bsc SCXXV

25 Years of Excellence

July 31 - August 2

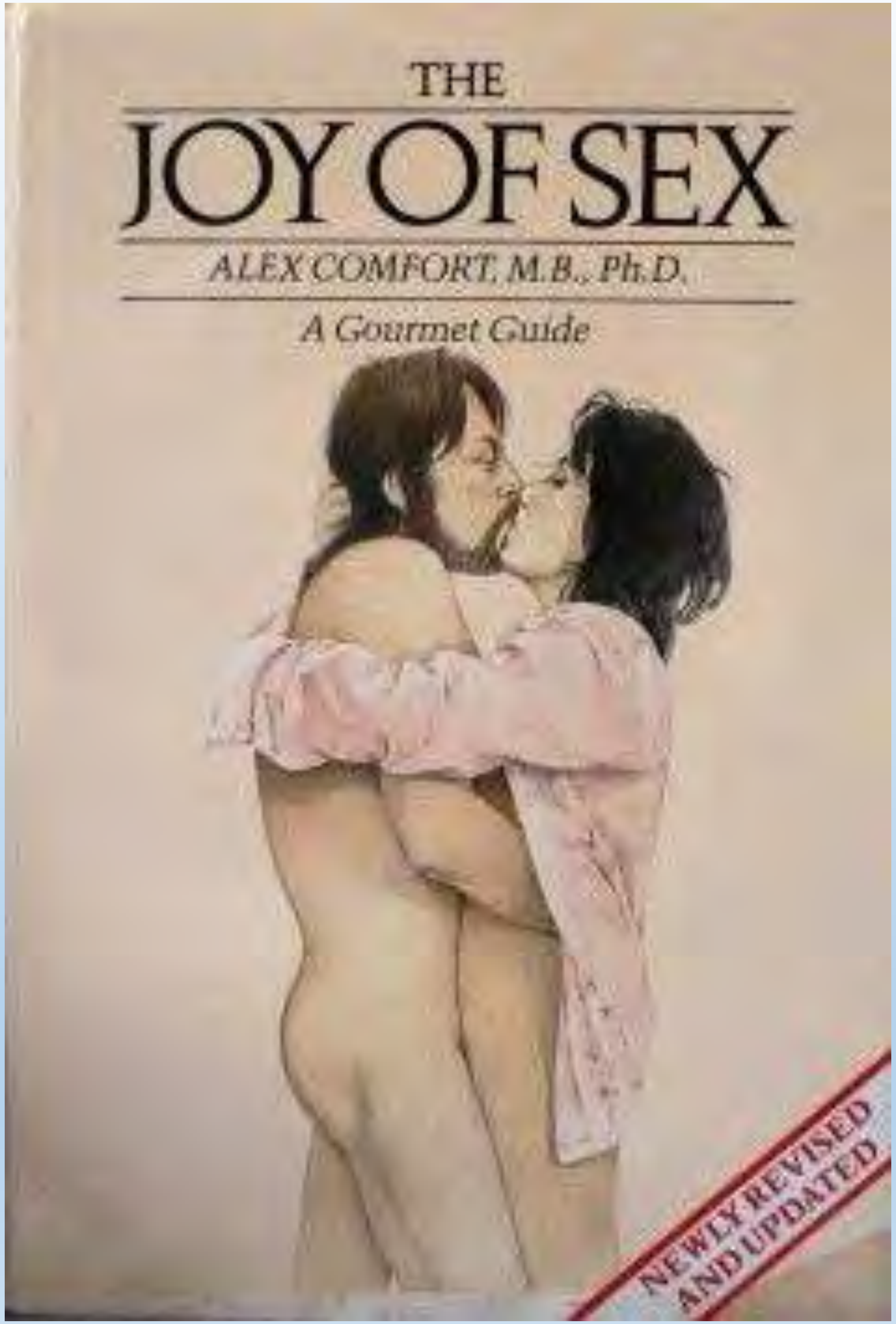
Westford, MA

Airflow Research

Flex Duct vs Sheet Metal

Building Science Summer Camp

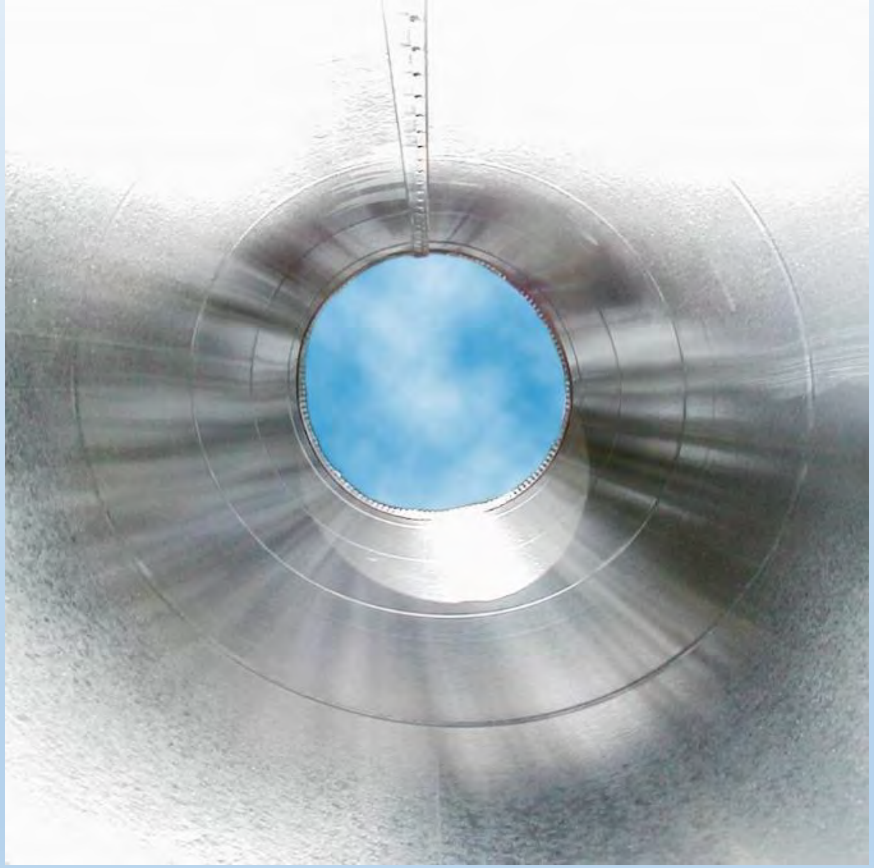
Circa 2017
Bailes, Van Rite



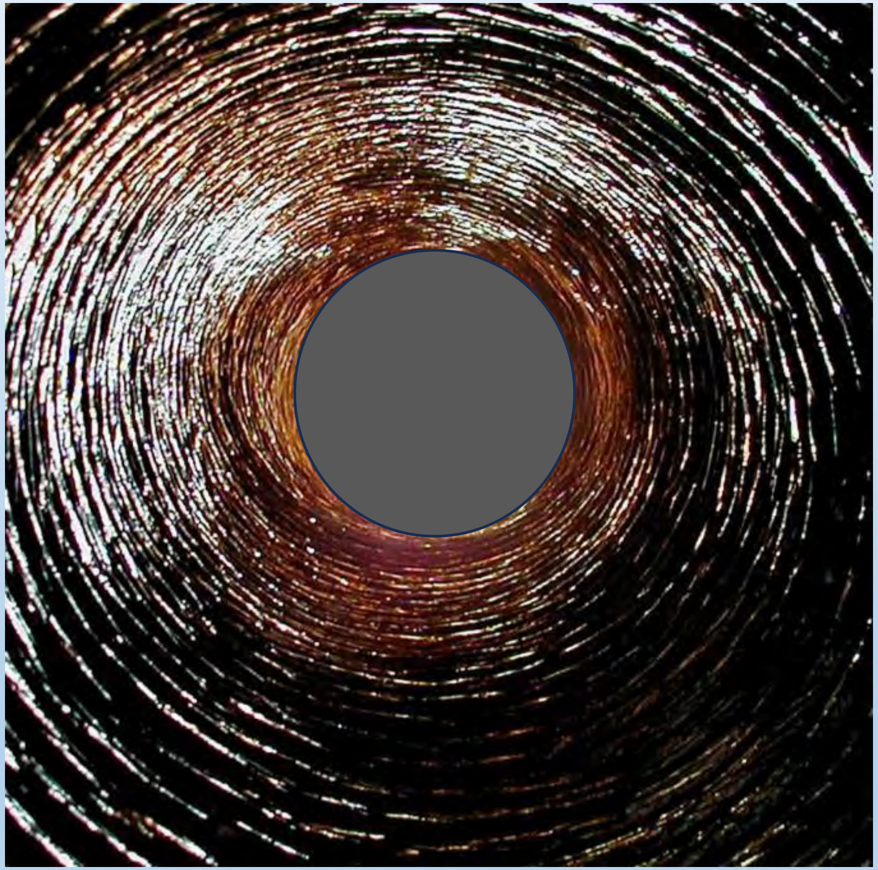
The

JOY OF FLEX

Sheet Metal Duct



Flex Duct



HVAC Duct Efficiency Study

2003

Air Distribution Institute

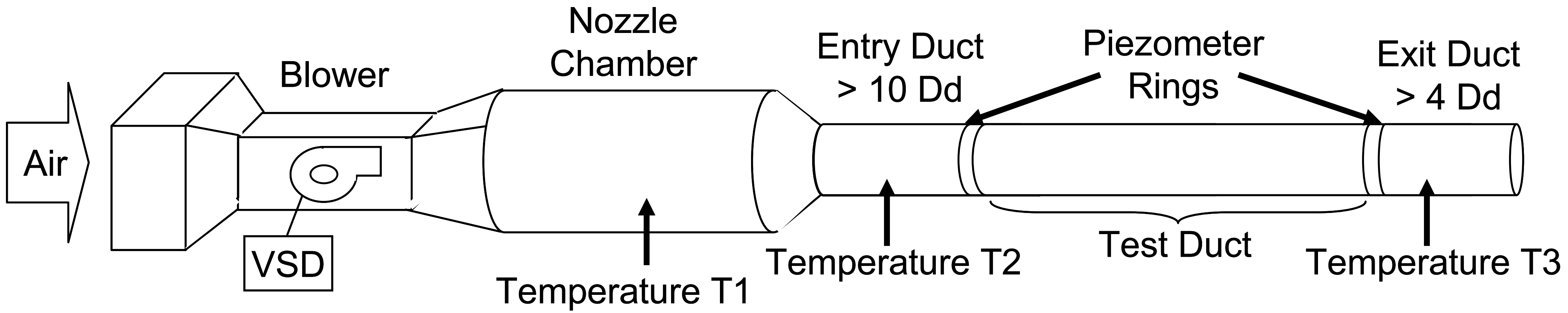
