ASHRAE Standard 62.1 2004
Ventilation Compliance Evaluation

Mechanical Technical Report #1

Bronx School for Law, Government, & Justice

Bronx, NY

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1.0 EXECUTIVE SUMMARY

The following report investigates if the Bronx School for Law, Government, & Justice meets the minimum outdoor air requirements of ASHRAE 62.1-2004. This report contains an analysis of all (10) air handling units serving the Bronx School, the calculated minimum outdoor air requirements from ASHRAE 62.1-2004, including detailed procedures and sample calculations and a comparison of the results with the original design. There were two applicable ways to determine the outdoor air requirement, Ventilation Rate Procedure and Indoor Air Quality Procedure, a comparison between the two is also included.

The Bronx School for Law, Government & Justice is an 114,000 square foot school located in Bronx, NY. It a six story plus a mechanical penthouse building and was one of the first specialized schools in New York City. The building is ventilated by a combination of ten (10) air handling units, totaling 134400 cfm of which 66040 cfm is outdoor air or nearly 50%. The building is a mixture of constant volume (7), and variable air (3) systems.

After an analysis with ASHRAE 62.1-2004 it was determined that the Bronx School for Law, Government & Justice more than adequately satisfies ASHRAE 62.1-2004. Some air handling units were well above the minimum requirements of ASHRAE. The reason for this large discrepancy is due to the fact the building is located in New York City and the New York City Energy Code was used for the design and the determination of the minimum outdoor air. The large population density of New York City requires a more stringent code to be used for the assurance of proper ventilation. The school is approximately 50% outdoor air with one unit (AHU-6) as a 100% outdoor air unit.

2.0 ASSUMPTIONS

1.) In calculating ventilation the following types of spaces were neglected:
   a) Restrooms – All restrooms are exhausted through toilet exhaust fans and draw supply air, through undercuts, from adjacent corridors.
   b) Janitor's closets – All janitors' closets are connected to the toilet exhaust system and draw supply air from adjacent corridors.
   c) Elevators – All Elevators are equipped with self-ventilation.
   d) Stairways – All Stairways are ventilated from adjoining corridors.

2.) Ventilation Effectiveness (E_z) = 1.0, since the ceiling supply of warm air will never exceed 15˚F above space temperature because steam fin tube radiators were installing in all major occupied spaces.

3) The occupant diversity, D, was assumed to be (1.0) at all times. This was done to be conservative and to assure that each space was receiving the proper outdoor air ventilation.

4) The zone primary airflow, V_{pz}, for both VAV and CAV systems were assumed to be the designed airflow for each space.

5) This analysis of ASHRAE 62.1-2004 used the Ventilation Rate Procedure and not the Indoor Air Quality Procedure however; a comparison of two can be seen in section 6.0 of this report.

3.0 PROCEDURE

The following steps are for the determination of the outdoor air intake flow (V_t) using the Ventilation Rate Procedure.

Step 1: Original designed ventilation rates for all air handlers and their designed outdoor air percentage.

Step 2: All space characteristics (area, use, design occupancy) for each space and its corresponding air handling unit had to be determined. Floor areas (A_z) for each space were obtained from the architectural drawings by The Hillier Group. The design occupancy (P_z) was determined by the architect and the original load calculations.

Step 3: The breathing zone outdoor airflow (V_{bz}) for each space had to be determined. This was done from Equation 6.1 from ASHRAE 62.1.

$$V_{bz} = R_p P_z + R_a P_z \qquad [6.1]$$

where:

R_p = outdoor airflow rate required per person as determined from Table 6-1[1].
R_a = outdoor airflow rate required per unit area as determined from Table 6.1[1].
A_z = floor areas, determined in Step 2.
P_z = design occupancy, determined in Step 2.

Step 4: The next item to be determined is the zone outdoor airflow (V_z) which could be determined from Equation 6.2.

$$V_{oz} = V_{bz}/E_z \qquad [6.2]$$

From assumption (2) $E_z = 1.0$ which leads to $V_{oz} = V_{bz}$

Step 5: If one air handler is only supplying a mixture of outdoor air and recirculated air to only one zone then (V_{ot}) is calculated using Equation 6.3. If the air handler is a 100% outdoor air system then (V_{ot}) can be calculated using step 6, otherwise steps 7 to 10 most be followed.

$$V_{ot} = V_{oz} \qquad [6.3]$$

[1] Table 6.1 can be found in ASHRAE 62.1 2004

Step 6: If one air handler supplies 100% outdoor air then (V_{ot}) can be determined using Equation [6.4].

$$V_{ot} = \sum_{\text{all zones}} V_{oz} \qquad [6.4]$$

Step 7: If the air handler serves multiply spaces and is not and is not a 100% outdoor unit then the zone primary outdoor air fraction (Z_p) must be determined for each space served by that air handler using Equation 6.5.

$$Z_p = V_{oz}/V_{pz} \quad [6.5]$$

Step 8: After finding all the Z_ps for a particular air handling unit the largest or maximum Z_p is used. This maximum Z_p is used in conjunction with Table 6.3, from ASHRAE 62.1, to determine the system ventilation efficiency (E_v).

Step 9: The next value to be determined is the uncorrected outdoor air intake (V_{ou}) and from assumption (3) (V_{ou}) can be determined with the modified Equation 6.6.

$$V_{ou} = \sum_{\text{all zones}} V_{oz} \qquad [6.6]$$

Step10: Once V_{ou} is determined the outdoor air intake flow (V_{ot}) can be determined using Equation 6.8.

$$V_{ot} = V_{ou}/Ev \quad [6.8]$$

Step11: Once the outdoor air flow rate is determined compare the required value and determine if the designed value meets the calculated ASHRAE standard value.

