The Impact of OACF

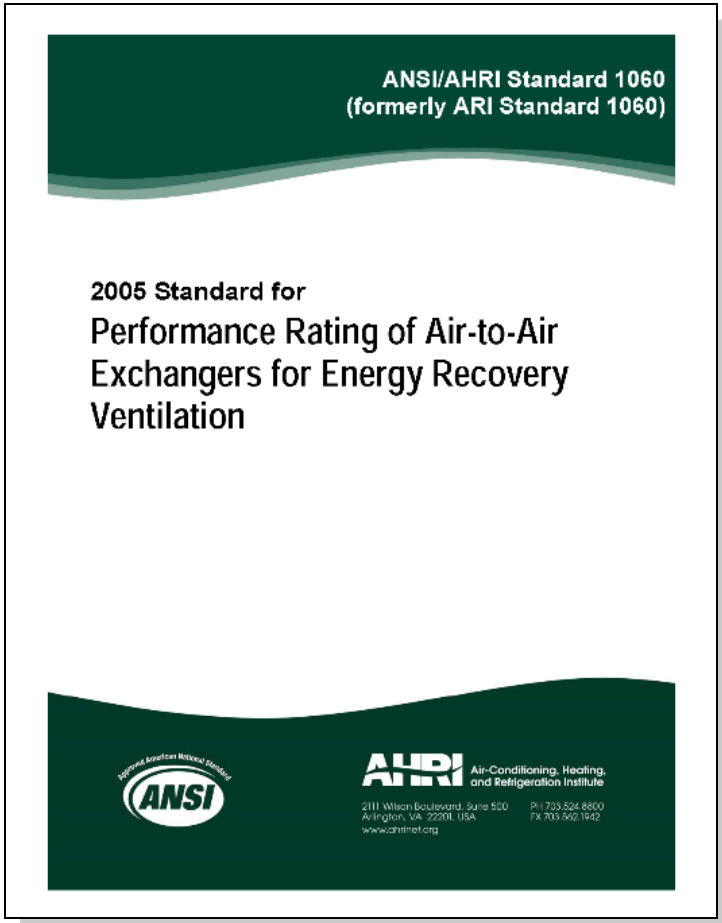
Outdoor Air Correction Factor and Systems

Doug Branger , Venmar CES Inc.

Objectives

1. Understand the importance of AHRI 1060 and independent certification
2. Grasp the concepts of EATR and OACF its implications with respect to different air-to-air energy recovery technologies and applications
3. Realize the impact of OACF on system design and energy consumption
4. Learn how to build performance-based specifications with not to exceed values for OACF to ensure that you are meeting project requirements

AHRI Standard 1060-2005



PURPOSE:

To establish definitions, test requirements, rating requirements, minimum data requirements for Published Ratings, marking and nameplate data and conformance conditions for Air-to-Air Heat Exchangers intended for use in Air-to-Air Energy Recovery Ventilation Equipment

ARI Certification Program started in Q1 2001

Old

ARI PERFORMANCE CERTIFIED ™

=

New

AHRI CERTIFIED ™
www.ahridirectory.org
Air-to-Air ERV
AHRI Standard 1060
Energy Recovery COMPONENT is certified. Actual performance in packaged equipment may vary.

EATR Definition

Exhaust Air Transfer Ratio (EATR). The tracer gas concentration difference between the Leaving Supply Airflow and the Entering Supply Airflow divided by the tracer gas concentration difference between the Entering Exhaust Airflow and the Entering. Supply Airflow at the 100% rated airflows, expressed as a percentage.

$$EATR = \frac{C_2 - C_1}{C_3 - C_1}$$

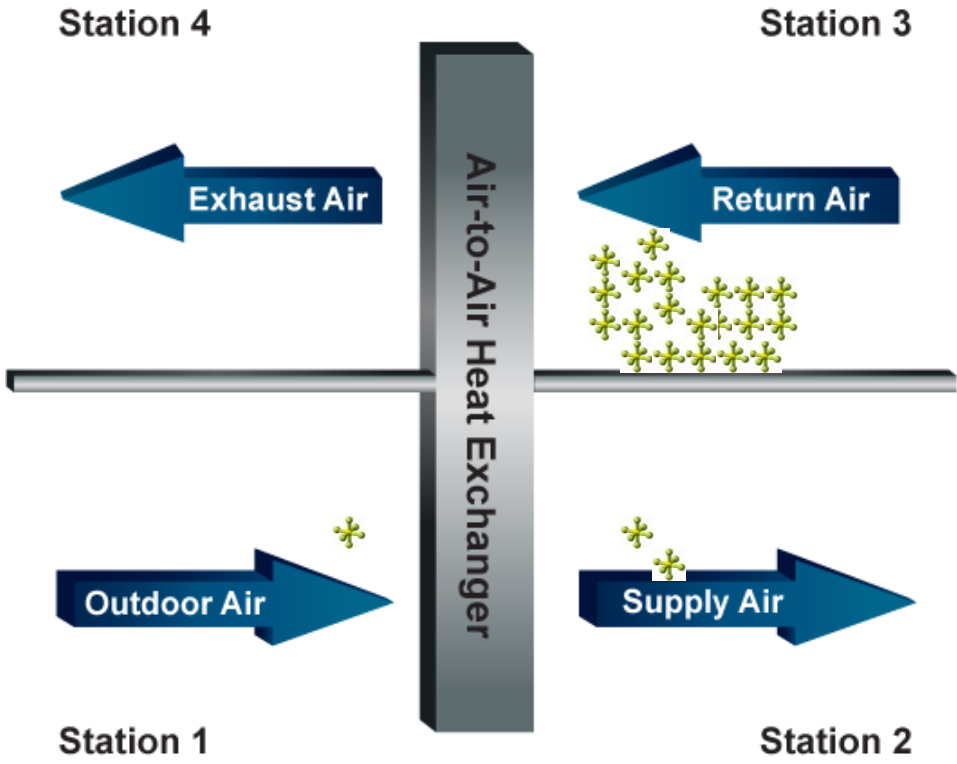
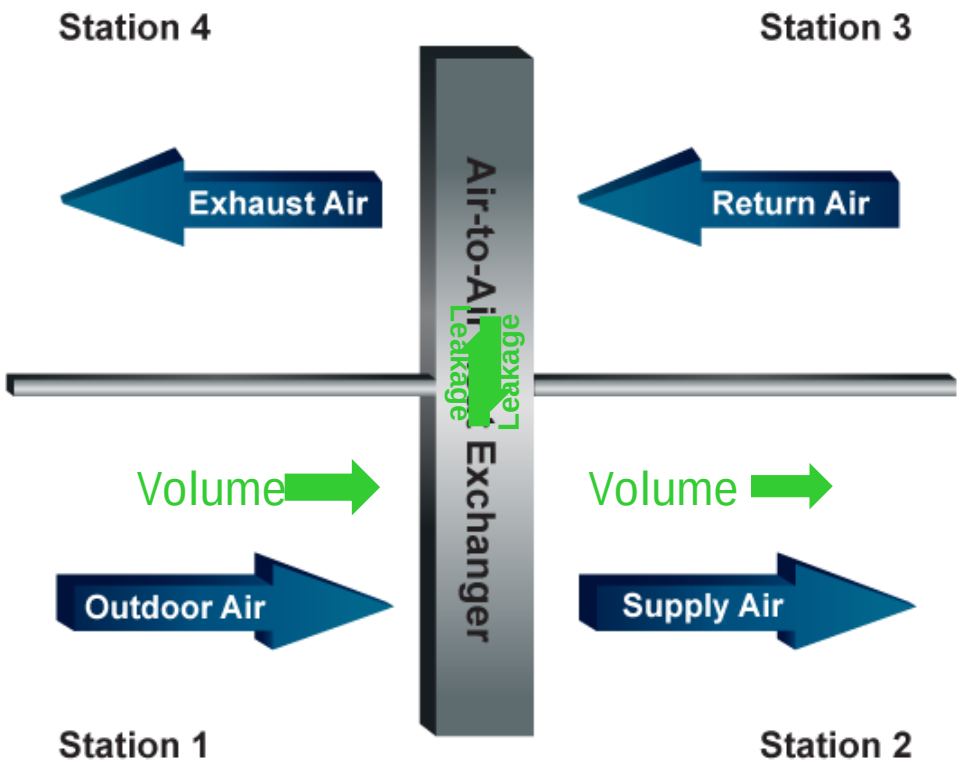


