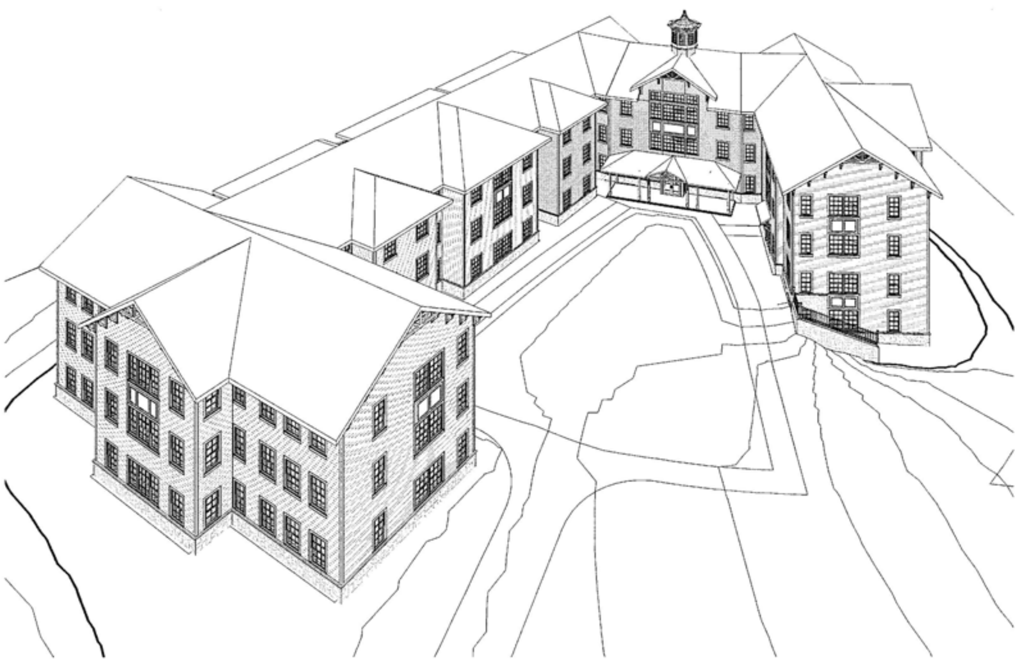
ASHRAE STANDARD 62.1-2004
VENTILATION COMPLIANCE EVALUATION

MECHANICAL TECHNICAL REPORT #1



NEW STUDENT HOUSING BUILDING
AT
THE MOUNT ST. MARY'S UNIVERSITY
EMMITSBURG, MD

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TABLE OF CONTENTS

Table of Contents…… 2
Executive Summary…… 3
Purpose…… 4
Assumptions…… 5
Procedure…… 6
Sample Calculation…… 8
Space Characteristics…… 9
Outdoor Air Requirements…… 12
Zone Primary Outdoor Air Fractions…… 14
Outdoor Air Comparisons…… 16
Procedural Comparisons…… 18
References…… 19

EXECUTIVE SUMMARY

The purpose of this report is to analyze the three energy recovery units that supply ventilation air to the new student housing project soon to be built at the Mount St. Mary's University and to determine whether they are compliant with ASHRAE Standard 62.1-2004 ventilation requirements at design conditions.

This new student housing complex is slated to begin construction later this month at the Mount St. Mary's University in Emmitsburg, Maryland and should be completed by the fall of 2007. When finished, the building will stand three stories tall at approximately 60,000 SF, and it will be comprised primarily of 4-person suites all with operable windows.

This dedicated outdoor air system (DOAS) is a constant air volume (CAV) system that consists of three energy recovery units and thirty-six geothermal heat pumps. Each of the three energy recovery units has the capacity to supply 1050 CFM of 100% ventilation air tempered by exhaust air; there is no mixing of ventilation air and exhaust air prior to the introduction of the ventilation air into the spaces served by the units. The majority of these spaces served are 4-person suites, and there are also a handful of 2- and 3-person suites, lounges, laundry rooms, and corridors that receive ventilation. Each of these spaces is equipped with a geothermal heat pump that receives the ventilation air and mixes it with recirculated space air, which is then conditioned and reintroduced into the space served by the unit. Each energy recovery unit serves approximately a third of the building, and for this report, zones have been categorized into regions served by specific heat pumps.

