Exhaust Ventilation Modeling in eQUST for MF NCP



Relevant 90.1 Baseline Rules

G3.1.2.4 Fan System Operation

Supply and return fans shall operate continuously whenever *spaces* are occupied and shall be cycled to meet heating and cooling loads during unoccupied hours.

G3.1.2.9 System Fan Power

System fan electrical power for supply, return, exhaust, and relief for *Systems* 1 and 2:

 $Pfan = CFMs \times 0.3$



Relevant 90.1 Rules

G3.1.2.5 Ventilation

Minimum *ventilation system outdoor air* intake flow shall be the same for the *proposed design* and *baseline building design*.

Exception to G3.1.2.5

••••••

3. Where the minimum *outdoor air* intake flow in the *proposed design* is provided in excess of the amount required by the *building* code or the *rating authority*, the *baseline building design* shall be modeled to reflect the greater of that required by either the *rating authority* or the *building* code and will be less than the *proposed design*.



Example 1: Continuous Exhaust + Trickle Vents

Proposed In-Unit HVAC:

- PTACs that cycle with load to provide heating and cooling; PTAC fan power is 0.2 W/CFM, 2-speed fan
- Continuous 100 CFM exhaust from kitchens and bathrooms via rooftop exhaust fan (EF) @ 0.4 W/CFM
- Make-up air through trickle vents

Proposed Corridor HVAC

- Roof-top unit (RTU) provides heating, cooling and ventilation to corridors
- 0.7 W/CFM RTU supply fan

Exhaust and make-up ventilation rates meet applicable codes (i.e. no over-ventilation penalty)

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Baseline In-Unit PTAC Fan Power and Control

Air-Side	HVAC Syster	n Parameters	P 14		_		
	Currently	Active System:	Apartmen	t PTAC		~	System -
Basi	cs Fans	Outdoor Air	Cooling	Heating Pre	conditioner	Meters Re	efrigeratic
F	an Power an Fan Power Pa	d Control F	low Parameter gle-duct syste	rs Night C	ycle Control	1	
		Design	Delta T	Static	Tot Eff	Mech Eff	
		kW/cfm	٩F	in WG	Frac	Frac	
	Supply:	0.000300	0.93		n/a	n/a	n/a
	Unused:	n/a	n/a	n/a	n/a	n/a	n/a
	Return:	n/a	n/a	n/a	n/a		n/a
	Fan Control a	nd Placement —				_	
		Fan Sche	edules	Fan (Control	Fan Plac	cement
	Cooling:	- undefined -	•	Constant V	olume 👻	n/a	•
					1		



Baseline In-Unit PTAC Sizing

ide HVAC System Parameters	
	Air-Side HVAC System Parameters
Currently Active System: Apartment PTAC	
Basing Dans Outdoor Air Cooling Upsting Dresondition	Currently Active System: Apartment PTAC
Paris Outdoor Air Cooling Heating Precondition	Racian Earn Outdoor Air Cooling Heating Process
System Name: Apartment PTAC	
System Type Pkgd Terminal AC	Coil Capacity / Control Unitary Power Condenser Ca
	Cooling Capacity
General Parameters	Cool Source: n/a
Return Air Path: n/a	
Control Zone: n/a	Total Configs Constitut
System Reports: Yes	Btu/h
Dual Duct Type: n/a	Sensible Cooling Capacity: Btu/h
WL/GS Ht Pump: n/a	Cool Sizing Ratio: 1.15 ratio
System Sizing	
Sizing Ratio: 1,00 ratio	
	Air-Side HVAC System Parameters
	Currently Active System: Apartment PTAC
	Racion Fans Outdoor Air Cooling Heating D
Project Building	Basics Paris Outdoor Air Cooling Heading P
	Coil Cap / Control Unitary Power Preht / Basebrd S
Component rice	
EXFlow_Apts	Heating Canacity
Site Data	- Treating capacity
Project Data	Heat Source: Hot Water Loop
Seeling 80	Zone Heat Source: n/a
Standard US Holidays	Heating Capacity: Btu/h
Fixed Shades	Heat Sizing Ratio: 1.25 ratio
Entire Vear	
Churchean	

Preconditioner

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Baseline In-Unit PTAC Ventilation Rate

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Air-Side HVAC System Spreadsheet Summary

