

Exhaust Ventilation Modeling in eQUEST 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:

$$P_{fan} = CFMs \times 0.3$$

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)

Baseline In-Unit PTAC Fan Power and Control

Air-Side HVAC System Parameters

Currently Active System: **Apartment PTAC** System

Basics | Fans | Outdoor Air | Cooling | Heating | Preconditioner | Meters | Refrigeration

Fan Power and Control | Flow Parameters | Night Cycle Control

Fan Power Parameters for single-duct systems

	Design kW/cfm	Delta T °F	Static in WG	Tot Eff Frac	Mech Eff 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 and Placement

	Fan Schedules	Fan Control	Fan Placement
Cooling:	- undefined -	Constant Volume	n/a

Baseline In-Unit PTAC Sizing

Air-Side HVAC System Parameters

Currently Active System: Apartment PTAC

Basics | Fans | Outdoor Air | Cooling | Heating | Preconditioner

System Name: Apartment PTAC

System Type: Pkgd Terminal AC

General Parameters

Return Air Path: n/a

Control Zone: n/a

System Reports: Yes

Dual Duct Type: n/a

WL/GS Ht Pump: n/a

System Sizing

Sizing Ratio: 1.00 ratio

Sizing Option: n/a

Air-Side HVAC System Parameters

Currently Active System: Apartment PTAC

Basics | Fans | Outdoor Air | Cooling | Heating | Preconditioner

Coil Capacity / Control | Unitary Power | Condenser | Capacity C

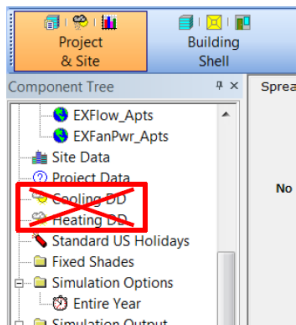
Cooling Capacity

Cool Source: n/a

Total Cooling Capacity: Btu/h

Sensible Cooling Capacity: Btu/h

Cool Sizing Ratio: 1.15 ratio



Air-Side HVAC System Parameters

Currently Active System: Apartment PTAC

Basics | Fans | Outdoor Air | Cooling | Heating | Preconditioner

Coil Cap / Control | Unitary Power | Preht / Basebrd | Supp Heat/Defrost

Heating Capacity

Heat Source: Hot Water Loop

Zone Heat Source: n/a

Heating Capacity: Btu/h

Heat Sizing Ratio: 1.25 ratio

Baseline In-Unit PTAC Ventilation Rate

Air-Side HVAC System | Spreadsheet | Summary

Display Mode: Outside Air & Exhaust

	Zone Name	OA Air Flow (cfm)	OA Changes	OA Flow/Area (cfm/ft2)	Tracking Control	Exhaust Flow (cfm)	Exhaust kW/Flow (kW/cfm)	Exhaust Static (in. w.g.)	Exhaust Eff (ft/min)	Control	Power fFlow	Source
1	Lobby Zn			0.06	No Airflow Tracking		n/a	n/a	n/a	Cycling	n/a	n/a
2	EL1 Core Zn (G.C5)			0.06	No Airflow Tracking		n/a	n/a	n/a	Cycling	n/a	n/a
3	EL1 Core Zn (M.C14)			0.06	No Airflow Tracking		n/a	n/a	n/a	Cycling	n/a	n/a
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	Balanced Infiltratio
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	Balanced Infiltratio
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	Balanced Infiltratio
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	Balanced Infiltratio
9	EL1 ESE Perim Zn (M)	0.01	n/a		No Airflow Tracking	100.00	0.000000	n/a	n/a	Constant Volum	n/a	Balanced Infiltratio
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	Balanced Infiltratio
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	Balanced Infiltratio
12	EL1 ENE Perim Zn (M)	0.01	n/a		No Airflow Tracking	100.00	0.000000	n/a	n/a	Constant Volum	n/a	Balanced Infiltratio
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	Balanced Infiltratio
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	Balanced Infiltratio
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	Balanced Infiltratio
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	Balanced Infiltratio
17	EL1 ESE Perim Zn (T)	0.01	n/a		No Airflow Tracking	100.00	0.000000	n/a	n/a	Constant Volum	n/a	Balanced Infiltratio
18	EL1 East Perim Zn (T)	0.01	n/a		No Airflow Tracking	100.00	0.000000	n/a	n/a	Constant Volum	n/a	Balanced Infiltratio
19	EL1 East Perim Zn (G)	0.01	n/a		No Airflow Tracking	100.00	0.000000	n/a	n/a	Constant Volum	n/a	Balanced Infiltratio