After following the Ventilation Rate Procedure as outlined in Section 6.2 of AHSRAE Standard 62.1-2004, it is apparent that the three energy recovery units alone do not introduce enough outside air to the building to meet ventilation requirements. The building requires approximately 3400 CFM of ventilation air and is receiving only 2850 CFM, making the system insufficient by approximately 15%. However, when natural ventilation through the operable windows is analyzed and taken into account, it quickly becomes evident that the building would receive more than adequate ventilation to all crucial spaces. Therefore, the ventilation system, when analyzed in conjunction with natural ventilation, is compliant with ASHRAE Standard 62.1-2004 as it is described in Section 5.1.1 of the standard.

PURPOSE

The purpose of ASHRAE Standard 62.1-2004 as stated in the standard is "to specify minimum ventilation rates and indoor air quality that will be acceptable to human occupants and are intended to minimize the potential for adverse health effects." Two methods of achieving this required ventilation are specified: the Ventilation Rate Procedure and the Indoor Air Quality Procedure. The following analysis of the student housing project at the Mount St. Mary's University will utilize the Ventilation Rate Procedure to determine whether the proposed building will receive adequate ventilation through its air handling system. This procedure is based upon the principle that contaminants within the supplied spaces should be cycled out of the building if enough fresh air is introduced into the system.

ASSUMPTIONS

- Local air quality is acceptable for ventilation during occupied hours.
- Smoking is not permitted in the building.
- Outdoor air intakes are sufficiently far from building exhaust as to ensure acceptable ventilation air.
- For spaces of variable occupancy such as the lounges and laundry rooms, occupancy was determined based on conservative estimates made by the mechanical engineer.
- The zone air distribution effectiveness (E_z) is assumed to be 1.0 based on the fact that supply air is introduced into all spaces at the ceiling level. It is unknown what value was used during design, but such a value is adequate for a conservative estimate.
- Occupancy types for building spaces were based on those deemed most similar in table 6.1 of the standard. A summary of those types selected can be seen in the table below:

Space Classifications	
Space Type	**Occupancy Category**
Living Area	Bedroom / Living Room
Lounge	Main Entry Lobbies
Laundry Room	Laundry Facilities, Central
Electrical / Telecom Room	Electrical Equipment Room
Corridor	Corridor

  Each suite consists of bedrooms and a common area, but because the standard considers them to be the same occupancy category, the calculations were simplified by regarding each suite as a single entity.
- Spaces not considered for ventilation included:
  - Mechanical spaces
  - Janitor's closets
  - Bathrooms
  - Stairways

PROCEDURE

Step One:

Identify zones and their occupancy and square footages. Zones were designated by spaces served by the same geothermal heat pump. As stated in the assumptions, all unknown occupancies were given values estimated by the mechanical engineer. Square footages were gathered by measuring the areas of the spaces on electronic drawings in AutoCAD.

Step Two:

Determine the breathing zone outdoor airflow (V_{bz}) using the equation:

$$V_{bz} = R_p P_z + R_a A_z$$

Where:

A_z = *zone floor area*: the net occupiable floor area of the zone
P_z = *zone population*: the largest number of people expected to occupy the zone during typical hours
R_a = outdoor airflow rate required per unit area
R_p = outdoor airflow rate required per person

Values for the outdoor flow rates were determined from Table 6.1 in the standard that correlate to those occupancy categories listed in the assumptions.

Step Three:

Determine the zone air distribution effectiveness (E_z) using Table 6.2. As stated in the assumptions, this value was estimated to be 1.0.

Step Four:

Determine the design zone outdoor airflow (V_{oz}) for each space using the equation:

$$V_{oz} = V_{bz} / E_z$$

This value is the amount of outdoor air that must be provided to the zone by the supply air distribution system.

Step Five:

Determine the zone primary outdoor air fraction (Z_p) using the equation:

$$Z_p = V_{oz} / V_{pz}$$

Where:

Z_p = system ventilation efficiency
V_{pz} = the primary airflow to the zone from the air handler including outdoor air and recirculated return air

The critical space is defined by the maximum Z_p value.

