Technical Assignment #1

ASHRAE Standard 62.1-2004 Ventilation Compliance Evaluation Report

Photo by Fred Martin

Clemson University Advanced Material Research Laboratory
Anderson, SC

David Anderson
Mechanical Option

Thursday, October 5, 2006

Table of Contents

Table of Contents	2
Executive Summary	3
Assumptions	4
Procedure	4
Calculations	7
Discussion	7
Procedure Comparison	8
Appendix A	9

Executive Summary

The Ventilation Rate Calculation Procedure from ASHRAE Standard 62.1-2004 is the procedure used to calculate and determine if Clemson University AMRL complies with the ventilation requirements at the specified design conditions. Clemson University AMRL building has a gross square foot area of 111, 270, which encompass office, research laboratory, clean room, and conferencing spaces within the two stories.

Supply air is delivered to the ARML by 19 air-handling units (AHU), ranging from 1,000 cfm to 20,650 cfm. The amount of minimum outside air to the 19 AHU's vary between 300 cfm to 20,650 cfm. The air class associated with these spaces is 1.0 based on the air distribution and from ASHRAE Standard 62.1-2004.

As discussed further on in calculations, all AHU units are compliant with ASHRAE 62.1-2004 except AHU-11. AHU-11 had a required outdoor air intake greater than the design OA supply. All other units were over designed, and with that gained extra points in LEED certification.

Assumptions

AHSRAE Standard 62.1-2004 was used to obtain the minimum ventilation rates in the zone. If a zone in the building did not match one from the Standard, then one was assumed for the space which is given below.

Variable air volume (VAV) was used in some spaces, which can be seen in Appendix A by the spreadsheets. Outside air requirements where met for all of the spaces in the zone.

It is also assumed that the design of this building was to exceed minimum requirements since achieving LEED certification.

All calculations are to my best of knowledge due to my calculations.

Procedure

The procedure used for determining V_{ot} (outdoor air intake flow) of all air-handling units followed section 6.2 of ASHRAE 62.1-2004. Steps are described below with reference to EXCEL documents for the calculations. Refer to assumptions when necessary.

Step 1:

Find Az from the provided floor plans for each space in each zone. Determine Pz for each space in each zone. Some will have zero occupant densities.

Step 2:

Breathing Zone Outdoor Airflow (V_{bz}):

$$V_{bz} = R_p * P_z + R_a * A_z \qquad (6\text{-}1)$$

R_p = outdoor airflow rate required per person
P_z = zone population

R_a = outdoor airflow rate required per unit area
A_z = zone floor area

Find values of R_p and R_a from Table 6-1.

Step 3:

Zone Air Distribution Effectiveness (E_z):

Find the value for the effectiveness from Table 6-2, based on the distribution configuration of the space in the multi-purpose building.

Step 4:

Zone Outdoor Airflow (V_{oz}):

$V_{oz} = V_{bz} / E_z$ (6-2)

Step 5:

Zone Primary Outdoor Air Fraction (Z_p):

$Z_p = V_{oz} / V_{pz}$ (6-5)

V_{pz} = zone primary airflow

VAV systems, where minimum expected primary airflow for design

Step 6:

System Ventilation Efficiency (E_v):

Find the value for the efficiency from Table 6-3 or Appendix A. If efficiency is less than or equal to 0.55, use Table 6-3. If less than 0.55, use Appendix A.

Appendix A- Multiple Zone Systems

Used when E_v is greater than 0.55 and Table 6-3 cannot be used.

Step 6a:

Diversity Factor (D):

$D = P_s / (\sum_{\text{all zones}} P_z)$

Ps= System population

Step 6b:

Uncorrected Outdoor Air Intake (V_{ou}):

$Vou = D*\sum R_p*P_z + \sum R_a*A_z$

Step 6c:

System Primary Airflow (V_{ps}):

$V_{ps} = \sum V_{pz}$

Step 6d:

Average Outdoor Air Fraction (X_s):

$X_s = V_{ou} / V_{ps}$

Step 6e:

Discharge Outdoor Air Fraction (Z_d):

$Z_d = V_{oz} / V_{dz}$

Step 6f:

Single Supply Systems:

$E_{vz} = 1 + X_s - Z_d$

Used only if ventilation air is a mixture of outdoor and recirculated air from a single location.

Step 6g:

System Ventilation Efficiency (E_v)

E_v = minimum (E_{vz})

Step 7:

Occupant Diversity (D):

$D = P_s / (\sum_{\text{all zones}} P_z)$

P_s = System population

Step 8:

Uncorrected Outdoor Air Intake (V_{ou}):

$V_{ou} = D*\sum R_p*P_z + \sum R_a*A_z$

Step 9:

Design Outdoor Air Intake Flow (V_{ot}):

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

Calculations:

The final calculations can be seen in Appendix A. This gives a table of calculated versus design criteria.

Discussion:

Referring to Appendix A, I calculated each AHU with all system components included. Referring to Appendix B, the comparison of Design SA and OA to the calculated V_{ot} is shown. As noted in the executive summary, all AHU's met AHRAE Standard 62.1-2004, except AHU-11. Its calculated V_{ot} was 600 cfm, where the design

OA flow was only 550 cfm. With this said, it is suspected that all spaces where over-designed in order to gain points to LEED certification.

Procedure Comparison

Ventilation Rate Procedure (VRP) vs. Indoor Air Quality Procedure (IAQP)

Both VRP and IAQP are methods in determining the compliance with ASHRAE Standard 62.1-2004. The VRP method was used in this report to evaluate all spaces to ensure proper ventilation to the building. According to the space and considerations, each method approaches the space in a different matter.

The Ventilation Rate Procedure is in the ASHRAE Standard 62.1.6.2, which deals with contaminant levels in the building space. This standard utilizes table 6-1 in Standard 62.1-2004 to account for various contaminants in certain locations. Occupancy levels are taken in consideration to allow the exhaust of CO_2 and other rates are to rid of certain contaminants which would be found in the air.

The Indoor Air Quality Procedure specifies various types of contaminants and the appropriate levels in the ASHRAE Standard 62.1.6.3. It also takes methods in consideration to reduce the contaminants in the space. Methods include choosing a different material with less contamination, or the use of cleaning devices. In order to receive credit, it must be proven that these devices reduce the VOC in the space.

In comparison, the VRP is more general and is able to be used prior to construction, since most materials will not be available for testing. The IAQP method measures the contaminants in the air, and not just the space or occupancy. The IAQP method would be more beneficial on a consultant based project where materials are given, such as VOC's and other contaminants including particles can be analyzed.

Appendix A

AHU #	Design SA (cfm)	Design OA (cfm)	Calculated Vot (cfm)
1	4000	1800	324
2	4500	1800	257
3	5700	1800	462
4	5200	1800	317
5	6300	6300	1784
6	5800	5550	1784
7	5000	400	399
8	10600	1050	737
9	11300	3350	1167
10	7000	800	561
11	7100	550	600
12	3100	2550	276
13	1600	1100	365
14	1000	300	275
15	6800	2000	253

References:

"ANSI/ASHRAE Standard 62.1-2004 – Ventilation for Acceptable Indoor Air Quality." ASHRAE, Inc. Atlanta, GA. 2004

Clemson University AMRL – plans and schedules. Construction Set. June 2004.