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

Proposed Design: PTAC Fan Power and Control

Parametric Run Definitions

Existing Parametric Runs

- 1 - Ex 1: PTAC W and Control
 - Parameter #1
- 2 - Ex 1: PTAC cycles
 - Parameter #1
- 3 - Ex 1: Exhaust fan power W
 - Parameter #1
- 4 - Ex 1: RTU fan W
 - Parameter #1

Name:

Type:

Component Type: Sort Component Type

References:

- Corridor PTAC
- Apartment PTAC
- Unit Heater

Select All

Clear All

Data Modifications:

Category	Keyword	Value	Units
Basic Specifications	SUPPLY-KW/FLOW	0.0002	kW/cfm
Fans - Fan Control	FAN-CONTROL	TWO-SPEED	

- Set PTAC fan power and control as specified

Proposed Design: In-Unit Exhaust Fans

Parametric Run Definitions

Existing Parametric Runs

- 1 - Ex 1: PTAC W and Control
 - Parameter #1
- 2 - Ex 1: Exhaust fan power W
 - Parameter #1
- 3 - Ex 1: RTU fan W
 - Parameter #1

Name:

Type:

Component Type: Sort Component Type

References:

- EL1 WSW Perim Zn (G.WSW6)
- EL1 West Perim Zn (G.W7)
- EL1 West Perim Zn (G.W8)
- EL1 WNW Perim Zn (G.WNW9)
- EL1 ESE Perim Zn (M.ESE10)
- EL1 East Perim Zn (M.E11)
- EL1 East Perim Zn (M.E12)
- EL1 ENE Perim Zn (M.ENE13)
- EL1 WSW Perim Zn (M.WSW15)
- EL1 West Perim Zn (M.W16)
- EL1 West Perim Zn (M.W17)

Select All

Clear All

Data Modifications:

Category	Keyword	Value	Units
Outside Air & Exhaust	EXHAUST-KW/FLOW	0.0004	kW/cfm
Outside Air & Exhaust	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

Existing Parametric Runs

- 1 - Ex 1: PTAC W and Control
 - Parameter #1
- 3 - Ex 1: Exhaust fan CFM and W
 - Parameter #1
- 4 - Ex 1: RTU fan W
 - Parameter #1

Name:

Type:

Component Type: Sort Component Type

References:

- Corridor PTAC
- Apartment PTAC
- Unit Heater

Data Modifications:

Category	Keyword	Value	Units
Basic Specifications	SUPPLY-KW/FLOW	0.0007	kw/cfm

Enter RTU fan power as specified

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	OA Air Flow (cfm)	OA Changes	OA Flow/Area (cfm/ft ²)
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.WSW4)	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.WSW14)	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.WNW18)	60.00	n/a	
17	EL1 ESE Perim Zn (T.ESE19)	60.00	n/a	

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

Parametric Run Definitions

Existing Parametric Runs

- 1 - Ex 1: PTAC W and Control
 - Parameter #1
- 2 - Ex 1: Exhaust fan power W
 - Parameter #1
- 3 - Ex 2: OA From
 - Parameter #1
 - Parameter #2
 - Parameter #3
- 4 - Ex 2: RTU Fan Watt
 - Parameter #1

Name:

Type:

Component Type: Sort Component Type

References:

- Corridor PTAC
- Apartment PTAC
- Unit Heater

Select All

Clear All

Data Modifications:

Category	Keyword	Value	Units
Basic Specifications	SUPPLY-KW/FLOW	0.0002	kw/cfm
Fans - Fan Control	FAN-CONTROL	TWO-SPEED	

Parametric Run Definitions

Parametric Run Definitions

Existing Parametric Runs

- 1 - Ex 1: PTAC W and Control
 - Parameter #1
- 2 - Ex 1: Exhaust fan power W
 - Parameter #1
- 3 - Ex 2: OA From
 - Parameter #1
 - Parameter #2
 - Parameter #3
- 4 - Ex 2: RTU Fan Watt
 - Parameter #1