Step Six:

Determine the system ventilation efficiency (E_v) for each air handling unit based on the maximum Z_p value for that system using Table 6.3. For maximum Z_p values greater than 0.55, Appendix A of the standard must be used.

Step Seven:

Determine the design uncorrected outdoor intake (V_{ou}) using the equation:

$$V_{ou} = D\Sigma_{all\ zones}R_pP_z + \Sigma_{all\ zones}R_aA_z$$

Where:

D = *occupant diversity*: defined by the equation:

$$D = P_s / \Sigma_{all\ zones} P_z$$

Where:

Ps = *system population*: the total population in the area served by the System

Step Eight:

Determine the design outdoor intake flow (V_{ot}) using the equation:

$$V_{ot} = V_{ou} / E_v$$

SAMPLE CALCULATION

For this example, the calculations are going to be solved for Suite 101 (Zone 1-1).

Step One:

Occupancy Category = **Bedroom / Living Room**
P_z = **4 People**
A_z = **708 SF**

Step Two:

R_a = **0.06 CFM/SF**
R_p = **5 CFM/Person**
$V_{bz} = R_pP_z + R_aA_z$ = (5 CFM/Person)(4 People)+(0.06 CFM/SF)(708 SF) = **63 CFM**

Step Three:

E_z = **1.0**

Step Four:

$V_{oz} = V_{bz} / E_z$ = 63 CFM / 1.0 = **63 CFM**

Step Five:

V_{pz} = **900 CFM**
$Z_p = V_{oz} / V_{pz}$ = 63 CFM / 900 CFM = **0.07**

Step Six:

$Z_p = 0.07 < 0.15$
E_v = **1.0**

Step Seven:

P_s = 143 People
$D = P_s / \Sigma_{all\ zones} P_z$ = 60 People / 69 People = 0.87
$V_{ou} = D\Sigma_{all\ zones}R_pP_z + \Sigma_{all\ zones}R_aA_z$ = (0.87)(345 CFM) + (802 CFM) = **1102 CFM**

Step Eight:

$V_{ot} = V_{ou} / E_v$ = 1102 CFM / 1.0 = **1102 CFM**

SPACE CHARACTERISTICS

ERU-1:

First Floor Level				
Zone	Space Name	Function	Space Area (A_z) [SF]	Occupancy (P_z) [People]
1-1	Suite 101	Bedroom / Living Room	708	4
1-2	Suite 102	Bedroom / Living Room	627	3
1-3	Double	Bedroom / Living Room	225	2
-	Corridor	Corridor	290	0
1-4	Small Lounge	Main Entry Lobbies	133	3
-	Elec/Telecom	Electrical Equip. Room	29	0
1-5	Suite 103	Bedroom / Living Room	768	4
1-6	Suite 104	Bedroom / Living Room	776	4
1-7	Suite 105	Bedroom / Living Room	607	3
-	Corridor	Corridor	290	0

Second Floor Level				
Zone	Space Name	Function	Space Area (A_z) [SF]	Occupancy (P_z) [People]
2-1	Suite 201	Bedroom / Living Room	708	4
2-2	Suite 202	Bedroom / Living Room	627	3
2-3	Double	Bedroom / Living Room	225	2
-	Corridor	Corridor	290	0
2-4	Small Lounge	Main Entry Lobbies	133	3
-	Elec/Telecom	Electrical Equip. Room	29	0
2-5	Suite 203	Bedroom / Living Room	768	4
2-6	Suite 204	Bedroom / Living Room	776	4
2-7	Suite 205	Bedroom / Living Room	607	3
-	Corridor	Corridor	290	0

Third Floor Level				
Zone	Space Name	Function	Space Area (A_z) [SF]	Occupancy (P_z) [People]
3-1	Suite 301	Bedroom / Living Room	708	4
3-2	Suite 302	Bedroom / Living Room	627	3
3-3	Double	Bedroom / Living Room	225	2
-	Corridor	Corridor	290	0
3-4	Small Lounge	Main Entry Lobbies	133	3
-	Elec/Telecom	Electrical Equip. Room	29	0
3-5	Suite 303	Bedroom / Living Room	768	4
3-6	Suite 304	Bedroom / Living Room	776	4
3-7	Suite 305	Bedroom / Living Room	607	3
-	Corridor	Corridor	290	0

ERU-2:

First Floor Level				
Zone	Space Name	Function	Space Area (A_z) [SF]	Occupancy
1-8	Suite 106	Bedroom / Living Room	793	4
1-9	Suite 107	Bedroom / Living Room	797	4
1-10	Suite 108	Bedroom / Living Room	776	4
1-11	Suite 109	Bedroom / Living Room	718	4
-	Corridor	Corridor	290	0
1-12	Suite 110	Bedroom / Living Room	720	4
1-13	Double	Bedroom / Living Room	197	2
-	Corridor	Corridor	290	0
1-14	Lounge	Main Entry Lobbies	750	5
-	Elec/Telecom	Electrical Equip. Room	24	0
-	Laundry	Laundry Facilities, Central	87	1

Second Floor Level				
Zone	Space Name	Function	Space Area (A_z) [SF]	Occupancy
2-8	Suite 206	Bedroom / Living Room	793	4
2-9	Suite 207	Bedroom / Living Room	797	4
2-10	Suite 208	Bedroom / Living Room	776	4
2-11	Suite 209	Bedroom / Living Room	718	4
-	Corridor	Corridor	290	0
2-12	Suite 210	Bedroom / Living Room	720	4
2-13	Double	Bedroom / Living Room	197	2
-	Corridor	Corridor	290	0
2-14	Lounge	Main Entry Lobbies	750	5
-	Elec/Telecom	Electrical Equip. Room	24	0
-	Laundry	Laundry Facilities, Central	87	1

Third Floor Level				
Zone	Space Name	Function	Space Area (A_z) [SF]	Occupancy
3-8	Suite 306	Bedroom / Living Room	793	4
3-9	Suite 307	Bedroom / Living Room	797	4
3-10	Suite 308	Bedroom / Living Room	776	4
3-11	Suite 309	Bedroom / Living Room	718	4
-	Corridor	Corridor	290	0
3-12	Suite 310	Bedroom / Living Room	720	4
3-13	Double	Bedroom / Living Room	197	2
-	Corridor	Corridor	290	0
3-14	Lounge	Main Entry Lobbies	750	5
-	Elec/Telecom	Electrical Equip. Room	24	0
-	Laundry	Laundry Facilities, Central	87	1

ERU-3:

Basment Level				
Zone	Space Name	Function	Space Area (A_z) [SF]	Occupancy
B-1	Suite 12	Bedroom / Living Room	720	4
-	Corridor	Corridor	267	0
-	Elec./Fire/Data	Electrical Equip. Room	71	0
B-2	Suite 13	Bedroom / Living Room	766	4
-	Corridor	Corridor	267	0
-	Elec./Fire/Data	Electrical Equip. Room	71	0
B-3	Suite 14	Bedroom / Living Room	694	4

First Floor Level				
Zone	Space Name	Function	Space Area (A_z) [SF]	Occupancy
1-15	Suite 111	Bedroom / Living Room	362	3
-	Corridor	Corridor	211	0
1-16	Suite 112	Bedroom / Living Room	720	4
1-17	Suite 113	Bedroom / Living Room	766	4
1-18	Suite 114	Bedroom / Living Room	694	4
-	Corridor	Corridor	211	0

Second Floor Level				
Zone	Space Name	Function	Space Area (A_z) [SF]	Occupancy
2-15	Suite 211	Bedroom / Living Room	362	3
-	Corridor	Corridor	211	0
2-16	Suite 212	Bedroom / Living Room	720	4
2-17	Suite 213	Bedroom / Living Room	766	4
2-18	Suite 214	Bedroom / Living Room	694	4
-	Corridor	Corridor	211	0

Third Floor Level				
Zone	Space Name	Function	Space Area (A_z) [SF]	Occupancy
3-15	Suite 311	Bedroom / Living Room	362	3
-	Corridor	Corridor	211	0
3-16	Suite 312	Bedroom / Living Room	720	4
3-17	Suite 313	Bedroom / Living Room	766	4
3-18	Suite 314	Bedroom / Living Room	694	4
-	Corridor	Corridor	211	0

OUTDOOR AIR REQUIREMENTS

Due to the repetitiveness of the floor layouts, only the first and basement floors have been analyzed in this section to save space.