ASHRAE RP-1333

ONCOR - TXU Electric Delivery

Lennox Industries

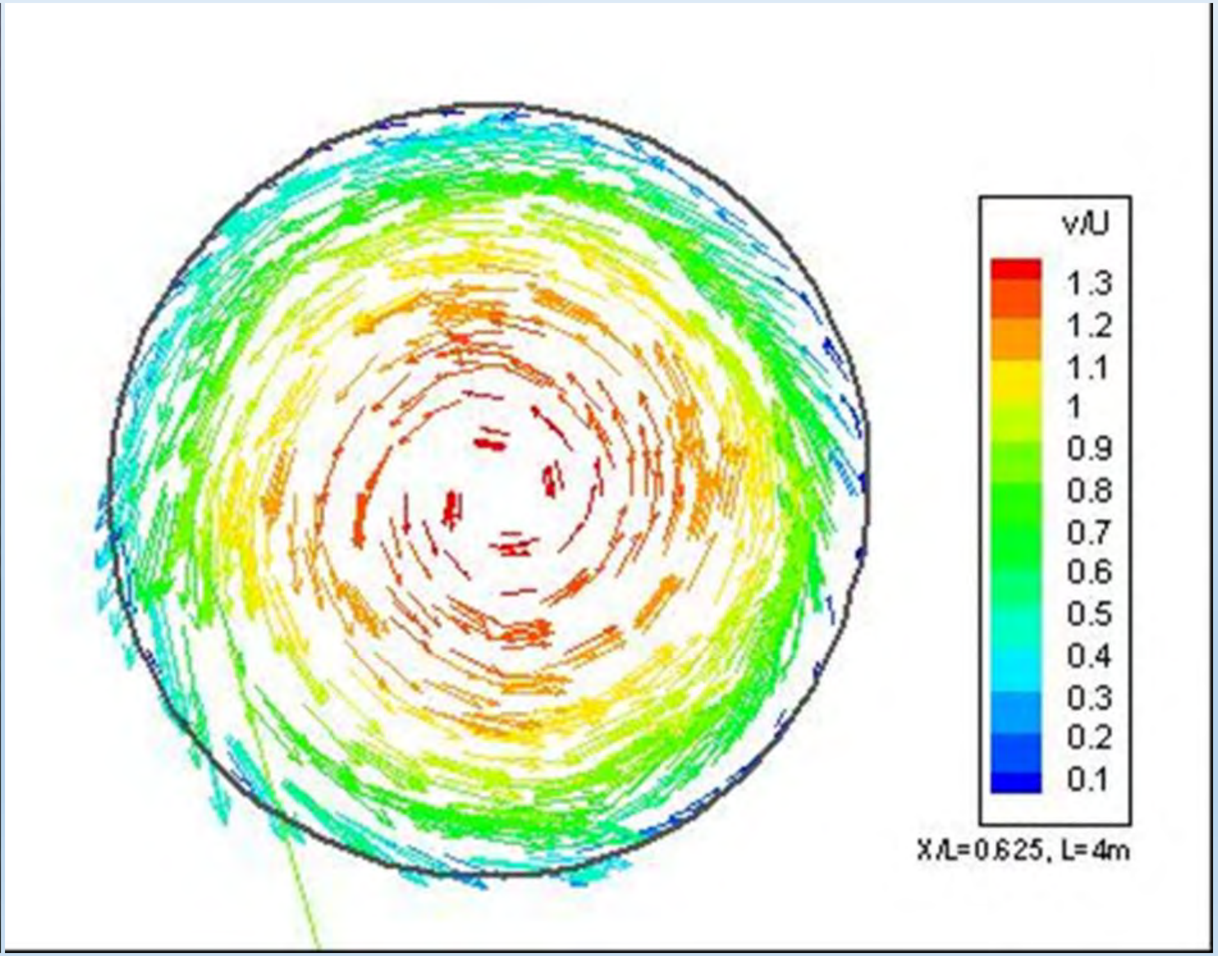
Texas A&M University

Data Acquisition (DAQ) setup

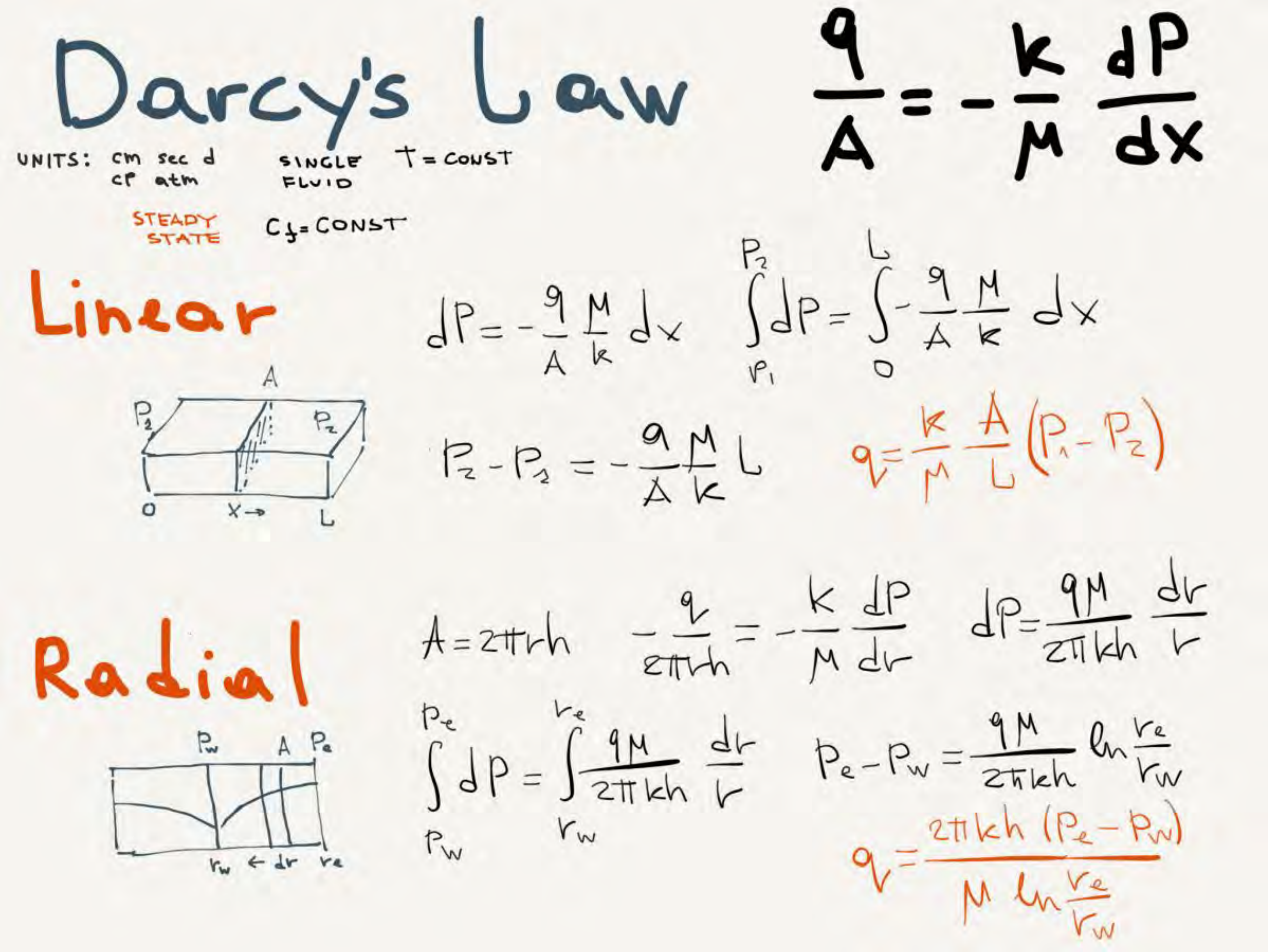


ASHRAE Standard 120

CFD Modelling

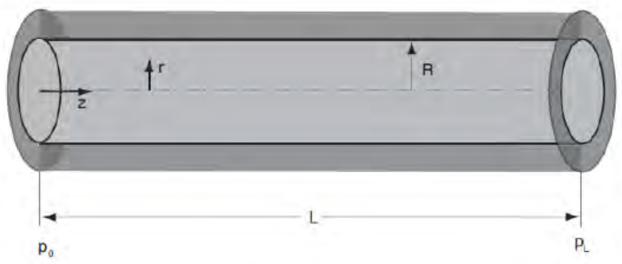


Darcy Equation



Colebrook Equation

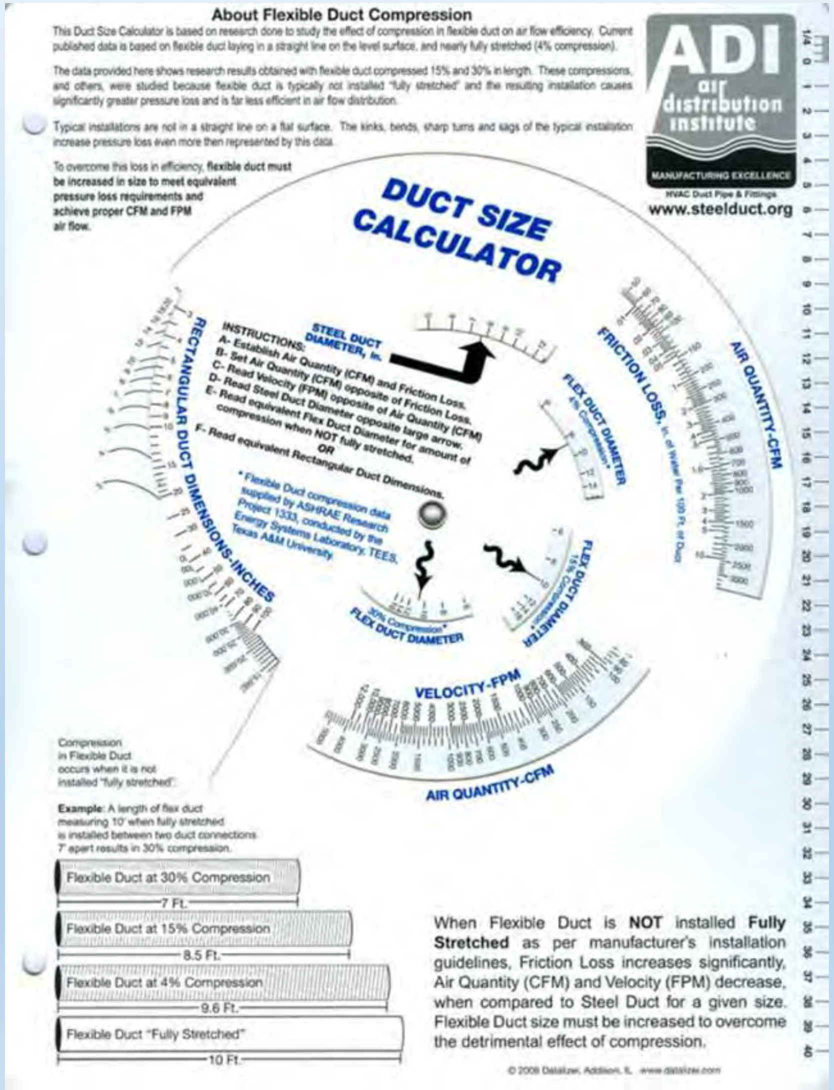
1. Tube flow is encountered in several material processes, such as in extrusion dies as well as sprue and runner systems, including those used in injection molds. Let's assume that the flow inside the tube is steady, fully developed, and is axis-symmetric. Furthermore, it has no entrance effects, the gravitational force is negligible, and the fluid is a Newtonian fluid. Based on the momentum equation in the z direction, simplify it and then solve for the velocity profile, $u_z(r)$ and the volumetric flow rate, Q. (10 points)