Name:

Type:

Component Type: Sort Component

References:

- Lobby Zn
- EL1 Core Zn (G.C5)
- EL1 Core Zn (M.C14)
- EL1 Core Zn (T.C23)
- EL1 WSW Perim Zn (G.WSW6)
- EL1 West Perim Zn (G.W7)
- EL1 West Perim Zn (G.W8)
- EL1 WNW Perim Zn (G.WNW9)
- EL1 ESE Perim Zn (M.ESE10)
- EL1 East Perim Zn (M.E11)
- EL1 East Perim Zn (M.E12)

Select All

Clear All

Data Modifications:

Category	Keyword	Value
Outside Air & Exhaust	EXHAUST-KW/FLOW	0.0004
Outside Air & Exhaust	OUTSIDE-AIR-FLOW	0.0000

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

RTU Make-up to Apartments

Parametric Run Definitions

Existing Parametric Runs

- 1 - Ex 1: PTAC W and Control
 - Parameter #1
- 2 - Ex 1: Exhaust fan power W
 - Parameter #1
- 3 - Ex 2: OA From
 - Parameter #1
 - Parameter #2
 - Parameter #3
- 4 - Ex 2: RTU Fan Watt
 - Parameter #1

Name:

Type:

Component Type: Sort Component Type

References:

Corridor PTAC
 Apartment PTAC
 Unit Heater

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

Parametric Run Definitions

Existing Parametric Runs

- 1 - Ex 1: PTAC W and Control
 - Parameter #1
- 2 - Ex 1: Exhaust fan power W
 - Parameter #1
- 3 - Ex 2: OA From
 - Parameter #1
 - Parameter #2**
 - Parameter #3
- 4 - Ex 2: RTU Fan Watt
 - Parameter #1

Name:

Type:

Component Type: Sort Component Type

References:

- Lobby Zn
- EL1 Core Zn (G.C5)
- EL1 Core Zn (M.C14)
- EL1 Core Zn (T.C23)
- EL1 WSW Perim Zn (G.WSW6)
- EL1 West Perim Zn (G.W7)
- EL1 West Perim Zn (G.W8)
- EL1 WNW Perim Zn (G.WNW9)
- EL1 ESE Perim Zn (M.ESE10)
- EL1 East Perim Zn (M.E11)
- EL1 East Perim Zn (M.E12)

Select All

Clear All

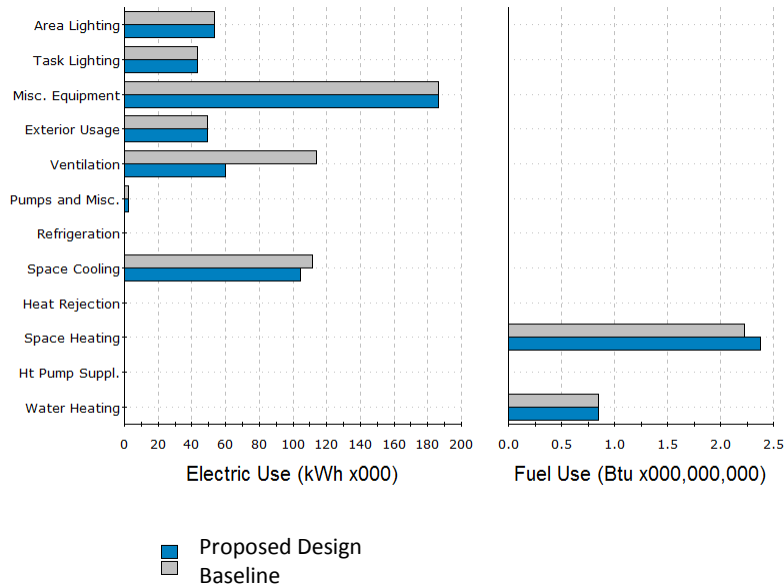
Data Modifications:

Category	Keyword	Value
Outside Air & Exhaust	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 $60 \times 8 = 480$ CFM
- First floor has 4 apartments, so $4 \times 60 = 240$ CFM must be added to the corresponding Thermal Zone (Parameter #3 above, not shown)

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 multifamily 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?