Mechanical Systems Technical Assignment I

ASHRAE Standard 62.1 ventilation compliance evaluation

Blake Herrschaft
Mechanical Option
The Waverly on Lake Eola
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Executive Summary:

All building HVAC systems in the United States must comply with ASHRAE standards. This report examines the compliance of The Waverly on Lake Eola with ASHRAE standard 62.1 by a comparison with ASHRAE's ventilation rate calculation procedure. ASHRAE standard 62.1 is used to assure that systems are designed with proper ventilation levels to avoid health problems, and maximize zone comfort. The Waverly on Lake Eola is a 23 story luxury condominium facility. There are five stories of parking and other amenities for residents of the building. The 3rd through 5th floor include some apartments in addition to parking. The 22nd floor is a 3,000 square foot luxury penthouse. The 23rd floor is reserved for building systems.

The Waverly on Lake Eola's mechanical system uses a unique system to supply air. All 230 apartments are supplied by a separate heat pump that acts as an air handling unit for that zone. The 22nd floor penthouse utilizes two heat pumps. Three rooftop heat pumps supply shared spaces throughout the building. Four supply fans located on the roof are used for stairwell pressurization. All supply air utilizes 100% outdoor air to maximize comfort to building residents. Buildings utilizing 100% outdoor air typically have no problem complying with ASHRAE standard 62.1, so long as the proper amount of air is supplied to each space.

The Waverly is split into a 23 story tower section, and a "wave" section of 19 floors. Since all apartments are designed to similar specifications based on their occupancy, calculations were focused to a specific part of the building. All zones with heat pumps attached to a specific relief hood were studied. The Southwestern most section of the tower was chosen for evaluation. This relief hood is connected to heat pumps supplying apartments from the 3rd to the 22nd floors. This required studying the supply air, occupancy, space use, and floor area of each space supplied by this air handling unit.

After running calculations based on ASHRAE standard 62.1, it is apparent that these spaces not only meet outdoor air requirements, but far exceed the necessary specifications. This provides for a healthy and comfortable environment for residents of the building. The use of 100% outdoor air provides consistently high levels of outdoor air entering each space. The reason all buildings are not designed to 100% outdoor air specifications is to decrease energy use. The design of The Waverly on Lake Eola focuses more on clean air than energy savings, providing a comfortable environment for residents.

Calculations and Results:

Assumptions:

A number of assumptions were made before following through with the calculations provided by ASHRAE standard 62.1. It is assumed that outdoor air is of acceptable quality for ventilation. It is also assumed that the systems run on their prescribed 100% outdoor air supply. Since all apartments are designed to roughly the same specifications, only a sample of the apartments was tested for effective design. Following one relief hood down from the roof to the 3rd floor created a logical path or air handlers to study.

Variables:

- A_z = Zone Floor Area in square feet
- P_z = Zone Population: largest number of people typically assumed in zone This is calculated based on Table E-2[a] based on number of bedrooms. 2 people for first bedroom and one for each additional bedroom in the unit.
- R_p = Outdoor airflow required per person based on Table E-2[a]
- R_a = Outdoor airflow rate per unit area from Table E-2[a]
- V_{bz} = Breathing Zone Outdoor Airflow: outdoor airflow required in zone of occupied space based on calculations from standard 62.1
- V_{oz} = Zone Outdoor Airflow: outdoor airflow required based on zone air distribution effectiveness (E_z)
- V_{ot} = Outdoor air intake flow
- E_z = Zone air distribution effectiveness based on Table 6-2
- Z_p = Primary Outdoor Air Fraction

Calculations and Results (cont.) :

Calculations:

- Z_p = 1 for 100% outdoor air systems
- E_z = 1 for apartment spaces
- R_a = (0.35 air changes per hour)/(60 minutes) = 0.06cfm/ft^2
  (value matches Table 6-1)
- R_p = 15 per person from Table E-2[a]
- $V_{bz} = R_p (P_z) + R_a (A_z)$
  From Table E-2[a]: kitchens require a V_{bz} of 100 cfm while bathrooms require a V_{bz} of 50 cfm in apartments.
- $V_{ot} = V_{oz} = V_{bz}/ E_z = V_{bz}/1 = V_{bz}$

Results:

All calculations were made on excel spreadsheet and compared to current design specifications in each room. The excess outdoor air required is also shown on the spreadsheet. One kitchen area does not meet the requirement provided by Table E-2[a]; however the neighboring spaces more than make up for the missing 10 cfm required. All other areas met or exceeded requirements provided by ASHRAE standard 62.1.

While all areas meet requirements for ventilation, it seems that the heat pumps associated with floors 4-18 in this section have been sized below the design for the spaces. The spaces are designed to have a total of 830 cfm while the heat pump is only capable of making 760 cfm. This is a mistake in design and either the heat pump should be changed to HP 19 which can handle 1070 cfm, or the design of airflow should be slightly decreased to each space. The latter decision would cut down on energy costs while remaining compliant with ASHRAE standards. This is most likely what happened and why the 760 cfm heat pump was chosen.