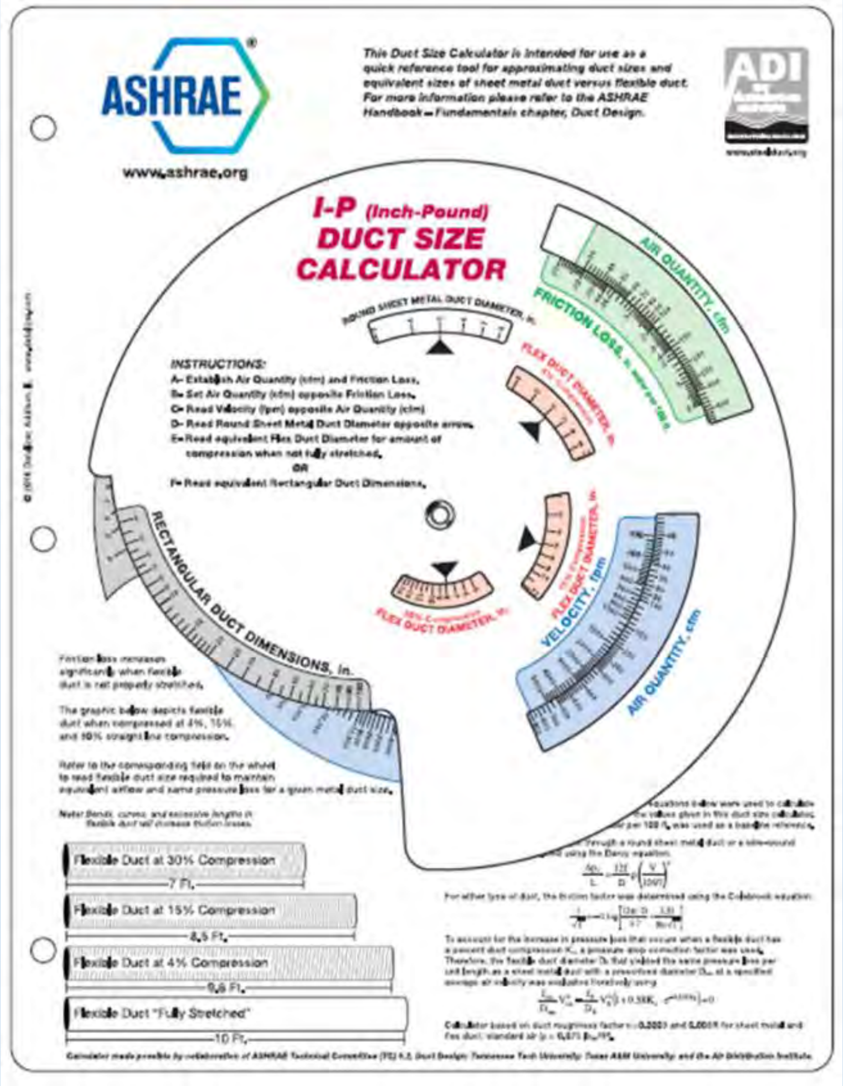


$$\rho\left(\frac{\partial u_z}{\partial t}+u_r\frac{\partial u_z}{\partial r}+\frac{u_\theta}{r}\frac{\partial u_z}{\partial \theta}+u_z\frac{\partial u_z}{\partial z}\right)= -\frac{\partial p}{\partial z}+\mu\left[\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial u_z}{\partial r}\right)+\frac{1}{r^2}\frac{\partial^2 u_z}{\partial \theta^2}+\frac{\partial^2 u_z}{\partial z^2}\right]+\rho g_z$$

2. As a mechanical or manufacturing engineer or as a professional and a member of the global community, please list a few ways that we can reduce the overall consumption of plastics for products, as well as a few ways that we can reduce, if not eliminate, the post-consumer plastic waste. Please be as creative, thoughtful, or bold as you can. We love to hear from your ideas.