Display Mode: Outside Air & Exhaust

	Zone Name	OA Air (cfr	Flow n)	Ch	OA anges	OA Flow/Area (cfm/ft2)	Tracking Control	Ex	haust Flow (cfm)	Exha (aust kW/Flow (kW/cfm)	Exhaust Static (in.	Exhaus t Eff	Control	Power fFlow		Source	
1	Lobby Zn				1	0.06	No Airflow Tracking 👻				n/a	n/a	n/a	Cycling 👻	n/a	n/a		
2	EL1 Core Zn (G.C5)		1			0.06	No Airflow Tracking 👻				n/a	n/a	n/a	Cycling 👻	n/a	n/a		1
3	EL1 Core Zn (M.C14)		1			0.06	No Airflow Tracking 👻		2		3 n/a	n/a	n/a	Cycling -	n/a	n/a	4	
4	EL1 Core Zn (T.C23)	-				0.06	No Airflow Tracking 👻				n/a	n/a	n/a	Cycling 👻	n/a	n/a		
5	EL1 WSW Perim Zn (G		0.01		n/a		No Airflow Tracking 👻		100.00		0.000000	n/a	n/a	Constant Volum 👻	n/a	Balanc	ed Infiltra	tio 👻
6	EL1 West Perim Zn (G		0.01		n/a		No Airflow Tracking 👻		100.00		0.000000	n/a	n/a	Constant Volum 👻	n/a	Balanc	ed Infiltra	tio 👻
7	EL1 West Perim Zn (G		0.01		n/a		No Airflow Tracking 👻		100.00		0.000000	n/a	n/a	Constant Volum 👻	n/a	Balanc	ed Infiltra	tio 👻
8	EL1 WNW Perim Zn (G		0.01		n/a		No Airflow Tracking 👻		100.00		0.000000	n/a	n/a	Constant Volum 👻	n/a	Balanc	ed Infiltra	tio 👻
9	EL1 ESE Perim Zn (M.B		0.01		n/a		No Airflow Tracking 👻		100.00		0.000000	n/a	n/a	Constant Volum 👻	n/a	Balanc	ed Infiltra	tio 👻
10	EL1 East Perim Zn (M.		0.01		n/a		No Airflow Tracking 👻		100.00		0.000000	n/a	n/a	Constant Volum 👻	n/a	Balanc	ed Infiltra	tio 👻
11	EL1 East Perim Zn (M.		0.01		n/a		No Airflow Tracking 👻		100.00		0.000000	n/a	n/a	Constant Volum 👻	n/a	Balanc	ed Infiltra	tio 👻
12	EL1 ENE Perim Zn (M.B		0.01		n/a		No Airflow Tracking 👻		100.00		0.000000	n/a	n/a	Constant Volum 👻	n/a	Balanc	ed Infiltra	tio 👻
13	EL1 WSW Perim Zn (M		0.01		n/a		No Airflow Tracking 👻		100.00		0.000000	n/a	n/a	Constant Volum 👻	n/a	Balanc	ed Infiltra	tio 👻
14	EL1 West Perim Zn (M		0.01		n/a		No Airflow Tracking 👻		100.00		0.000000	n/a	n/a	Constant Volum 👻	n/a	Balanc	ed Infiltra	tio 👻
15	EL1 West Perim Zn (M		0.01		n/a		No Airflow Tracking 👻		100.00		0.000000	n/a	n/a	Constant Volum 👻	n/a	Balanc	ed Infiltra	tio 👻
16	EL1 WNW Perim Zn (M		0.01		n/a		No Airflow Tracking 👻		100.00		0.000000	n/a	n/a	Constant Volum 👻	n/a	Balanc	ed Infiltra	tio 👻
17	EL1 ESE Perim Zn (T.E		0.01		n/a		No Airflow Tracking 👻		100.00		0.000000	n/a	n/a	Constant Volum 👻	n/a	Balanc	ed Infiltra	tio 👻
18	EL1 East Perim Zn (T.I		0.01		n/a		No Airflow Tracking 👻		100.00		0.000000	n/a	n/a	Constant Volum 👻	n/a	Balanc	ed Infiltra	tio 👻
10	ELI Cash Daving 75 (T)				- 1-		No Airflow Trooling			_ ا			- 1-	Constant Value	- 1-			