Spreadsheet of Outdoor Air Requirements and Design Specifications:

Design Use	CFM	Az	Pz	Req. CFM	Rp	Ra	Vbz	Excess OA
Floor 3								
HP 3	760							
Bedroom	180	238	2		15	0.06	44.28	135.72
Bath	60	73	1	50			50	10
Main Room	225	244	2		15	0.06	44.64	180.36
Kitchen	125	60	2	100			100	25
Laundry	60	30	1		15	0.06	16.8	43.2
Total on HP	650						255.72	394.28
Floors 4-18								
HP 18	760							
Master Bedroom	120	194	2		15	0.06	41.64	78.36
Master Bath	50	68	1	50			50	0
Bedroom 2	90	140	1		15	0.06	23.4	66.6
Family Room	140	255	3		15	0.06	60.3	79.7
Window Room	150	216	3		15	0.06	57.96	92.04
Kitchen	90	130	3	100			100	-10
Bathroom 2	50	64	1	50			50	0
Electrical	50	51	1		15	0.06	18.06	31.94
Entrance	50	54	3		15	0.06	48.24	1.76
Hall	40	58	2		15	0.06	33.48	6.52
Total on HP	830						483.08	346.92
Floor 19								
HP 18	760							
Master Bedroom	115	187	2		15	0.06	41.22	73.78
Master Bath	65	85	1	50			50	15
Family Room	290	325	2		15	0.06	49.5	240.5
Kitchen	100	121	2	100			100	0
Bath/Laundry	50	62	1	50			50	0
Hall	50	80	2		15	0.06	34.8	15.2
Total on HP	670						325.52	344.48

Spreadsheet of Outdoor Air Requirements and Design Specifications(cont.) :

Floors 20-21								
HP 25	1070							
Master Bedroom	140	157	2		15	0.06	39.42	100.58
Master Bath	100	121	1	50			50	50
Bedroom 2	125	109	1		15	0.06	21.54	103.46
Large Room	420	365	3		15	0.06	66.9	353.1
Kitchen	110	110	3	100			100	10
Bathroom 2	75	60	1		15	0.06	18.6	56.4
Half Bath	50	24	1	50			50	0
Hall	50	61	3		15	0.06	48.66	1.34
Total on HP	1070						395.12	674.88
Penthouse (22)								
HP 26	1070							
Bedroom 2	140	152	1		15	0.06	24.12	115.88
Bathroom 2	40	45	1	50			50	-10
Bedroom 3	110	124	1		15	0.06	22.44	87.56
Bedroom 4	140	120	1		15	0.06	22.2	117.8
Study	140	150	3		15	0.06	54	86
Family Room	125	94	7		15	0.06	110.64	14.36
Kitchen	125	108	4	100			100	25
Bathroom 3	50	55	1		15	0.06	18.3	31.7
Laundry	50	30	1		15	0.06	16.8	33.2
Hall	50	100	2		15	0.06	36	14
Entrance	50	0	0	0	0	0	0	50
Total on HP	1020						454.5	565.5
Penthouse (cont.)								
HP 27	650							
Master Bedroom	130	158	2		15	0.06	39.48	90.52
Master Bath	75	114	2	50			50	25
Master Closet	40	78	0	0			0	40
Bedroom 5	105	90	1		15	0.06	20.4	84.6
Window Room	300	430	7		15	0.06	130.8	169.2
Total on HP	650						240.68	409.32
Total from HP	16020							
Total CFM OA	16750					Vot	8829.78	7920.22

Indoor Air Quality versus Ventilation Rate Procedure:

The Ventilation Rate Procedure is the current ASHRAE requirement for typical building design. The procedure is based on outdoor air intake rates determined for space type, occupancy level, and floor area. The minimum rates are based on contaminant sources and strengths that are typical for the spaces listed.

Unique spaces and spaces using highly volatile chemicals may need to be designed to a higher specification. The Indoor Air Quality Procedure has been created for such applications. In the case where certain target contaminant concentrations need met for human safety, the IAQ Procedure should be followed as well as the Ventilation Rate Procedure. The IAQ procedure utilizes ASHRAE standard 62.1.6.3 as opposed to 62.1.6.2, and is typically used with systems that can monitor contaminant levels and adjust outdoor air intake accordingly. IAQ also takes into account the contaminants that may be included in the outdoor air, while the Ventilation Rate Procedure assumes clean outdoor air.

Using 100% outdoor air, such as practiced in The Waverly on Lake Eola, is one way to create a building with better air quality than prescribed by current ASHRAE standards. As more studies of “sick building syndrome” are preformed it is likely that the IAQ procedure will be mandatory practice in all facilities. Mechanical systems designers should start designing systems with the IAQ procedure in mind in order to not only make the buildings safer for the occupants, but stay on the cutting edge of building technology.