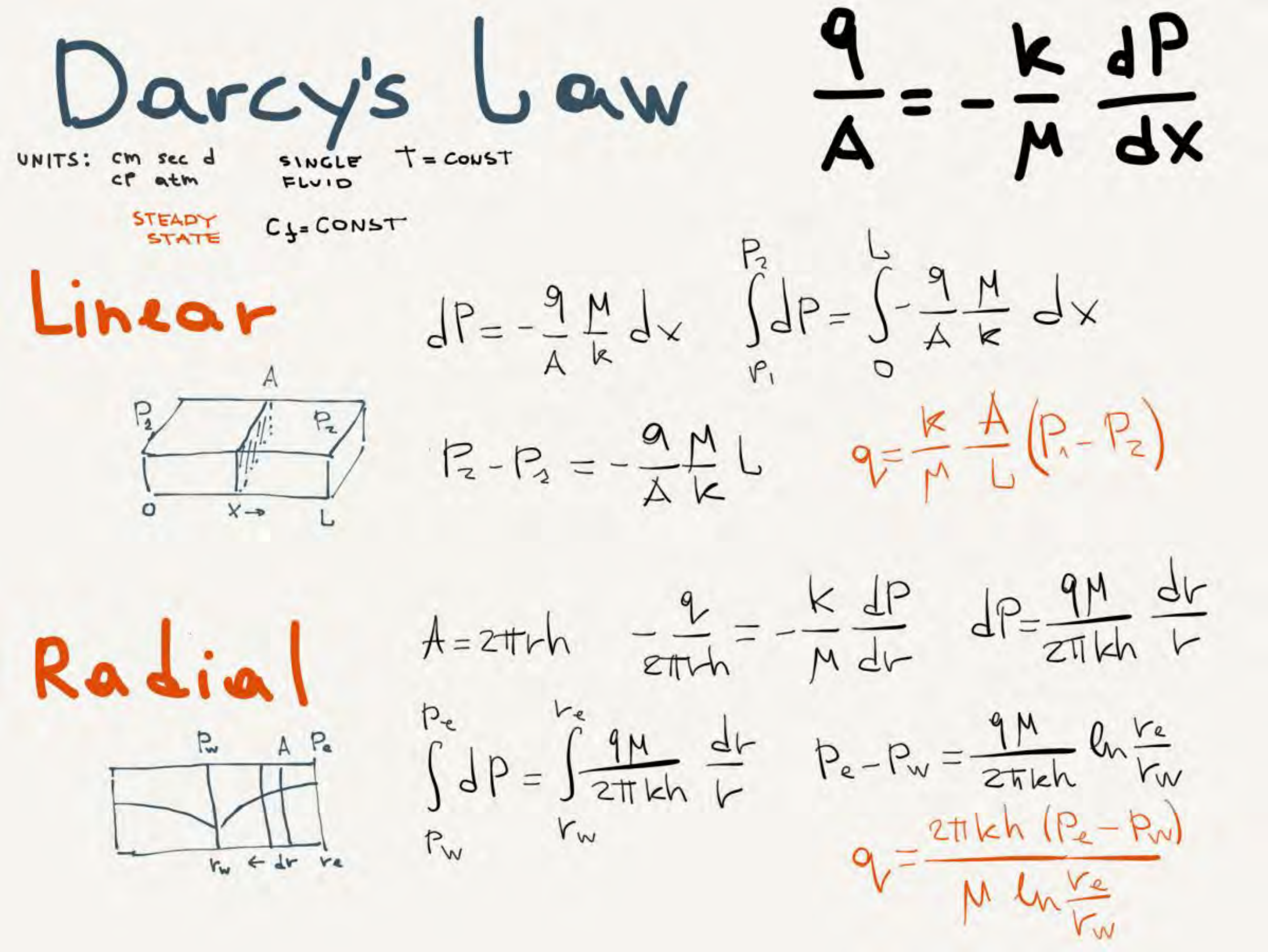
ADI and ASHRAE Duct Size Calculators





Big Whoop

Darcy Equation



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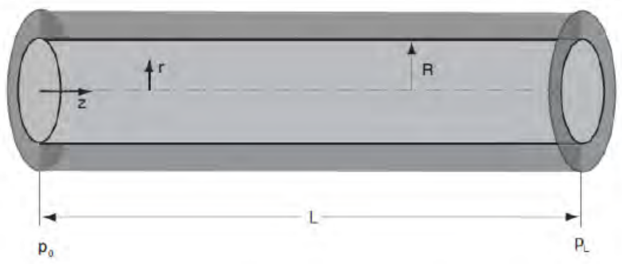

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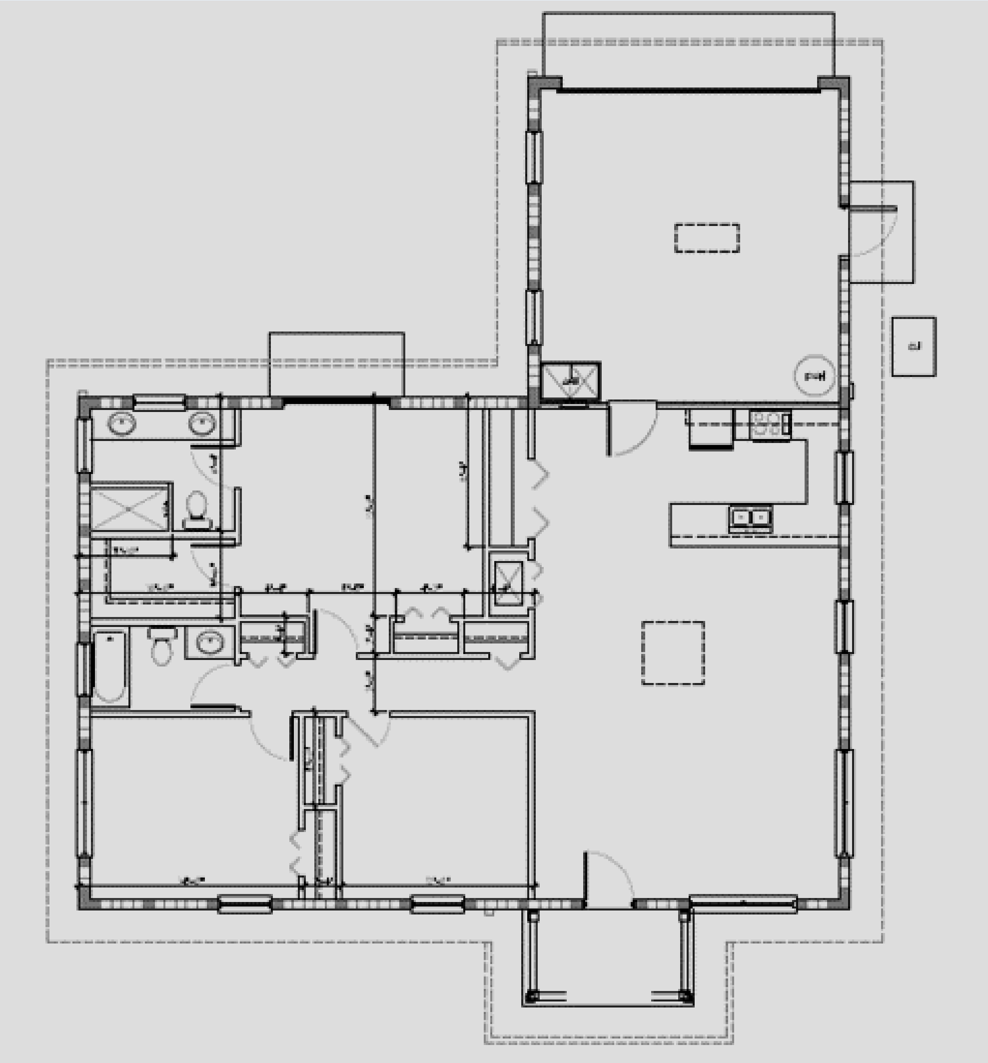
Andy Ask