Figure 1. Generic Configuration of an Air-to-Air Heat Exchanger Used for Energy Recovery in Ventilation Applications

OACF Definition

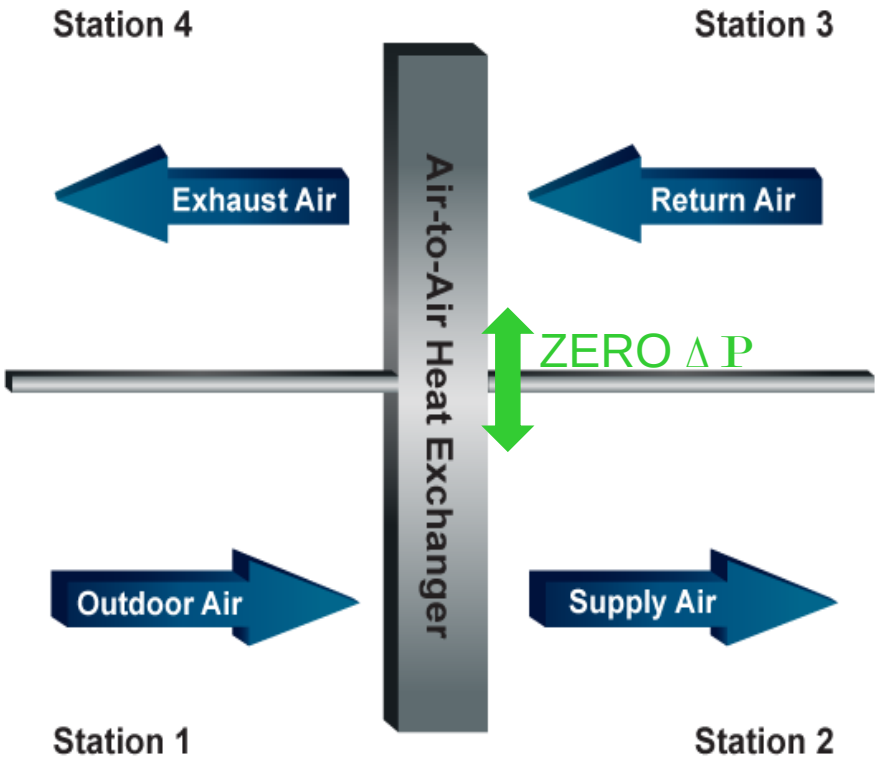
- ***Outdoor Air Correction Factor (OACF).*** The Entering Supply Airflow divided by the measured (gross) Leaving Supply Airflow

- OACF greater than 1.0
  - leakage from supply to exhaust
  - Example
    - Q1/Q2 = 5000/4800 = 1.04
- OACF less that 1.0
  - Leakage from exhaust to supply
  - Example
    - Q1/Q2 = 4800/5000 = 0.96



Impact of pressure differential

- Pressure differential impacts leakage (OACF & EATR)
- AHRI Performance rating at ZERO pressure differential between S3 & S2
  - Sensible, Latent, Total Effectiveness
  - Pressure Drop
  - EATR & OACF
- Certification test for EATR & OACF
  - Optional pressure differentials between S3 & S2
    - -5.00, -3.00, -1.00, -0.50, 0.50, 1.00, 3.00, 5.00 in H2O



Leakage with air to air exchangers

- Wheels
  - Leakage between airstreams impacted primarily by face seal
- Plates
  - Leakage impacted by Pittsburg crimps or banked assemblies
- Pipes
  - Leakage potential only at center partition