ERU-1:

First Floor Level (Same for All Three Levels)								
Zone	Space Name	Function	Space Area (Az) [SF]	Occupancy (Pz) [People]	People Outdoor Air Rate (Rp) [CFM/Person]	Area Outdoor Air Rate (Ra) [CFM/SF]	Breathing Zone Outdoor Airflow (Vbz) [CFM]	Space Outdoor Airflow (Voz) [CFM]
1-1	Suite 101	Bedroom / Living Room	708	4	5	0.06	63	63
1-2	Suite 102	Bedroom / Living Room	627	3	5	0.06	53	53
1-3	Double	Bedroom / Living Room	225	2	5	0.06	24	24
-	Corridor	Corridor	290	0	0	0.06	18	18
1-4	Small Lounge	Main Entry Lobbies	133	3	5	0.06	23	23
-	Elec/Telecom	Electrical Equip. Room	29	0	0	0.06	2	2
1-5	Suite 103	Bedroom / Living Room	768	4	5	0.06	67	67
1-6	Suite 104	Bedroom / Living Room	776	4	5	0.06	67	67
1-7	Suite 105	Bedroom / Living Room	607	3	5	0.06	52	52
-	Corridor	Corridor	290	0	0	0.06	18	18

ERU-2:

First Floor Level (Same for All Three Levels)								
Zone	Space Name	Function	Space Area (Az) [SF]	Occupancy (Pz) [People]	People Outdoor Air Rate (Rp) [CFM/Person]	Area Outdoor Air Rate (Ra) [CFM/SF]	Breathing Zone Outdoor Airflow (Vbz) [CFM]	Zone Outdoor Airflow (Voz) [CFM]
1-8	Suite 306	Bedroom / Living Room	793	4	5	0.06	68	68
1-9	Suite 307	Bedroom / Living Room	797	4	5	0.06	68	68
1-10	Suite 308	Bedroom / Living Room	776	4	5	0.06	67	67
1-11	Suite 309	Bedroom / Living Room	718	4	5	0.06	64	64
-	Corridor	Corridor	290	0	0	0.06	18	18
1-12	Suite 310	Bedroom / Living Room	720	4	5	0.06	64	64
1-13	Double	Bedroom / Living Room	197	2	5	0.06	22	22
-	Corridor	Corridor	290	0	0	0.06	18	18
1-14	Lounge	Main Entry Lobbies	750	5	5	0.06	70	70
-	Elec/Telecom	Electrical Equip. Room	24	0	0	0.06	2	2
-	Laundry	Laundry Facilities, Central	87	1	5	0.12	16	16

ERU-3:

Basement Level								
Zone	Space Name	Function	Space Area (Az) [SF]	Occupancy (Pz) [People]	People Outdoor Air Rate (Rp) [CFM/Person]	Area Outdoor Air Rate (Ra) [CFM/SF]	Breathing Zone Outdoor Airflow (Vbz) [CFM]	Zone Outdoor Airflow (Voz) [CFM]
B-1	Suite 12	Bedroom / Living Room	720	4	5	0.06	64	64
-	Corridor	Corridor	267	0	0	0.06	17	17
-	Elec/Telecom	Electrical Equip. Room	71	0	0	0.06	5	5
B-2	Suite 13	Bedroom / Living Room	766	4	5	0.06	66	66
-	Corridor	Corridor	267	0	0	0.06	17	17
-	Elec/Telecom	Electrical Equip. Room	71	0	0	0.06	5	5
B-3	Suite 14	Bedroom / Living Room	694	4	5	0.06	62	62

First Floor Levels (Same for All Three Levels)								
Zone	Space Name	Function	Space Area (Az) [SF]	Occupancy (Pz) [People]	People Outdoor Air Rate (Rp) [CFM/Person]	Area Outdoor Air Rate (Ra) [CFM/SF]	Breathing Zone Outdoor Airflow (Vbz) [CFM]	Zone Outdoor Airflow (Voz) [CFM]
1-15	Suite 111	Bedroom / Living Room	362	3	5	0.06	37	37
-	Corridor	Corridor	211	0	0	0.06	13	13
1-16	Suite 112	Bedroom / Living Room	720	4	5	0.06	64	64
1-17	Suite 113	Bedroom / Living Room	766	4	5	0.06	66	66
1-18	Suite 114	Bedroom / Living Room	694	4	5	0.06	62	62
-	Corridor	Corridor	211	0	0	0.06	13	13

ZONE PRIMARY OUTDOOR AIR FRACTIONS

Due to the repetitiveness of the floor layouts, only the first and basement floors have been analyzed in this section to save space.