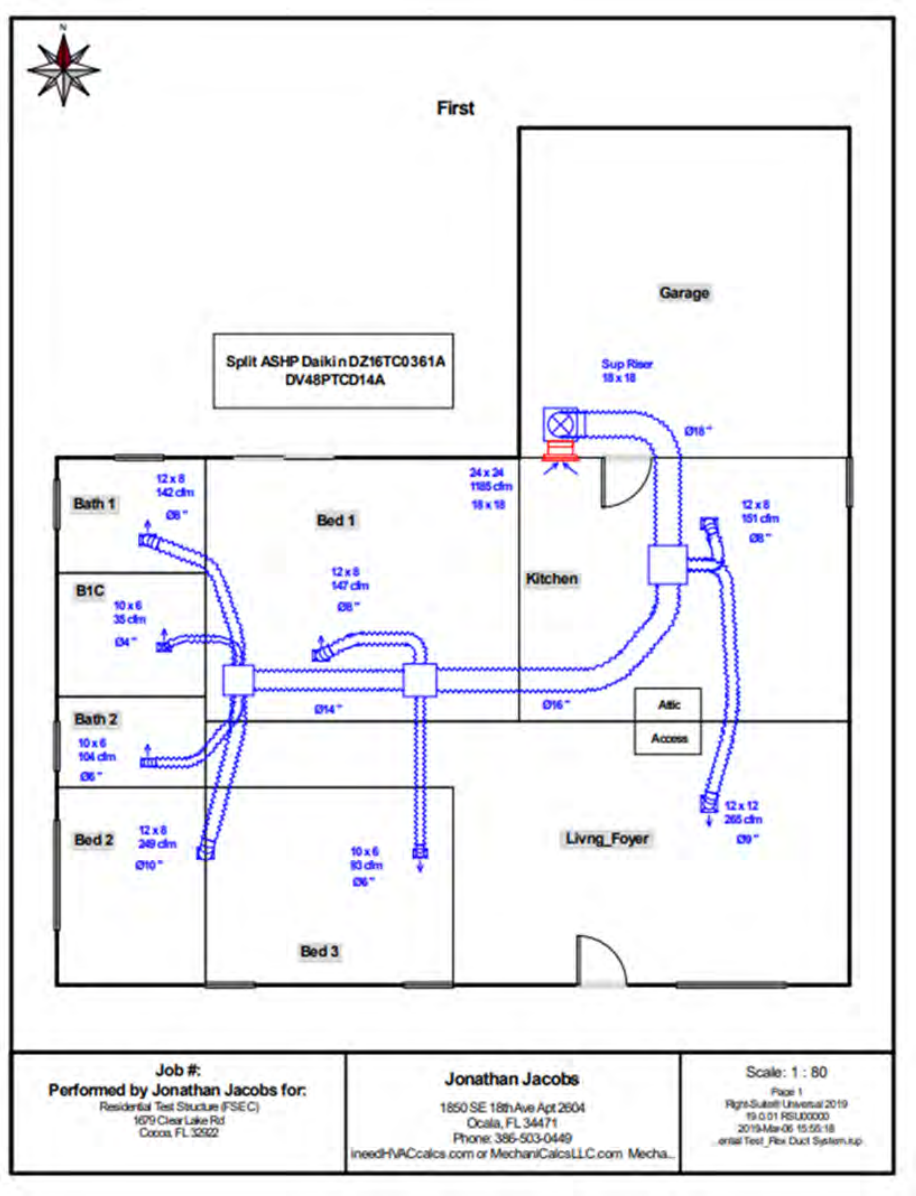
FLORIDA SOLAR ENERGY CENTER

FLEXIBLE RESIDENTIAL TEST STRUCTURE

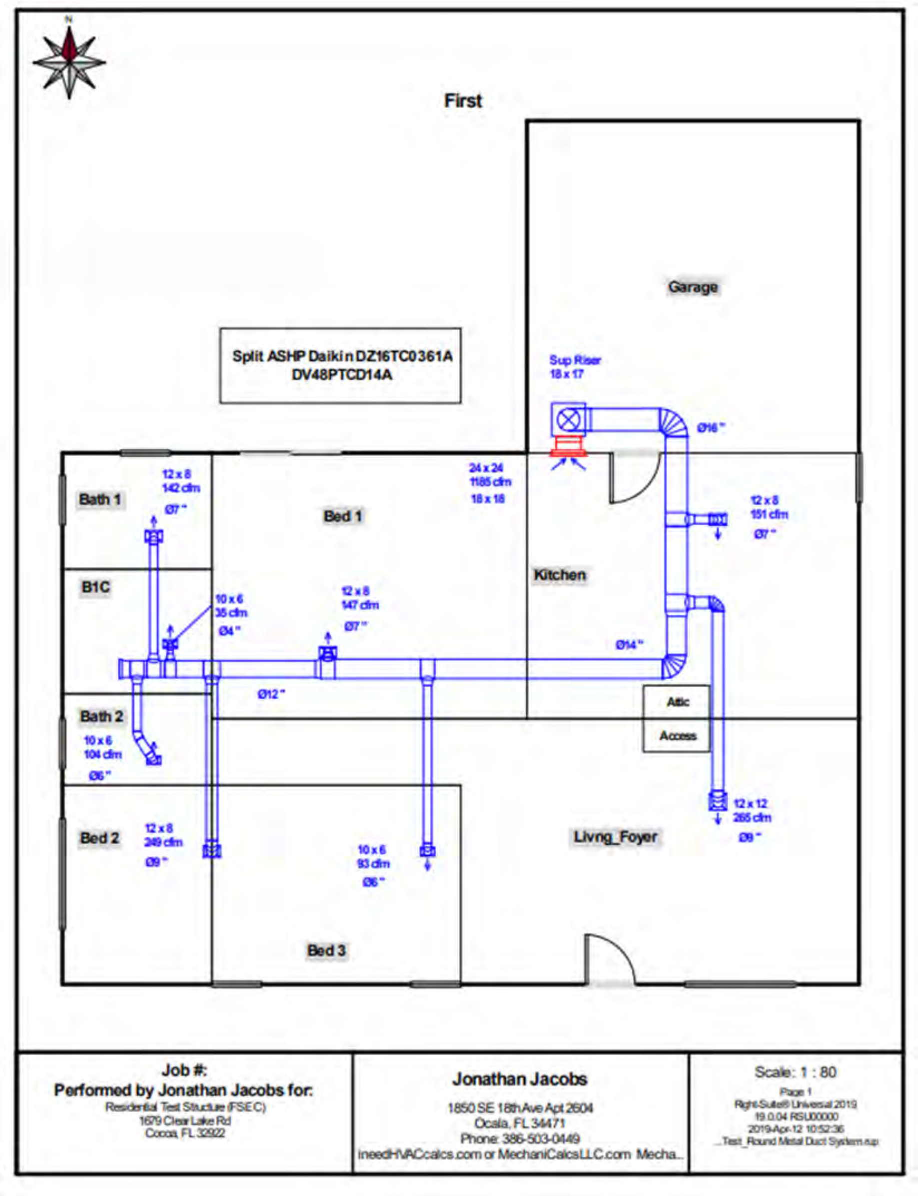
Single Zone



Flex Duct House



Metal Duct House



Sheet Metal Duct

Flexible Duct

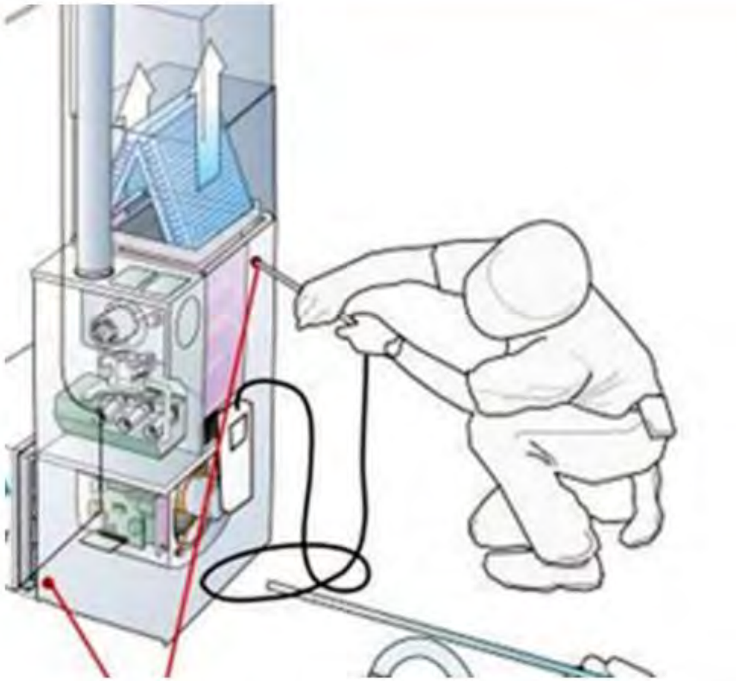
5% LESS OPERATING COST

TEST 1

- **<u>BEST METAL</u>** .34" wc TESP, High Fan Speed vs
- **<u>BEST FLEX</u>** .44" wc TESP, High Fan Speed

  - **SHEET METAL DUCT HOUSE USED 5% LESS HVAC ENERGY**
  - **75° Inside, 80° Outside**

Contracting Business – February 10, 2016



SERVICE

Measure Static Pressure in Six Simple Steps

Feb. 10, 2016

It typically should take less than five minutes to measure a residential system's static pressure.