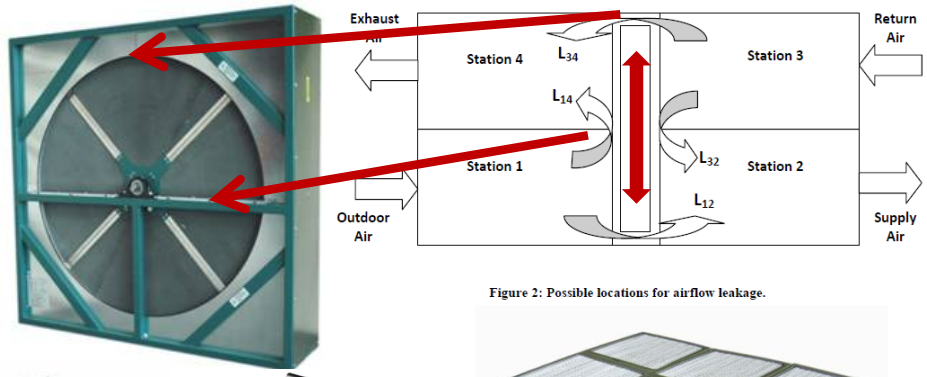
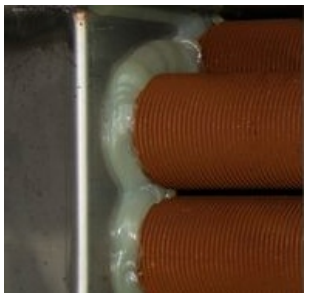
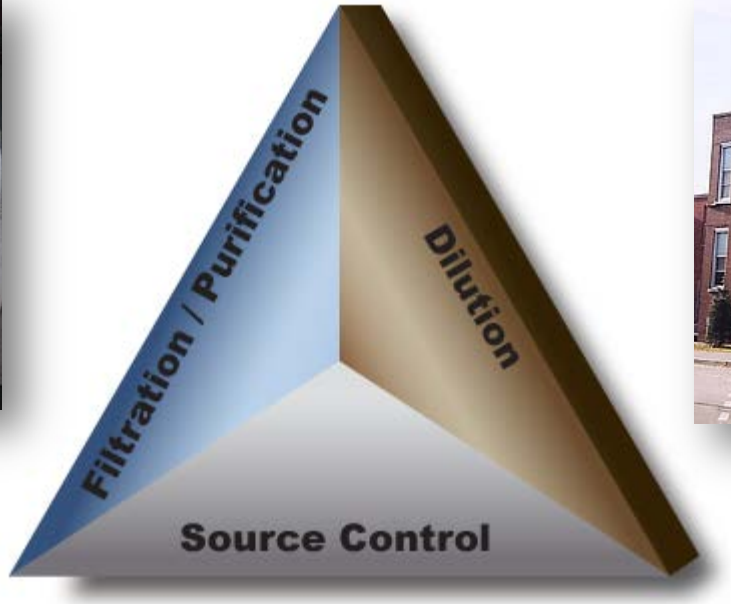


Figure 2: Possible locations for airflow leakage.



Technology by Application



EATR allowance by Application Standard 62 - 5.17.2

Class 1: Low contaminants (ex. Classroom exhaust)

Class 3: Significant contaminants (ex. Parking garage)

Class 2: Moderate contaminants (ex. Toilet exhaust)

Class 4: Highly objectionable fumes (ex. Lab hood exhaust)

Managing return air: A mixture of any Class of air is classified with the highest class of its constituents.

Exception: Energy recovery resulting in **10% or less** EATR from **Class 2** or **5% or less** from **Class 3** does not affect the classification of Class 1 air.

The need for a wheel purge?

- Purge significantly increases OACF, increasing energy costs
- Majority of applications
  - Dilution ventilation, Class I EATR is not critical
  - Class II air ≤10% EATR
  - Class III air ≤ 5% EATR

No Purge Req'd

- Source Control – Class IV
  - Mechanical seals minimize leakage; wear over time?
  - For wheel, consider blow thru draw through, but watch OACF
  - Plates & Heat Pipes, peace of mind

Factors Effecting EATR & OACF

Fan Placement and the effect on EATR & OACF

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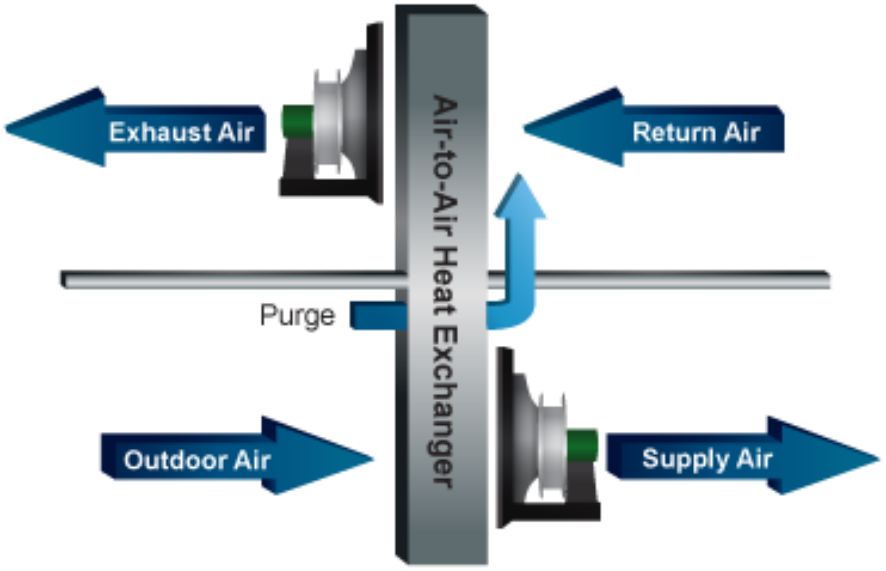
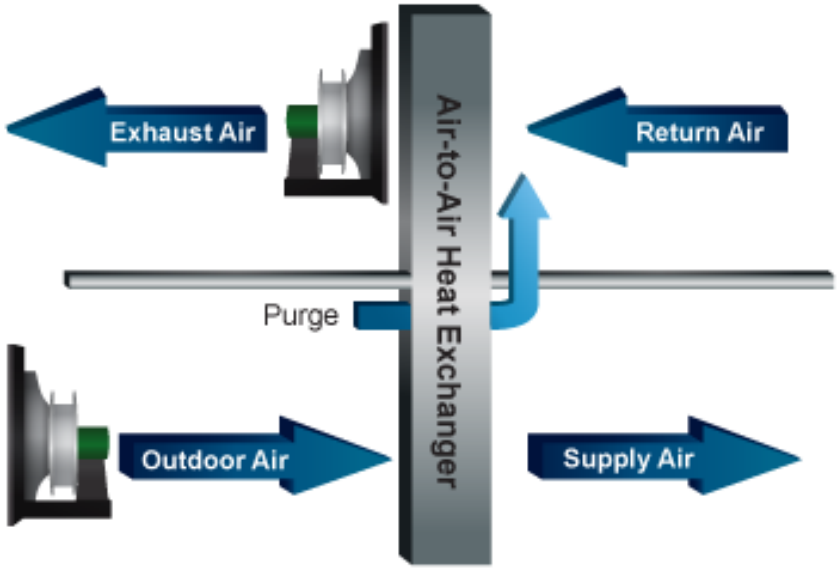
Draw Through, Draw Through



Minimizes OACF

Blow Through, Draw Through (Exhaust)