ERU-1:

First Floor Level (Same for All Three Levels)				
Zone	Zone Outdoor Airflow (V_{oz}) [CFM]	Zone Primary Airflow (V_{pz}) [CFM]	Zone Primary Outdoor Air Fraction (Z_p)	Max Z_p
1-1	63	900	0.07	
1-2	53	980	0.05	
1-3	42	400	0.11	0.11
1-4	25	400	0.06	
1-5	67	900	0.07	
1-6	67	1000	0.07	
1-7	70	900	0.08	

ERU-2:

First Floor Level (Same for All Three Levels)				
Zone	Zone Outdoor Airflow (V_{oz})	Zone Primary Airflow (V_{pz})	Zone Primary Outdoor Air Fraction	Max Z_p
1-8	68	1000	0.07	
1-9	68	900	0.08	
1-10	67	1000	0.07	
1-11	82	800	0.10	0.10
1-12	64	900	0.07	
1-13	40	400	0.10	
1-14	88	1000	0.09	

ERU-3:

Basement Floor Level				
Zone	Zone Outdoor Airflow (V_{oz})	Zone Primary Airflow (V_{pz})	Zone Primary Outdoor Air Fraction	Max Z_p
B-1	86	1000	0.09	0.09
B-2	88	1000	0.09	
B-3	62	815	0.08	

First Floor Level (Same for All Three Levels)				
Zone	Zone Outdoor Airflow (V_{oz})	Zone Primary Airflow (V_{pz})	Zone Primary Outdoor Air Fraction	Max Z_p
1-15	50	530	0.09	0.09
1-16	64	900	0.07	
1-17	66	900	0.07	
1-18	75	1000	0.08	

OUTDOOR AIR COMPARISONS

	Max Z_p	System Ventilation Efficiency (E_v)	Population Density (P_s)	Occupant Diversity (D)	Uncorrected Outdoor Intake (V_{ou}) [CFM]	Nominal Outside Air (ΣV_{oz}) [CFM]	Required Outside Air (V_{ot}) [CFM]	Actual Supplied Ventilation Air [CFM]
ERU-1	0.11	1	60	0.87	1102	1161	1102	1050
ERU-2	0.10	1	66	0.79	1325	1431	1325	1050
ERU-3	0.09	1	57	1.00	990	1001	990	750
Total Building						**3593**	**3417**	**2850**

After analysis of the ventilation system at the new student housing project, the final values seem somewhat out of balance at first glance.

When comparing the nominal outside air to the required outside air, one would initially expect the required air to be greater than that of the nominal air. This is because for many building systems, the ventilation efficiency is often much less than 100%, leading to a necessary increase in ventilation air to compensate for this lack of performance. In this instance, the building in question is a student dormitory supplying ventilation air directly to geothermal heat pumps with no prior mixing. The heat pumps then recirculate far more air than they intake from the energy recovery units, leading to very low zone primary outdoor air fractions and, by consequence, very high system ventilation efficiencies if one uses the values in Table 6-3. At the same time, student dormitories are generally considered to be closed systems, meaning that the total population of the building can easily be determined by simply totaling the number of students in residence. All rooms serving other functions, such as lounges and laundry rooms, must be adequately ventilated, but the primary users of such spaces are still the residents of the dormitory, not outside parties. The population density will then either yield values of 1.0 or less depending upon the types of spaces served by specific units. When coupled with the concept of such high system ventilation efficiencies, any population density less than 1.0 will actually decrease the required ventilation air required for the spaces served by the energy recovery units.