- 1. Set OA Air Flow (cfm) to 0.01 to force PTAC run continuously (eQUEST work-around)
- 2. Enter exhaust as specified
- 3. Enter 0 W/CFM exhaust, since we allocated the full baseline fan power to PTAC supply fan (an acceptable simplification with negligible impact on results)
- 4. Set "Source" as shown, to indicate that make-up air is provided via infiltration

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Proposed Design: PTAC Fan Power and Control

Existing Parametric Runs	Name:	Parameter #1				
Parameter #1	Type:	BDL Command	•			
□ ■ Parameter #1 □ 3 - Ex 1: Exhaust fan power W □ ■ Parameter #1 □ 4 - Ex 1: BTU fan W	Component Type:	HVAC System	•	Sort C	Component Type	
□ ■ Parameter #1	References:	□Corridor PTAC ☑Apartment PTAC □Unit Heater				
	Select All					
	Clear All					
	Data Modifications:					
	Category		Keyword		Value	Units
	Basic Specification	s ·	SUPPLY-KW/FLOW	•	0.0002	kW/cfi
	Fans - Fan Control		FAN-CONTROL	•	TWO-SPEED 🔻	
•	Set PTAC fan po	wer and cont	rol as specified			



Proposed Design: In-Unit Exhaust Fans

Parametric Run Definitions						×
Existing Parametric Runs	Name:	Parameter #1				
2 - Ex 1: Exhaust fan power W	Туре:	BDL Command	~]		
B Parameter #1	Component Type:	Thermal Zone	•] 🔽 Sort (Component Type	
	References: Select All Clear All Data Modifications:	♥ EL1 WSW Perim Zn (C ♥ EL1 West Perim Zn (C ♥ EL1 West Perim Zn (C ♥ EL1 WWW Perim Zn (C ♥ EL1 ESE Perim Zn (M. ♥ EL1 East Perim Zn (M. ♥ EL1 EASt Perim Zn (M. ♥ EL1 WSY Perim Zn (N. ♥ EL1 West Perim Zn (N. ♥ EL1 West Perim Zn (N.	S.WSW6) S.WSW6) S.WSW S.WSW9 ESE10) ESE10 ESE10) ESE10			
1	Category		Keyword		Value	Units
	Outside Air & Exha	ust 💌	EXHAUST-KW/FLOW	-	0.0004	kW/cfm
	Outside Air & Exha	ust 🔻	OUTSIDE-AIR-FLOW	•	0	cfm

- 1. Set exhaust fan power as specified
- 2. Set PTAC supply air flow to 0, to allow PTAC cycle with load



Proposed Design: Corridor RTU

Parametric Run Definitions	here in the second	_	The Internet			X
Existing Parametric Runs 1 - Ex 1: PTAC W and Control 9 Parameter #1 3 - Ex 1: Exhaust fan CFM and W 9 Parameter #1 1 - Ex 1: RTU fan W - E Parameter #1	Name: Type: Component Type:	Parameter #1 BDL Command HVAC System	<u>-</u>]] 🔽 Sort (Component Type	
	Select All	Apartment PTAC				
	Data Modifications:					
	Category		Keyword		Value	Units
	Basic Specification	s 🔻	SUPPLY-KW/FLOW	•	0.0007	kW/cfm

Enter RTU fan power as specified

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Example 2: Continuous Exhaust + Mechanical Supply Ventilation

Same as Example 1, except corridor RTU is ducted to supply 60 CFM make-up air to each apartment



Baseline HVAC

Same as Example 1, except...

Air-Side HVAC System Spreadsheet Summary Display Mode: Outside Air & Exhaust

	Zone Name	0/	A Air Flow (cfm)	OA Changes	OA Flow/Area
1	Lobby Zn				0.06
2	EL1 Core Zn (G.C5)				0.06
3	EL1 Core Zn (M.C14)				0.06
4	EL1 Core Zn (T.C23)				0.06
5	EL1 WSW Perim Zn (G.WSW6		60.00	n/a	
6	EL1 West Perim Zn (G.W7)		60.00	n/a	
7	EL1 West Perim Zn (G.W8)		60.00	n/a	
8	EL1 WNW Perim Zn (G.WNW9		60.00	n/a	
9	EL1 ESE Perim Zn (M.ESE10)		60.00	n/a	
10	EL1 East Perim Zn (M.E11)		60.00	n/a	
11	EL1 East Perim Zn (M.E12)		60.00	n/a	
12	EL1 ENE Perim Zn (M.ENE13)		60.00	n/a	
13	EL1 WSW Perim Zn (M.WSW		60.00	n/a	
14	EL1 West Perim Zn (M.W16)		60.00	n/a	
15	EL1 West Perim Zn (M.W17)		60.00	n/a	
16	EL1 WNW Perim Zn (M.WNW		60.00	n/a	
17	EL1 ECE Dorim Zn (T ECE10)		60.00	n/5	