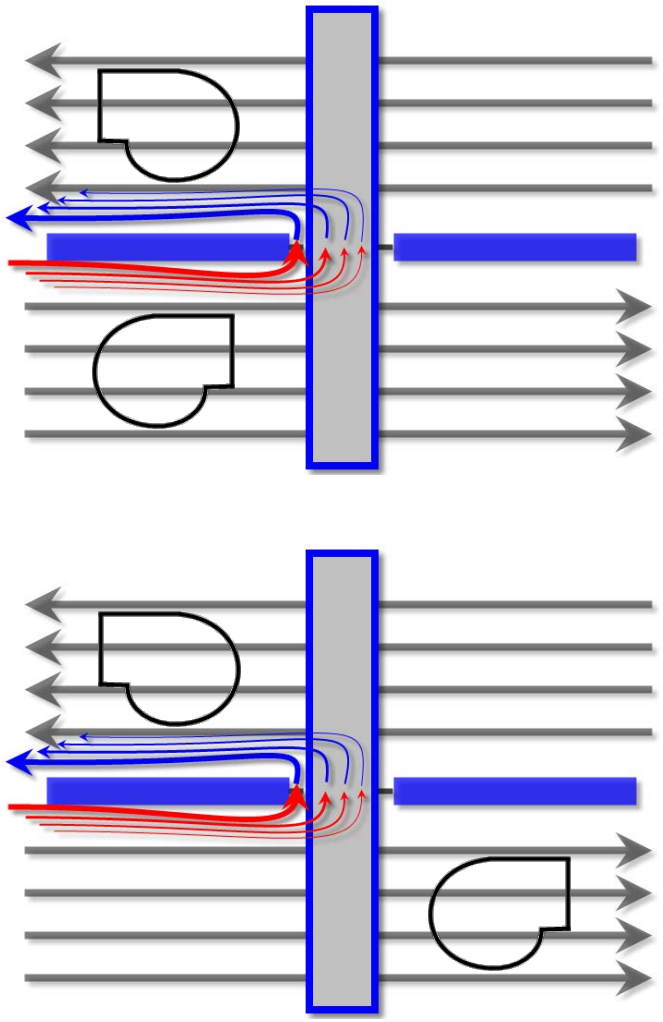


Maximizes OACF

OACF Impacts

System Effectiveness

- Additional air to move at stations 1 and 4
- Blower power consumption…
  - OACF Impact – Blow / Draw
    - S/A & E/A fans impacted
  - OACF Impact – Draw / Draw
    - E/A fan impacted



Conditions that impact OACF

Life Cycle & Other Considerations

- Seal wearing on wheels
  - Increases flow crossing at given pressure differential
- Fi
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  -
- Ai
  …
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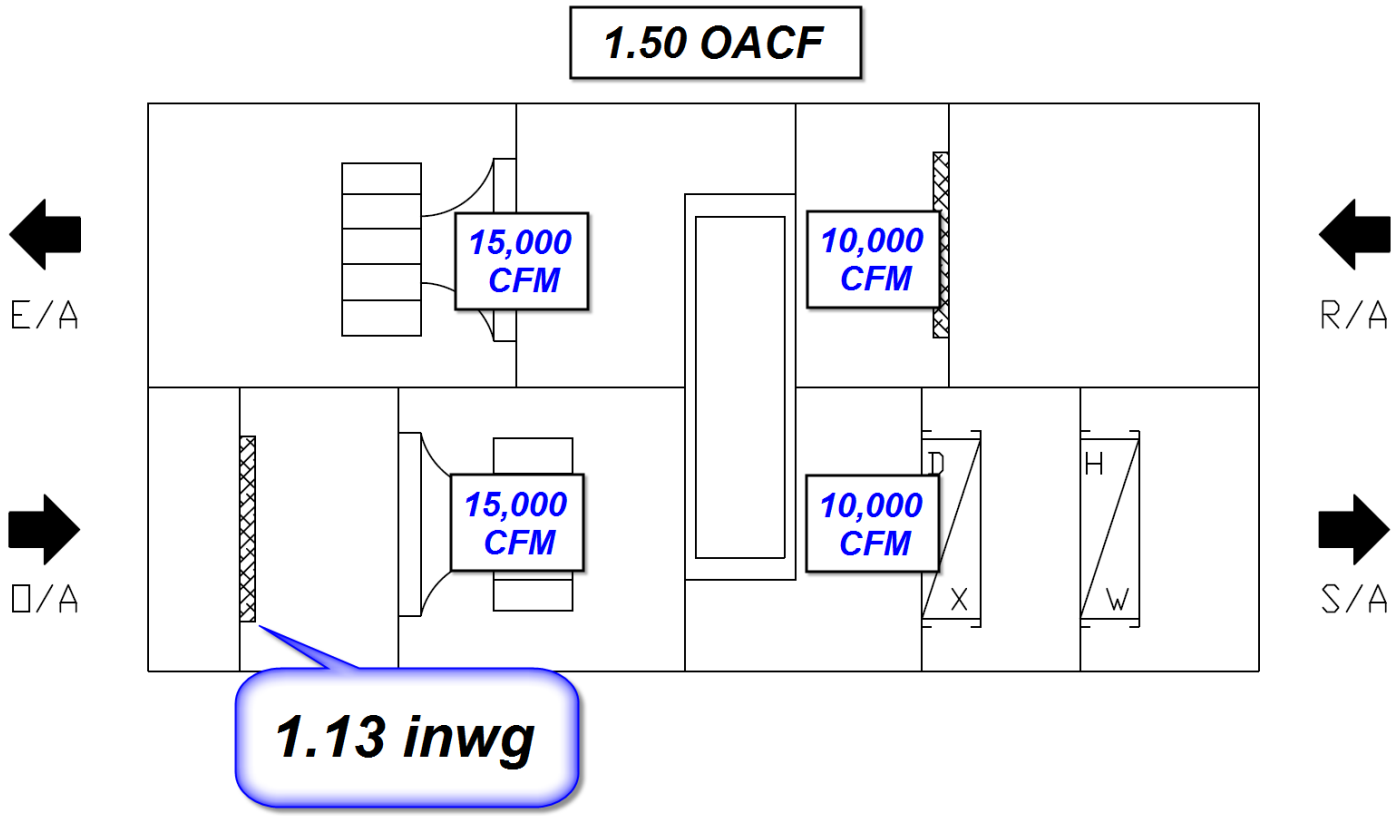
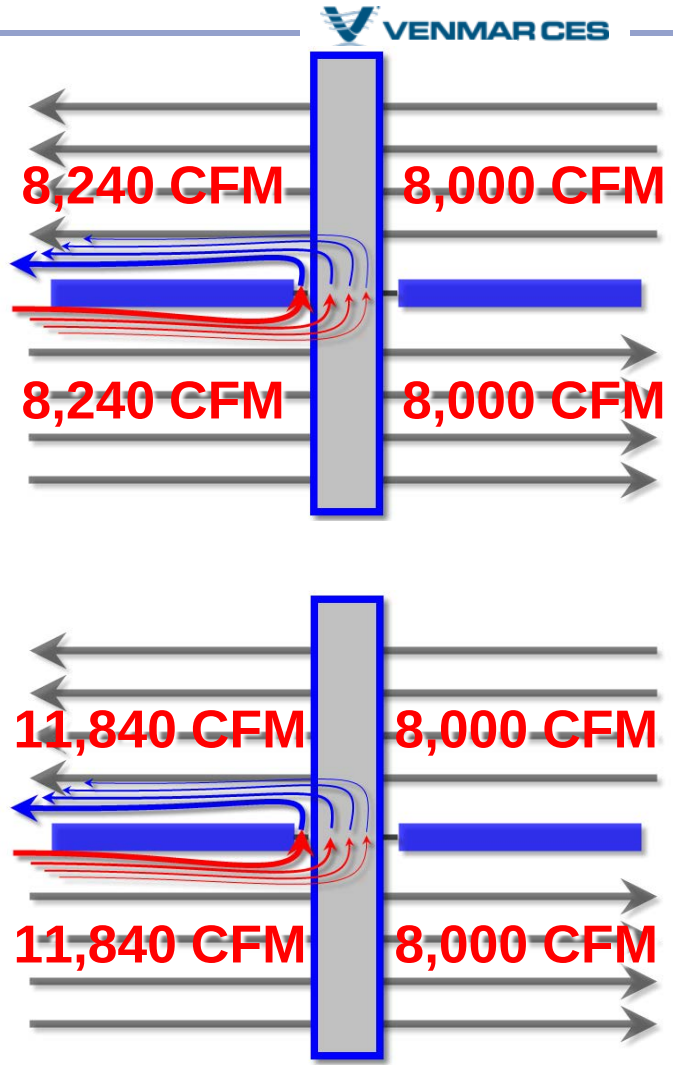


