"Ø	65	55	45
6"Ø	100	90	75
7"Ø	160	135	110

Fitting #	Fitting Size	Total Equivalent Length in ft.	# Fittings
1	5" x 90° Round	31	0.9
	6" x 90° Round	34	0.9
2	6" Round – 3"x10" Rectangle	41	1.1
3	6" Round – 3"x10" Rectangle	92	2.6
4	6" Round – 3"x10" Rectangle	46	1.3
5	5" Round – 6" Oval (3"x7-3/4")	1	0.0
	6" Round – 6" Oval (3"x7-3/4")	20	0.6
6	5" Round – 6" Oval (3"x7-3/4")	29	0.8
	6" Round – 6" Oval (3"x7-3/4")	110	3.1
	6" Round – 8" Oval (3"x10-7/8")	55	1.5
7	6" Round – 6" Oval (3"x7-3/4")	77	2.2
8	5" Round – 6" Oval (3"x7-3/4")	24	0.7
	6" Round – 6" Oval (3"x7-3/4")	149	4.2
	6" Round – 8" Oval (3"x10-7/8")	60	1.7
9	6" Oval (3"x7-3/4")	85	2.4
10	6" Oval (3"x7-3/4")	123	3.5