Rob 'Doc' Falke

2018 National Comfort Institute Total External Static Pressure Study

- 500 Homes across USA
- Flex duct and metal duct
- Average TESP was .82" wc

14% LESS OPERATING COST

TEST 2

- **BEST METAL** .34” wc TESP, High Fan Speed vs
- **BAD FLEX** 1.0” wc TESP, High Fan Speed
  - **SHEET METAL DUCT HOUSE USED 14% LESS HVAC ENERGY**
  - **75° Inside, 80° Outside**

How do you screw up a good flex duct system ?

- Add more than minimum length required
- Add more turns and restrictions
- Create more sag and linier compression

Test 3 - Added Flex Duct to Produce .82" TESP

T & B	Flex Diameter	Test 1 length	Add for Test 3	Notes	Test 3 Total Length
			Trunk + 30%		
T-1	18"	219"	66"	measured total at install	285"
T-2	16"	300"	90"	used full 25 ft length	390"
T-3	14"	124"	37"		161"
		643" / 53.6 ft	193" / 16 ft		836" / 69.7 ft
			Branch + 50%		
B-1	8"	173"	87"		260"
B-2	9"	221"	111"		332"
B-3	6"	131"	67"		198"
B-4	8"	121"	61"		182"
B-5	10"	164"	82"		246"
B-6	4"	80"	40"		120"
B-7	8"	192"	96"		288"
B-8	6"	159"	80"		239"
		1,241" / 103.4 ft	624" / 52 ft		1,865" / 155.4 ft
		157 total feet	**68 total feet**		**225.1 total feet**
				Adding 68 feet of duct total (43% more)	

9% LESS OPERATING COST

TEST 3

- **BEST METAL** .34” wc TESP, High Fan Speed vs
- **AVERAGE FLEX** .82” wc TESP, High Fan Speed

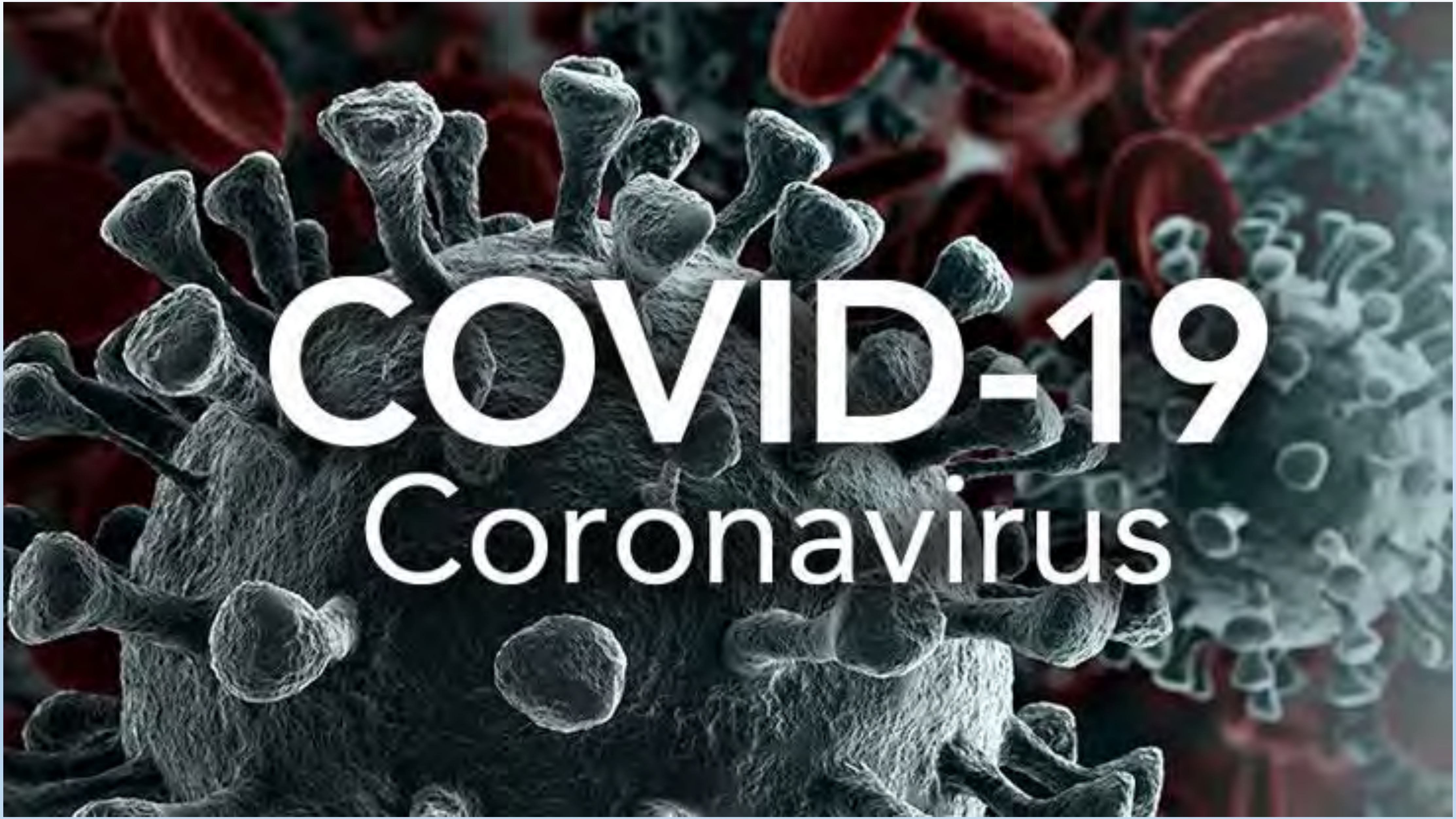
  - **SHEET METAL DUCT HOUSE USED 9% LESS HVAC ENERGY**
  - **ANUALIZED**

Peak Cooling Power Use During Hot Summer Period 4:15 pm – 5:45 pm

	Metal AHU	Metal Condenser	Flex AHU	Flex Condenser	Metal Total	Flex Total
Power (kW)	0.265	2.335	0.399	2.445	2.600	2.843
Delta flex- metal (kW)			0.134	0.110		0.244
Delta flex- metal (%)			50.5%	4.7%		9.4%

Big Whoop

Does Anyone Care ?