Energy Modeling: OACF vs Fan Power

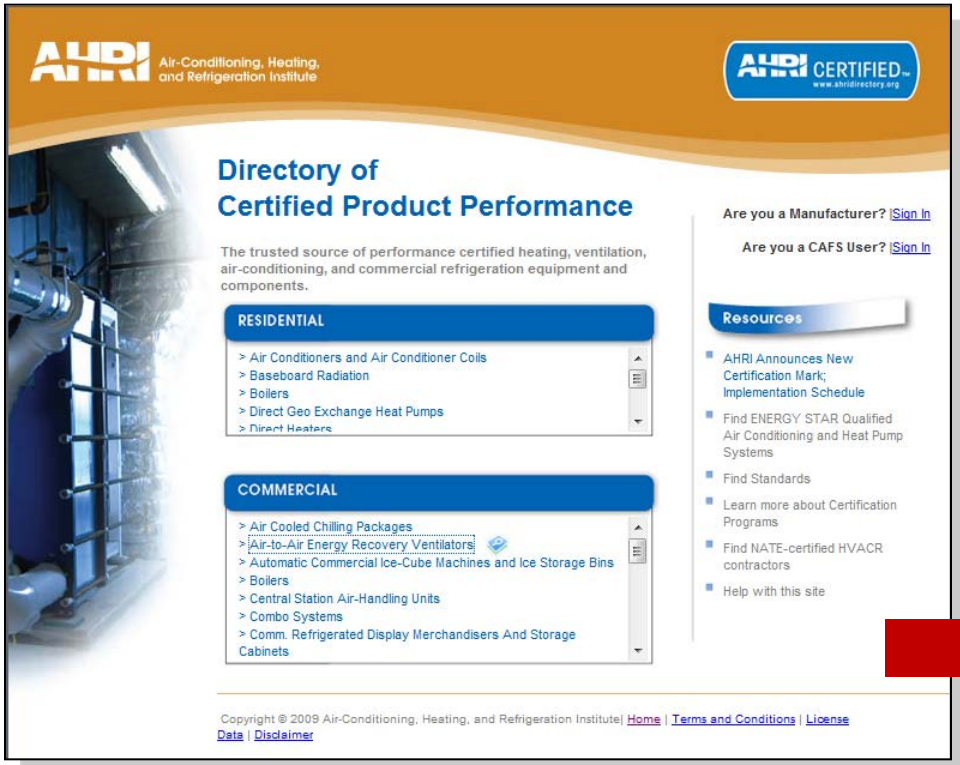
Example: Wheel @ 8,000 CFM

- 1.03 OACF vs 1.48 OACF
- 20-Year energy model (8,000 CFM)
  - 5 day/week / 9 h/day operation
  - $ 0.11 /kWh
  - 2% annual utility inflation
- 1.03 OACF
  - 261 kWh life cycle energy use
  - $ 697 life cycle energy cost
- 1.48 OACF
  - 4,170 kWh life cycle energy use
  - $ 11,145 life cycle energy cost



AHRI Certified Components

http://www.ahridirectory.org



Certified Performance

Heat Pipes / Plate Heat Exchangers

VENMAR CES

Leakage Ratings	Pressure Differential	EATR(%)	OACF
Test 1:	-5.00	0.00	1.00
Test 2:	0.00	0.00	1.00
Test 3:	5.00	0.00	1.00

Trade/Brand name: THERMOGAIN

Rated as follows in accordance with AHRI Standard 1060-2005 for Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment and subject to verification of rating accuracy by AHRI-sponsored, independent, third party testing:

Leakage Ratings	Pressure Differential	EATR(%)	OACF
Test 1:	-5.00	0.00	1.00
Test 2:	0.00	0.00	1.00
Test 3:	5.00	0.00	1.00

Thermal Effectiveness Ratings at 0" Pressure Differential

	Sensible(%)	Latent(%)	Total(%)

Leakage Ratings	Pressure Differential	EATR(%)	OACF
Test 1:	-3.00	0.00	1.00
Test 2:	0.00	0.00	1.00
Test 3:	3.00	0.00	1.00

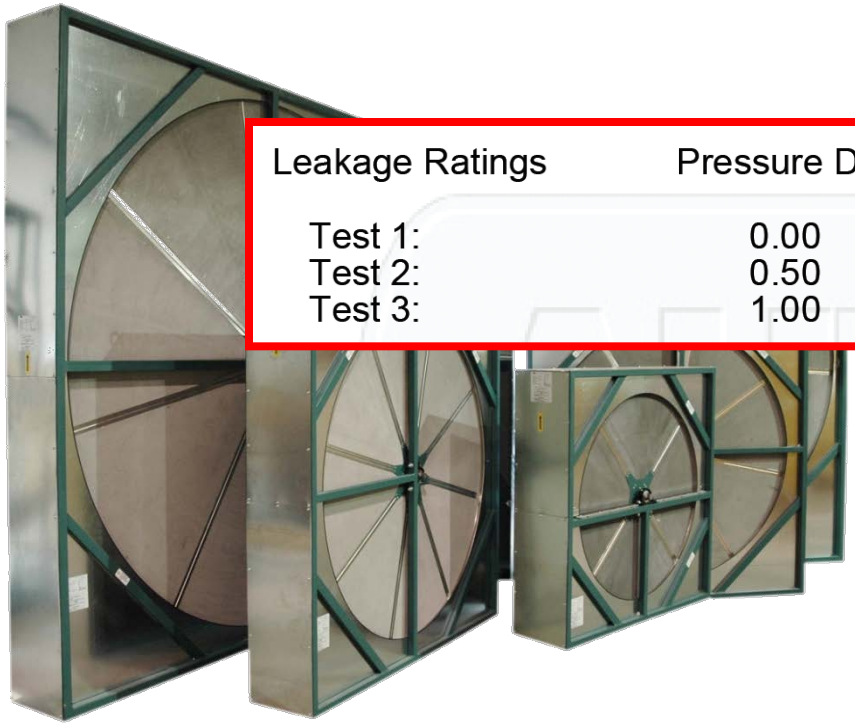
* Ratings followed by an asterisk (*) indicate a voluntary rerate of previously published data, unless accompanied with a WAS, which indicates an involuntary rerate.

