9/18/02
Revised 10/21/02

ASHRAE Standard 62 Ventilation Compliance Evaluation

Introduction: The following report analyzes the prescribed amount of ventilation air for the Residence, based on the ASHRAE Standard 62-2001 Ventilation Rate Procedure. The required ventilation (outdoor) air is then compared to the design outdoor air supplied. A discussion then follows comparing the ventilation rate procedure to the indoor air quality procedure.

Methodology: To determine the required ventilation air, I first divided the building into spaces, one for each fan coil. There were also spaces identified which have no direct air supply. From Table 2.3 (Residential) in section 6.1.3.1 of Standard 62, the only spaces with outdoor air requirements are living spaces, which require "0.35 air changes per hour but not less than 15 CFM per person."

To facilitate using the multiple spaces equation (section 6.1.3.1), I grouped connected spaces into zones. While the minimum 0.35 air changes per hour could be calculated in either the space or zone groupings, I needed to check the 15 CFM per person minimum using the zone groupings. Because the building is a single family home for five permanent residents, the occupancy is small and extremely variable, using the zones to estimate occupancy makes more sense.

After finding the minimum outdoor air required for each zone, I calculated Z for each zone. Zcritical was identified and used in the multiple spaces equation to calculate a ratio of outdoor air to supply air for the entire building. Knowing this ratio and the total amount of air supplied to the building allowed me to determine the minimum CFM of ventilation air required. I then compared this to the actual minimum CFM of outdoor air specified in the fan coil schedule on the mechanical plans. The attached spreadsheet displays the results of this analysis.

Sample Calculations:

0.35 Air Changes/Hour (CFM) = 0.35(/hour) x Volume (ft^3) / 60 (minutes/hour)

Multiple Spaces Equation

Y = X / (1 + X – Zc)

Z = Minimum Outdoor Air (CFM) / Supply Air (CFM)

Zc = Zcritical = Max of Z's

X = Sum of Outdoor Air (CFM) / Sum of Supply Air (CFM)

Y = Corrected ratio of Outdoor Air (CFM) / Supply Air (CFM)

Fan Coil Supplied Spaces		Area	Avg. Clg. Ht.	Volume	0.35 AC/HR	Supply	Existing Min OA	Min OA
FC		(Sq. Ft)	(Ft)	(Cubic Ft)	(CFM)	(CFM)	(%)	(CFM)
1	Dave's office	158	12	1896	11.1	820	10	82
2	Great room/ entry/ coat	992	15	14880	86.8	2235	10	223.5
3	Wine room	96	9.5	912	5.3	550	--	--
4	Kitchen/ breakfast/ family	751	15	11265	65.7	1090	10	109
5	Hallway	423	8.5	3595.5	21.0	1520	10	152
6	Kathy's office	176	10.5	1848	10.8	970	10	97
7	Exercise room	540	9.5	5130	29.9	750	10	75
8	Master suite	866	13	11258	65.7	1930	10	193
9	Bridge	60	9	540	3.2	490	10	49
10	Kid bedrooms and commons	1456	9	13104	76.4	1930	10	193
11	Theatre	450	14	6300	36.8	740		150
12	Outdoor room	170	17	2890	16.9	825	10	82.5
13	Massage room	113	8	904	5.3	255		150
14	Electronics closet	205	8	1640	9.6	1500	--	--
						15605	Totals	1556

Indirectly Ventilated Spaces					
1	Master stair	180	22	3960	23.1
2	Central stair	156	33	5148	30.0
3	Dining room	377	10	3770	22.0
4	Garage entry/ laundry	425	8	3400	19.8
5	Game room	680	9.5	6460	37.7
6	Guest Suite	398	11	4378	25.5

Ventilation Requirements		Volume		CFM				
Zone	Components	(Cubic Ft)	Occupancy	Supply	0.35 AC/HR	15/Person	Min. OA	Z
A	FC-1,2,4,5,6,9,10 & all Indirect	73704.5	7	9055	429.9	105	429.9	0.047
B	FC-3	912	--	550	--	--	0	0.000
C	FC-7,13	6034	3	1005	35.2	45	45	0.045
D	FC-8	11258	2	1930	65.7	30	65.7	0.034
E	FC-11	6300	8	740	36.8	120	120	0.162
F	FC-12	2890	2	825	16.9	30	30	0.036
G	FC-14	1640	--	1500	--	--	0	0.000
			Totals	15605			690.6	

Multiple Spaces Equation

X=	0.044	Zc=	0.162	Y=	0.0502

783 CFM of Required OA

1556 CFM of Existing OA

Conclusions: From the spreadsheet, it can be seen that the designed minimum supply of outdoor air exceeds the minimum ventilation requirement, using Standard 62, by a factor of almost two. This is misleading however. The minimum design ventilation was calculated using the maximum airflow rates for each fan coil, based on design conditions. At below design load conditions the total CFM of supply will be lower, and the ventilation air will still be ten percent of that, making the ventilation rate lower. The only time outdoor air will make up more than ten percent of the supply air is in the economizer mode, as no return air is used.

The ventilation requirements were not a real concern for J. Drew Rader, the Mechanical Engineer who designed this system. Using the 1997 Uniform Building Code, this home's ventilation was satisfied by the amount of operable windows in the building. The system is controllable via touch-screen panels in the house, allowing the owner to shut off the forced air system all together and open windows, weather permitting. Due to the adaptability of this system, which uses radiant heat in the winter and AC in the summer, it was anticipated that the Ventilation Rate Procedure would not be very applicable.

Discussion of IAQ: The above analysis dealt primarily with the ventilation rate procedure which bases the minimum amount of outdoor air supplied on prescriptive rates. Another method for determining the necessary amount of outdoor air is based on indoor air quality (IAQ). The IAQ procedure determines the necessary amount of outdoor air by maintaining the concentration of a room contaminate, usually carbon dioxide, below a critical value. The amount of carbon dioxide being generated in a room is a direct result of the number of people in that space. This means the IAQ procedure supplies only enough fresh air for the amount of people in a room. If no one is in a particular room, the amount of fresh air this room requires drops to some minimum setting.

IAQ control is more expensive due to the contaminate sensors and the logic that must be performed to constantly update the overall ratio of outdoor air to supply air. This type of control is good for buildings that will see a large decrease in utility bills. For example, office buildings have spaces such as conference rooms, which are either empty or relatively filled with people. Also, office buildings basically sit empty for eight hours a day and two days out of the week. This means there is a substantial amount of time when the ventilation rate could be reduced, thereby decreasing energy costs. Unlike an office building, a single family home has room occupancies varying from no one to maybe two occupants, and people are present most hours of the day.

Another issue with IAQ control is where to put the contaminate sensor. In a building with confined spaces, such as private offices, contaminate detection is rather straight forward. However in the large residence with which I am concerned, most of the spaces are connected by hallways and other openings. A poorly placed sensor could detect little carbon dioxide and reduce the outdoor air rate even though there are people at the other end of the space with little fresh air. This situation could be dealt with through the use of more sensors, making the IAQ control system that much more expensive. In a residence of this complexity an IAQ fresh air control system would simply cost more and provide more chance of a malfunction, something neither the owner nor the engineer desires.