When comparing the required outdoor air with the amount actually supplied by the energy recovery units, one would immediately come to the conclusion that none of the units are supplying adequate air and that the ventilation system for the entire building was undersized by approximately 15%. The building requires 3400 CFM of ventilation air and is only being supplied with 2850 CFM. However, the ventilation systems are not, in fact, undersized;

one the contrary, the building receives more than adequate ventilation if one also takes into account the fact that the windows every suite and lounge in the building are operable and accessible. According to Section 5.1.1 of the standard, "Use of natural ventilation systems designed in accordance with this section shall be permitted in lieu of or in conjunction with mechanical ventilation systems…Naturally ventilated spaces shall be permanently open to and within 8 m (25 ft) of operable wall or roof openings to the outdoors, the openable area of which is a minimum of 4% of the net occupiable floor area." While the scope of this report was to utilize the Ventilation Rate Procedure to determine whether or not the building ventilation system provided adequate ventilation, an analysis of the natural ventilation through the operable windows in combination with the ventilation system would easily show that the building more than meets desired ventilation requirements.

A simple analysis will again be done on Suite 101 to determine its capacity for natural ventilation:

- Maximum distance from operable window: **22 ft < 25 ft**
- Net occupiable floor area: 708 SF
- Openable window area: 76.5 SF
- Percent openable area to floor area:

76.5 SF / 708 SF = **10.8% > 4%**

Now the same analysis will be performed on one of the large lounges:

- Maximum distance from operable window: **18 ft < 25 ft**
- Net occupiable floor area: 750 SF
- Openable window area: 82.3 SF
- Percent openable area to floor area:

82.3 SF / 750 SF = **11% > 4%**

Because the spaces in the building are very repetitive, these two spaces are fairly representative of the majority of the rooms within the building. Based on this assumption, it is safe to estimate that between the CAV system and the natural ventilation from the operable windows, the building is receiving more than adequate ventilation.

It is pertinent to note that although the building might actually meet the required limits for outdoor air based on the natural ventilation alone, the building's ventilation system is still very beneficial to the general health and well being of the building's occupants. The CAV system guarantees a much more consistent supply of ventilation air, especially during winter months when most, if not all, of the building's windows will be closed. Also, the system helps to regulate the pressure inside of the building; were no mechanical ventilation system present, the building would most likely be exhausting air at a rate that would negatively pressurize the building.

PROCEDURAL COMPARISONS

As mentioned in the purpose of this report, there are two methods for achieving the required ventilation for a given building. Those two methods are the Ventilation Rate Procedure and the Indoor Air Quality Procedure.

The method used in this report was the Ventilation Rate Procedure, and it was developed with the intent "to specify minimum ventilation rates and indoor air quality that will be acceptable to human occupants." The procedure is based upon contaminant levels general to spaces on a per square foot basis, and also takes into account ventilation necessary for occupancy. Of the two methods, it is the simpler approach, requiring a less extensive understanding of the building spaces and allowing for a more flexible system capable of absorbing variations in conditions. Supply air delivery method, population density, diversity, and system efficiency are also estimated while the spaces themselves are assigned values based on general requirements for those types of spaces. This approach saves time but may not always be precise enough for more critical buildings.

The Indoor Air Quality Procedure was introduced in 1981, and it focuses far more intently upon actual contaminant levels of spaces. The aim of this procedure is "to maintain the concentrations of specific contaminants at or below certain limits identified during the building design and to achieve the design target level of perceived indoor air quality acceptability by building occupants and/or visitors." Instead of using generalized requirements, this procedure requires an in depth understanding of all spaces in question, as well as knowledge of the quality of the outside air. The contaminants in each space must be identified and their concentration limits and exposure periods specified, and the methods for monitoring these spaces must be well documented. Also, systems based on this procedure are very inflexible and must be designed with a far greater degree of accuracy. Such an approach might be necessary for buildings with critical functions, such as museums or hospitals, but generally the level of analysis is beyond the range of the engineer and the availability of necessary information.

For the purpose of this report, the Ventilation Rate Procedure is far more applicable than the Indoor Air Quality Procedure. None of the spaces within this dormitory are critical, and a certain degree of flexibility is desirable. Specific information about contaminant levels and outdoor air quality would have been impossible to obtain, and the building is simple enough that a more in depth analysis would have been unwarranted.

REFERENCES

- "ANSI/ASHRAE Standard 62.1-2004 - Ventilation for Acceptable Indoor Air Quality." ASHRAE, Inc. Atlanta, GA. 2004.
- Student Housing: The Mount St. Mary's University - plans and schedules. Construction Issue Set. August 11, 2006.