Leakage Ratings	Pressure Differential	EATR(%)	OACF
Test 1:	0.00	2.40	1.00
Test 2:	1.00	1.00	1.02
Test 3:	3.00	0.00	1.04

Certified Performance

Wheels

- Wheel Certification Numbers
- Venmar Wheel Example



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Certificate of Product Ratings

AHRI Certified Reference Number: 523057 Date: 3/6/2011 †Status: Active

Product: Component Air-to-Air Energy Recovery Ventilator
Model Number: ERW3000-T-78
Manufacturer: INNERGY TECH, INC.
Trade/Brand name: ERW3000

Rated as follows in accordance with AHRI Standard 1060-2005 for Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment and subject to verification of rating accuracy by AHRI-sponsored, independent, third party testing:

Product Type: Wheel Leaving Supply Air Flow (SCFM):

Leakage Ratings	Pressure Differential	EATR(%)	OACF
Test 1:	0.00	6.30	1.00
Test 2:	0.50	4.20	1.01
Test 3:	1.00	2.90	1.02

100% Air Flow Cooling	74	64	68
75% Air Flow Cooling	78	72	

	Net Sensible(%)	Net Latent(%)	Net Total(%)
100% Air Flow Heating	72	71	72
75% Air Flow Heating	77	75	76
100% Air Flow Cooling	72	62	66
75% Air Flow Cooling	77	70	73

† Models with an 'Active' status are those that are currently in production. Models with a 'Discontinued' status are those that the manufacturer has elected to stop producing, yet stock is still available. Models with an 'Obsolete' status are those that the manufacturer is required to stop manufacturing due to an AHRI certification program test failure.

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AHRI Air-Conditioning, Heating, and Refrigeration Institute

CERTIFICATE NO.: 129439436600714610

OACF / EATR Impacts

Certification numbers

- Competitor Wheel Numbers
- Some Wheel Types Are Sensible to Pressure Differentials (OACF Can Result)
- Wheel / Seal Design Importance

Leakage Ratings	Pressure Differential	EATR(%)	OACF
Test 1:	0.00	1.00	1.13
Test 2:	0.50	0.00	1.49
Test 3:	1.00	0.00	1.71

AHRI CERTIFIED™ www.ahridirectory.org

Certificate of Product Ratings

AHRI Certified Reference Number: Date: †Status: Active

Product: Component Air-to-Air Energy Recovery Ventilator
Model Number:
Manufacturer:
Trade/Brand name:

Rated as follows in accordance with AHRI Standard 1060-2005 for Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment and subject to verification of rating accuracy by AHRI-sponsored, independent, third party testing:

Product Type: Wheel Leaving Supply Air Flow (SCFM):

100% Air Flow Cooling	72	70
75% Air Flow Cooling	74	

	Net Sensible(%)	Net Total(%)
100% Air Flow Heating	72	70
75% Air Flow Heating	74	72
100% Air Flow Cooling	72	70
75% Air Flow Cooling	74	72

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OACF / EATR Impacts

Certification numbers

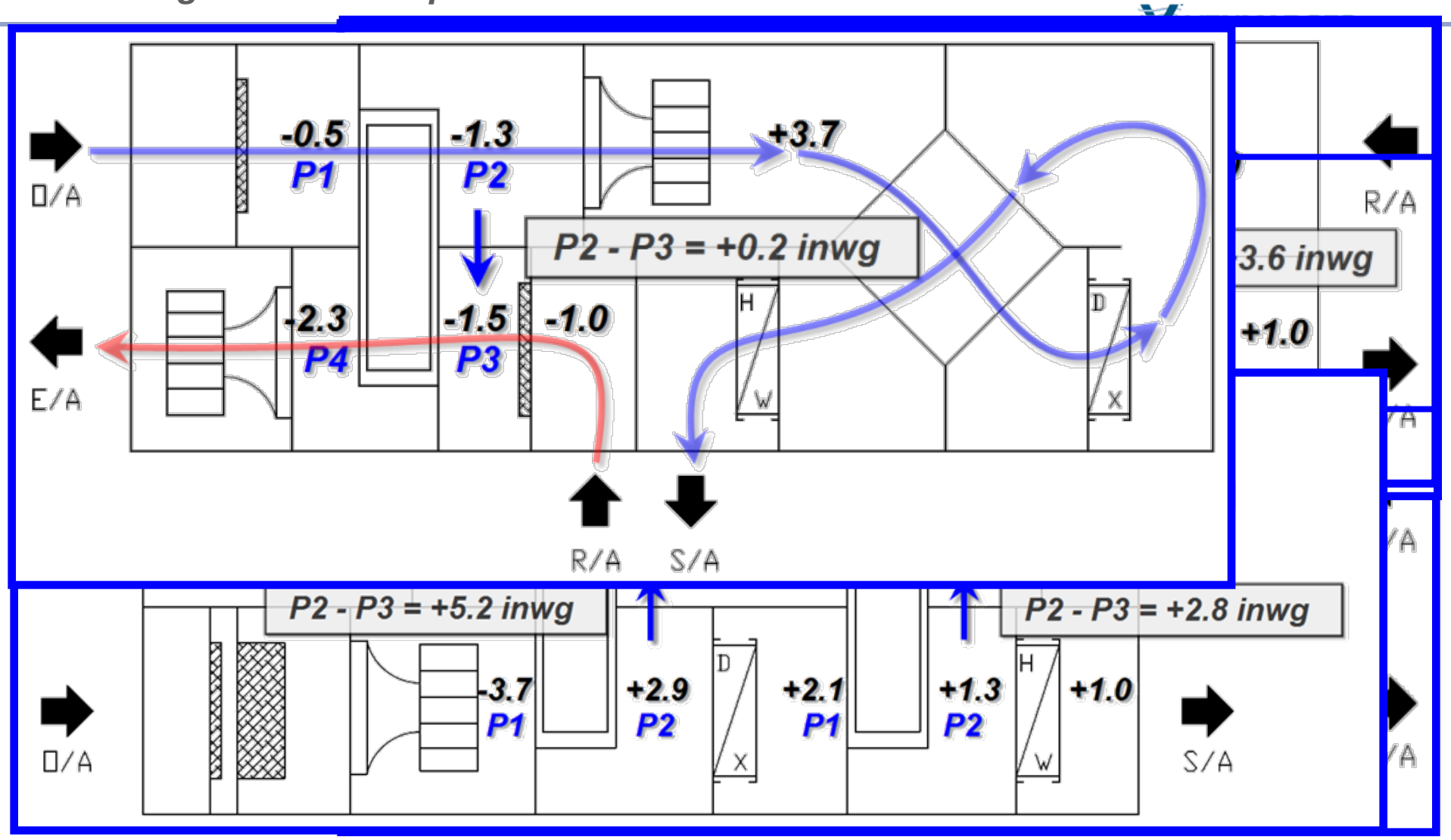
- Competitor Wheel Numbers
- Some Wheel Types Are Sensible to Pressure Differentials (OACF Can Result)
- Wheel / Seal Design Importance