COVID-19
Coronavirus

“Don’t Do Stupid Stuff”

R-6 Duct Wrap Installed Thickness = 1 5/8”

Product Data Sheet

Availability and Installed R-Values

Standard roll width: 48" (1.2m), 60" (1.5m)

Installed R (RSI) values: When installed in accordance with recommended installation procedures, SOFTR® Duct Wrap FRK will provide installed R (RSI) values as follows:

Nominal Thickness		Out-of-Package R (RSI) Value[1]		Installed Thickness[2]		Installed R (RSI) Value[1,2]	
in.	mm			in.	mm		
Type 75 – 0.75 pcf (12 kg/m³)							
1½	(38)	5.1	(0.90)	1⅛	(29)	4.2	(0.74)
2.2	(56)	7.4	(1.30)	1⅝	(42)	6.0	(1.06)
3	(76)	10.0	(1.76)	2¼	(57)	8.3	(1.46)

Turns Out, This Stuff Really Matters

What's the worst thing that can happen ?

17% LESS OPERATING COST

CALCULATED

- **BEST METAL** .34” wc TESP, High Fan Speed vs
- **AVERAGE FLEX** .82” wc TESP, High Fan Speed

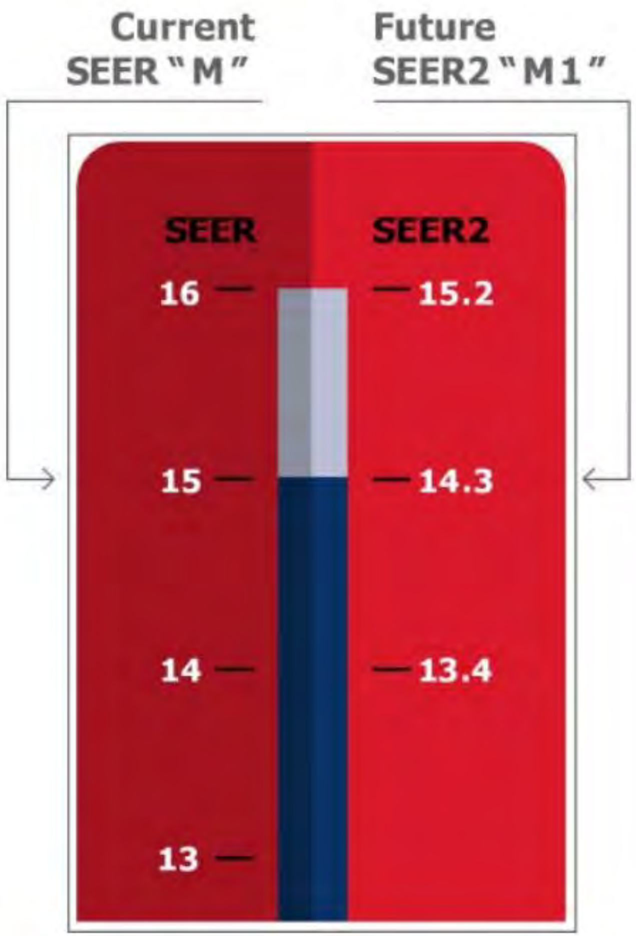
  - **SHEET METAL DUCT HOUSE MAY HAVE USED 17% LESS HVAC ENERGY IF THE DUCTS WERE INSULATED WITH R-6 INSTEAD OF R2.5 (RESULT OF OVER-COMPRESSED WRAP)**

Conclusions

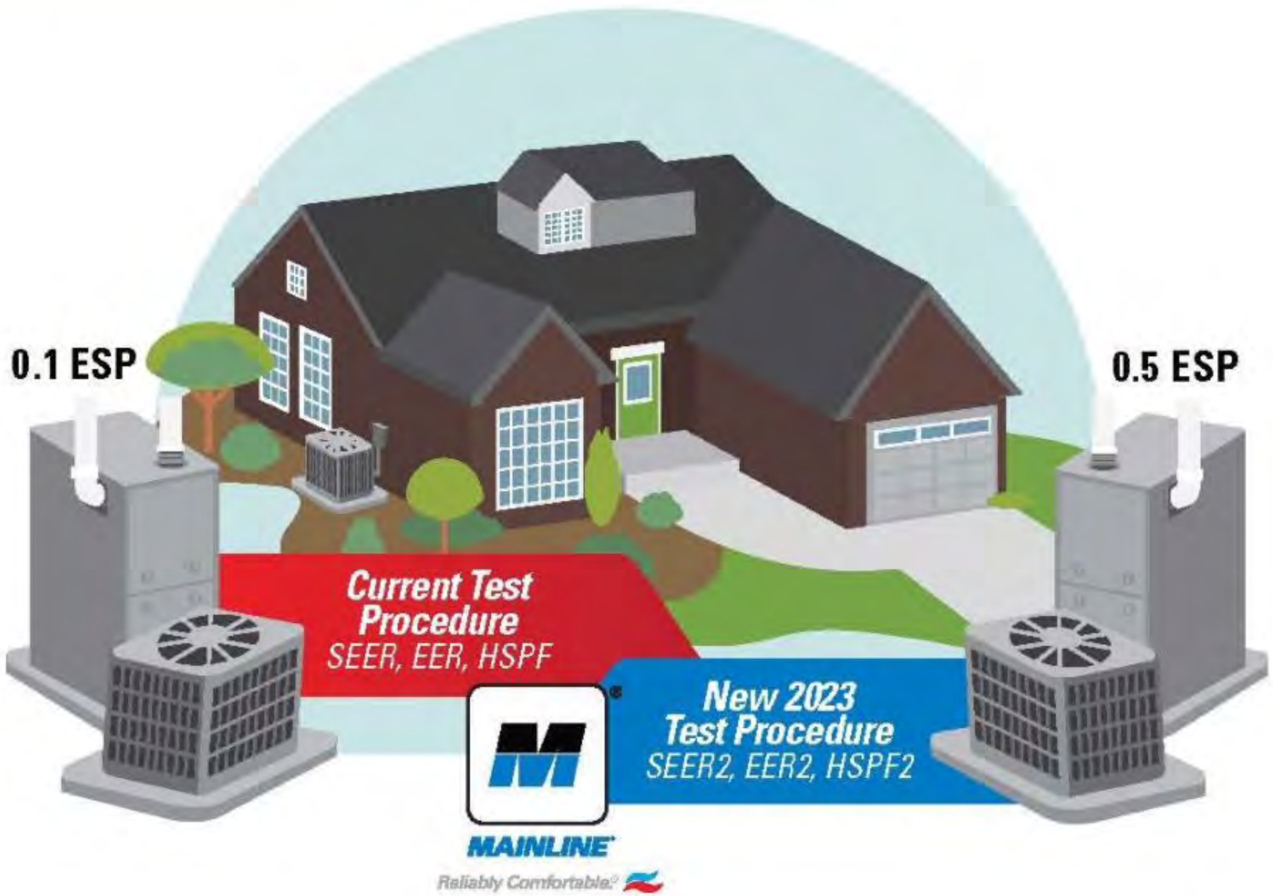
- Higher static pressure across the constant flow ECM fan resulted in higher cooling power and energy use.
- Test 1 Good Practice for metal and flex ducts
  - Flex duct system 13.4% (5.4%+8%) greater than metal duct.
- Test 2 Poor Practice
  - Flex duct system 21.8% (13.8%+8%) greater than metal duct.
- Test 3 Likely Practice
  - Flex duct system 16.8% (8.8%+8%) greater than metal duct.

SEER2

New Measurement



New Testing Procedure



Questions ?

Thank you