Air-Side HVAC System Parameters
Currently Active System: Corridor PTAC
Basics Fans Outdoor Air Cooling Heating Pre
System Name: Corridor PTAC
System Type: Pkgd Single Zone

Model RTU as PSZ system type instead of PTAC, to simplify modeling proposed design



In-unit supply CFM as specified

Proposed In-Unit Systems

1 - Ex 1: PTAC W and Control	Name:	Parameter #1							
Parameter #1	Туре:	BDL Command			•				
■ Parameter #1 3 - Ex 2: OA From ■ Parameter #1	Component Type:	HVAC System			•	Sort C	component Type	2	
— ■ Parameter #2 ■ Parameter #3 ⊉ 4 - Ex 2: RTU Fan Watt — ■ Parameter #1	References:	Corridor PTAC ØApartment PTAC Unit Heater							
	Select All Clear All								
	Data Modifications:	:							
	Category		Keyword				Value		Units
	Basic Specificatio	ns	 SUPPLY- 	W/FLOW		-	0.0002		kW/cfm
	Fans - Fan Contro	ol	▼ FAN-COM	TROL		-	TWO-SPEED	•	
1 - Ex 1: PTAC W and Control Parameter #1									
2 - Ex 1: Exhaust fan power W	Type:	BDI	L Command				•		
■ 2 - Ex 1: Exhaust fan power W ■ Parameter #1 ■ 3 - Ex 2: OA From ■ Parameter #1 ■ Parameter #2	Type: Compo	BDI	L Command ermal Zone				•	Sort	: Componen
 □ Parameter #1 □ Parameter #1 □ Parameter #2 □ Parameter #1 	Type: Compo Refere	BD onent Type: The ences: L E E E E E E E E E E E E E E E E E E E	L Command ermal Zone bby Zn L1 Core Zn L1 Core Zn L1 Core Zn L1 WSW Per L1 West Per L1 West Per	G.C5) M.C14) T.C23) im Zn (G. m Zn (G.	WSW6) W7) W8)		•	▼ Sort	: Componen
ⓐ 2 - Ex 1: Exhaust fan power W	Type: Compo Refere	BD) ences:	L Command ermal Zone L1 Core Zn L1 Core Zn L1 WSW Per L1 WSV Per L1 WSV Per L1 WSV Per L1 WSV Per L1 WSV Per L1 East Peri L1 East Peri	G.C5) M.C14) T.C23) im Zn (G. m Zn (G. im Zn (G. n Zn (M. n Zn (M.	WSW6) W7) W8) WNW9) SE10) E11)		•	Sort	: Componen
IIII 2 - Ex 1: Exhaust fan power W	Type: Compo Refere	Select All	L Command ermal Zone L1 Core Zn L1 Core Zn L1 Core Zn L1 WSW Per L1 WSK Per L1 WSK Per L1 Est Perir L1 Est Peri L1 Est Peri L1 Est Peri	G.C5) M.C14) T.C23) im Zn (G m Zn (G. m Zn (M. n Zn (M. n Zn (M. n Zn (M.	WSW6) W7) W8) WNW9) SE10) E11) E12)		•	▼ Sort	: Componer
<pre>@ 2 - Ex 1: Exhaust fan power W</pre>	Type: Compo Refere	Select All	L Command ermal Zone boby Zn LL Core Zn LL Core Zn LL Core Zn LL West Per LL West Per LL WEST Perin LL ESE Perin LL East Peri LL East Peri	G.C5) M.C14) T.C23) im Zn (G m Zn (G m Zn (G n Zn (M. n Zn (M. n Zn (M.	WSW6) W7) W8) SE10) E11) E12) Keyword		v	Sort	Componer
 Q = 2 = X : I: Exhaust fan power W □ Parameter #1 □ Parameter #1 □ Parameter #2 □ Parameter #2 □ Parameter #2 □ Parameter #2 □ Parameter #1 	Type: Compo Refere Data M Cate	BDI Select All Select	L Command ermal Zone bbby Zn L1 Core Zn L1 Core Zn L1 Core Zn L1 West Per L1 West Per L1 West Per L1 West Per L1 ESE Peri L1 ESE Peri L1 ESE Peri	G.C5) M.C14) T.C23) im Zn (G. m Zn (G. m Zn (M.E n Zn (M. n Zn (M.	WSW6) W7) W8) WNW9) SSE10) E11) E12) Kevword	W/ELOW	• •	Sort	Value