Leakage Ratings	Pressure Differential	EATR(%)	OACF
Test 1:	-1.00	6.10	0.99
Test 2:	0.00	0.40	1.13
Test 3:	1.00	0.00	1.23

Consult the directory:
www.ahrinet.org

Pressure Differentials

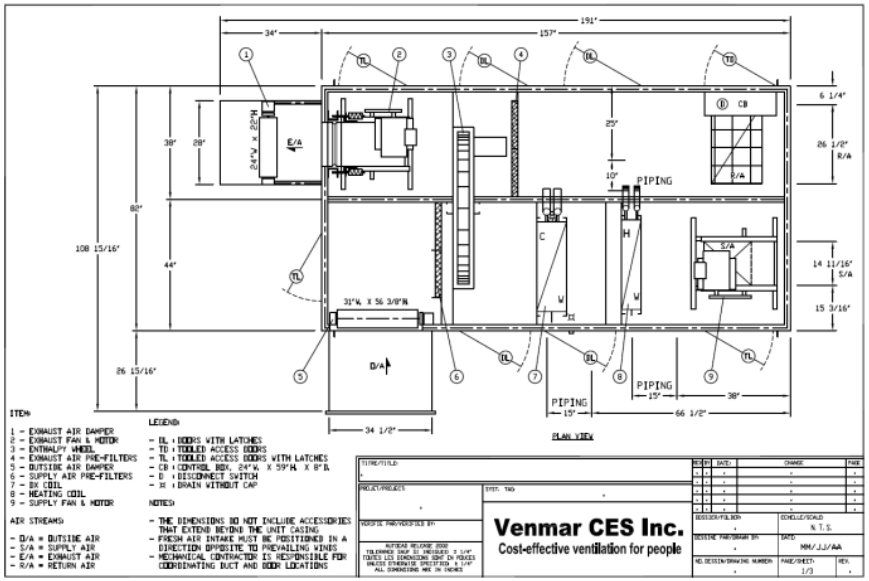
Configuration Examples



OACF Impacts On System Efficiency

19,000 CFM Building Example

- Application example:
  - 19,000 CFM
  - 4 x ERV5000e @ 4,500 CFM
  - 0.8 inwg ESP (S/A & R/A)
  - Standard filtration
  - C/W & H/W coils
  - Atlanta, GA weather conditions



OACF Impacts On System Efficiency

19,000 CFM Building Example

- OACF impact:
- 1) Design **BHP** at…

	S/A & E/A BHP	*TOTAL BHP*	*VARIATION*
• 1.00 OACF:			
• 1.03 OACF:			
• 1.11 OACF:			
• 1.25 OACF:			
• 1.50 OACF:			

OACF Impacts On System Efficiency

19,000 CFM Building Example

- OACF impact:
- 2) **Operation cost**: additional cost due to OACF at…

	ANNUAL COST	*20-YEAR COST**
• 1.00 OACF:		
• 1.03 OACF:		
• 1.11 OACF:		
• 1.25 OACF:		
• 1.50 OACF:		

Recap

Early Signs in Design to Dig Deeper

VENMAR CES

- High return / exhaust duct static pressure (because it can increase pressure differential)
- Standard Filtration
- Does high supply fan esp create high OACF? No, but configuration fan placement, BT does.
  - Therefore, with design of BT supply fan
    - Design (i.e. motor heat)
    - Odor control (locker, toilet, general class 2)
    - Footprint
    - Sound
- Pre-heat defrost

- SMACMA…most ductwork is specified with a not to exceed value (less than 1% up to 4%) why should an energy recovery device have more given the greater impact on energy consumption?

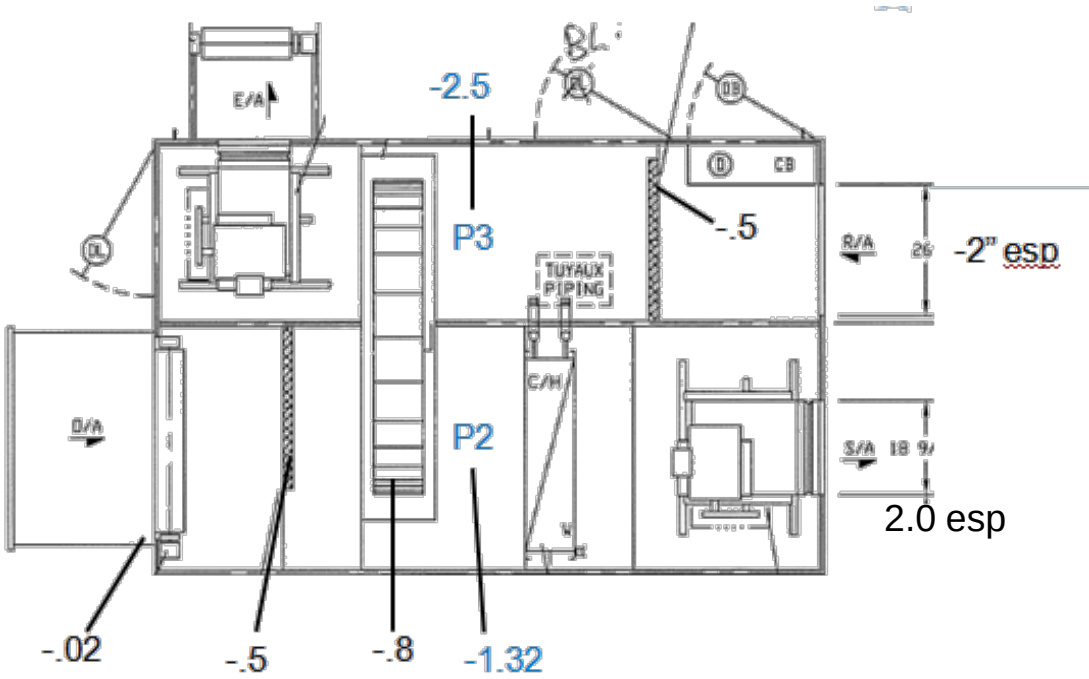
Case Study – Winston Salem ES

- AEDG K-12 Primary level school
- Required Ventilation Air 18,000 cfm
- 2 pipe system
- Standard Filtration, MERV 8

- SAF 9000 cfm @ 4.2 inwg tsp – 8.3 bhp
- Exh Fan 9000 cfm @ 3.5“ tsp – 6.7bhp

Qty (2) units centrally located
Fluted wheel, ERV

Summary: P2-P3 = 1.18



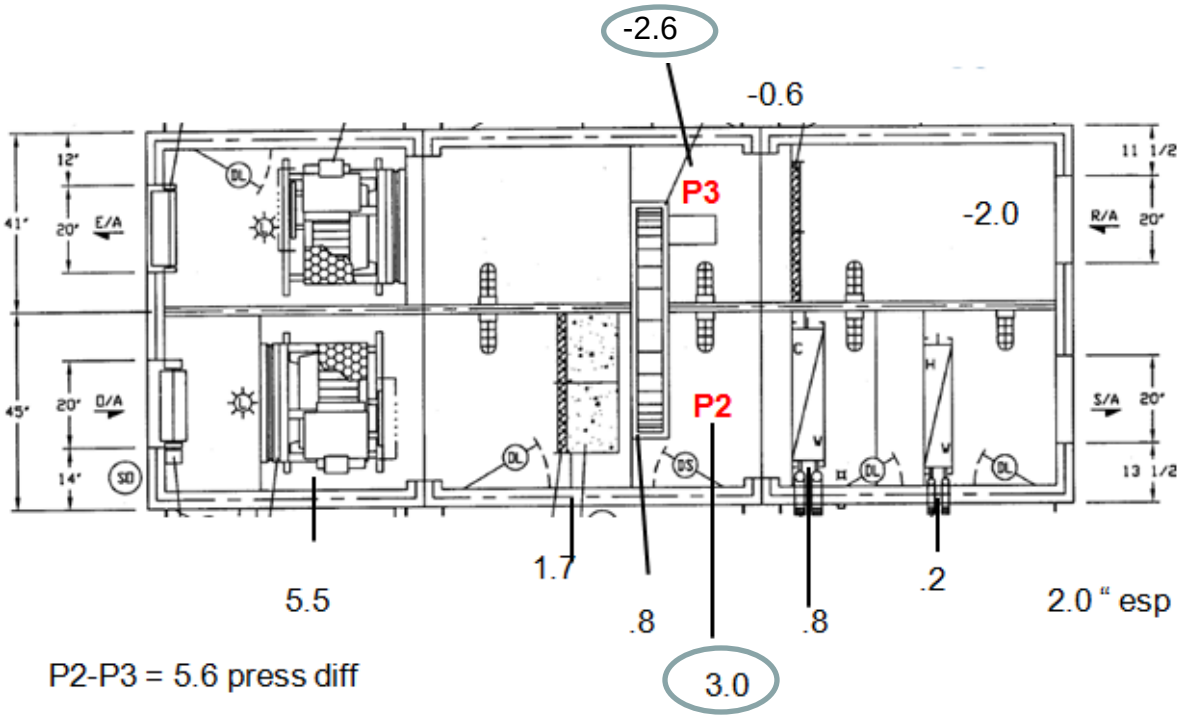
Case Study – Winston Salem Middle School

	CFM	OACF	CFM	Exhaust BHP	Exhaust kWh
Venmar CES	18000	1.01	18180	6.7/per	290
Brand X	18000	1.08	19440	7.1/per	2320

Estimated Annual Increase in Fan Operating Cost			
	Op Cost	LCC	LCC % of First Cost Equip
San Francisco, CA ($0.13 kWh)	$264	$6413	11%
NYC ($0.19/kWh)	$386	$9372	16%
Burlington, VT ($0.12/kWh)	$243	$5919	10%
Seattle, WA ($0.06/kWh)	$122	$2959	5%

Case Study – Turning Stone Casino

SAF 20,000 cfm @ 5.5 TSP = 28 BHP
Exh fan 19,000 cfm @ 3.9 TSP = 20 BHP



Case Study – Turning Stone Casino

	CFM	OACF	CFM	BHP per motor	kWh per motor
Venmar CES	20000	1.10	22000	20.0	9495
Brand X	20000	1.48	29600	24.4	45578

Estimated Annual Increase in Fan Operating Cost			
	Op Cost	LCC	LCC % of First Cost Equip
San Francisco, CA ($0.13 kWh)	$4,691	$113.9 K	91%
NYC ($0.19/kWh)	$6,856	$166.6 K	133%
Burlington, VT ($0.12/kWh)	$4,330	$105.2 K	84%
Seattle, WA ($0.06/kWh)	$2,165	$52.6 K	42%

Specification Verbiage

Manufacturer

Energy transfer ratings shall be ARI Certified to Standard 1060 and bear the ARI certification seal for ARI Air-to-Air Energy Recovery Ventilation Equipment Program based on ARI 1060. Ratings "in accordance with 1060" without certification shall be deemed unacceptable.

Non-ARI Certified Manufacturer

The manufacturer shall provide certified performance data in accordance with ASHRAE Standard 84 and ARI 1060. Independent performance test results shall be used to rate the product in accordance with the ARI Air-to-Air Energy Recovery Ventilation Equipment Program .

Equipment Schedules

- Specify maximum OACF 5% at 1in PD and 10% at 3 and 5 in PD
- Specify maximum EATR values of 5 or 10% at design differential pressures based on ASHRAE 62 - 5.17.2
- Specify AHRI Certified air-to-air energy recovery components in schedules AND specifications

Beyond this Presentation

Useful References

AHRI Certification:

http://www.ahridirectory.org

AHRI Publications:

http://www.ahrinet.org/standards.aspx

http://www.ahrinet.org/hvacr+industry+guidelines.aspx

ARI Guideline V: ARI Guideline V: Calculating the Efficiency of Energy Recovery Ventilation and Its Effect on Efficiency and Sizing of Building HVAC Systems

ARI Guideline W: Selecting, Sizing, & Specifying Packaged Air-To-Air Energy Recovery Ventilation Equipment (2005)

Questions?

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