Enter in-unit exhaust fans, PTAC fans, and corridor RTU fans the same as in Example #1

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RTU Make-up to Apartments

Parametric Run Definitions					
Existing Parametric Runs	Name:	Parameter #1			
Parameter #1 2 - Ex 1: Exhaust fan power W	Туре:	BDL Command	•		
3 - Ex 2: OA From	Component Type:	HVAC System	•	Sort Component Type	
 Parameter #1 Parameter #2 Parameter #3 4 - Ex 2: RTU Fan Watt Parameter #1 	References:	□Corridor PTAC ☑Apartment PTAC □Unit Heater			
	Select All Clear All Data Modifications:				
	Category		Keyword	Value	Units
	Outdoor Air - Vent	. & Economizer 📃	OA-FROM-SYSTEM	Corridor PTAC	•

Reference corridor RTU as the unit that supplies mechanical ventilation to apartments



RTU Make-up to Apartments

Existing Parametric Runs	Name:	Parameter #2		_	
 1 - Ex 1: PTAC W and Control Parameter #1 2 - Ex 1: Exhaust fan power W 	Туре:	BDL Command		•	
Parameter #1 3 - Ex 2: OA From	Component Type:	Thermal Zone		▼ ▼ Sort	Component Type
- E Parameter #1 - E Parameter #2 - E Parameter #3 - E Parameter #3 - E Parameter #1	References: Select All Clear All Data Modifications:	Lobby Zn EL1 Core Zn (G.C5) VEL1 Core Zn (M.C14) VEL1 Core Zn (T.C23) EL1 WCST Porm Zn (EL1 WCST Perim Zn (C EL1 WSST Perim Zn (C EL1 ESE Perim Zn (M EL1 East Perim Zn (M EL1 East Perim Zn (M	WSW6) .W7) .W8) .W89 .W89 .E11 .E12)		
	Category		Keyword		Value
	Outside Air & Exha	ust 💌	OUTSIDE-AIR-FLOW		480.0000

RTU OA CFM must be increased to include in-unit ventilation

- Floors 2-10 each have 8 apartments; in order to supply 60 CFM OA ducted to each apartment, the corridor ventilation on these floors must be increased by 60 x 8 = 480 CFM
- 2. First floor has 4 apartments, so 4*60=240 CFM must be added to the corresponding Thermal Zone (Parameter #3 above, not shown)

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Impact on Energy Consumption



- Similar changes in energy use between the baseline and proposed for both examples
- Ventilation (fan) energy is the area of greatest impact
- Savings strongly depend on efficient fan system design
- Example 2 has slightly higher overall energy use for both the baseline and proposed design

Note: The examples demonstrate methods for modeling different ventilation designs. Additional inputs, such as specified supply flow rates, heating and cooling capacities for RTU and PTACs will be required to meet 90.1 requirements.

Recommended Reading

Measure Guideline: Ventilation Guidance for Residential High Performance New Construction—Multifamily

Building America Report - 1507 September 2015 Joseph Lstiburek

Abstract:

The measure guideline provides ventilation guidance for residential high performance mulitfamily construction that incorporates the requirements of the ASHRAE 62.2 2013 standard. The measure guideline focus is on the decision criteria for weighing cost and performance of various ventilation systems.

The measure guideline is intended for contractors, builders, developers, designers and building code officials. The guide may also be helpful to building owners wishing to learn more about ventilation strategies available for their buildings.

The measure guideline includes specific design and installation instructions for the most cost effective and performance effective solutions for ventilation in multifamily units that satisfies the requirements of ASHRAE 62.2 2013.



Questions?