Step12: Repeat all steps for each individual air handler.

4.0 SAMPLE CALCULATION

The following sample calculation is from AHU-2 which serves classrooms and misc. spaces. The critical space for AHU-2 is a crime lab on the 4th floor with a max $Z_p = 0.38$.

$A_z = 1289$ SF
$P_z = 35$ people
$R_p = 10$ cfm/person
$R_a = 0.18$ cfm/ft^2
$E_z = 1.0$ (Assumption 2)
$V_{bz} = (P_z*R_p)+(A_z*R_a) = (35*10)+(1289*0.18) = 582$ cfm

$V_{oz} = V_{bz}/E_z = 582$ cfm

$V_{pz} = 1550$ cfm
$Z_p = V_{oz}/V_{pz}$

$Z_p = 0.38$
$E_v = 0.7$

$V_{ou} = \sum_{\text{all zones}} V_{oz} = 4431$ cfm

$V_{ot} = V_{ou}/E_v = 4431/.7 = 6630$ cfm

The designed outdoor air for AHU-2 is 9000 cfm.

The results from the calculation compared to the design shows there is more than adequate outdoor air for AHU-2.

5.0 SYSTEM & BUILDING ANAYSIS SUMMARY

OVERALL:
The Bronx School for Law, Government & Justice contains (10) air handling units serving all major spaces. The building's top level is a mechanical penthouse and houses all but (1) of the air handling units. All air handling units are gas fired units capable of supplying heat throughout the building. There are two steam boilers located in the cellar of the building which provide steam to fin tube radiators located in most perimeter spaces. The steam fin tube radiators are used as the primary heat source and the heating from the air handling units is used as a secondary source. Air is distributed throughout the building through ductwork that runs through vertical shafts that are strategically placed through the building. AHUs 3,4,6,8,10 are all single zone systems due to the design standards set by the owner, The New York City Construction Authority. Table 5.1 represents the scheduled design of each AHU, area served, total air and outside air. This data was compared to the results from the calculations of ASHRAE 62.1.

TABLE 5.1

Air Handling Units (AHU)	Location	Type	Total CFM	Min. Outdoor Air CFM	OA %
AHU 1 [Classrooms & misc.]	Penthouse	VAV	48000	26000	54.17
AHU 2 [Classrooms & misc.]	Penthouse	VAV	19000	9000	47.37
AHU 3 [Gymnasium]	Penthouse	CAV	18500	7500	40.54
AHU 4 [Library]	Penthouse	CAV	3400	1020	30.00
AHU 5 [Lobby & Corridor]	Penthouse	CAV	12000	6900	57.50
AHU 6 [Kitchen]	Penthouse	CAV	5200/2600	5200/2600	100/100
AHU 7 [Administration]	Cellar	VAV	12000	3800	31.67
AHU 8 [Dining]	Penthouse	CAV	6000	3360	56.00
AHU 9 [Plant Operations]	Penthouse	CAV	7200	2200	30.56
AHU-10 [Orchestra]		CAV	3100	1050	33.87
TOTAL			**133440**	**66030**	**49.13**

AHU-1 [Appendix A], **AHU-2** [APPENDIX B]:

Air Handling Units 1 and 2 are the two largest units in the building including all classrooms, science labs, computer labs and adjoining office spaces. The majority of the spaces AHU -1, 2 serve are located on the 2nd, 3rd and 4th floors. There are four classrooms located on the first floor which is also served by AHU-1. A large portion of the sensible load in these spaces comes from people therefore; it had to be assured that

enough fresh outdoor air had to be delivered to these spaces. This was important in the design to limit the amount of contaminants recirculating throughout the building.

AHU-1

Max Z_p = 0.34
E_v = 0.8
$V_{ot} = (V_{ou})/(E_{v)}$ = 13193 cfm
Designed OA = 26000 cfm

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied

AHU-2

Max Z_p = 0.38
E_v = 0.7
$V_{ot} = (V_{ou})/(E_{v)}$ = 6630 cfm
Designed OA = 9000 cfm

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied

AHU-3 [Appendix C]:

AHU-3 serves the gymnasium located on the 5th floor. The gymnasium is a double height space occupying the 5th and 6th floors. AHU-3 only serves the gymnasium and therefore; the outdoor air requirement was calculated from section 6.2.3 from ASHRAE 62.1. ASHRAE allows for a correction factor for occupancy diversity however, in this analysis it was assumed to be conservative to design at peak loads for all times. This assumption was made because of the large activity and assembly that would occur in the space and enough fresh outdoor air was needed to satisfy the occupants.

AHU-3

Max Z_p = [Not Needed per ASHRAE 62.1 section 6.2.3]
E_v = [Not Needed per ASHRAE 62.1 section 6.2.3]
$V_{ot} = (V_{ou}) = (V_{oz)}$ = 4245 cfm
Designed OA = 7500 cfm

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied

AHU-4 serves only the library and related spaces located on the 2nd floor. A separate unit for the library was installed for better temperature and humidity control. This was important because the library has to be relatively dry to prevent moisture to accumulate onto the books. Installing a separate air handler allowed for an isolated control.

AHU- 4

Max Z_p = 0.24
E_v = 0.9
V_{ot} = (V_{ou})/(E_v) = 735 cfm
Designed OA = 1020 cfm

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied

AHU-5 [Appendix E]:

AHU-5 serves the entrance lobby and the main corridors between floors one through 5. The New York City Energy Code requires that all corridors be served by a separate unit. This is ideal because of the traffic throughout the building is done through the corridor, contaminants circulate more readily. A separate unit is ideal to prevent these contaminants from recirculating throughout the building.

AHU- 5

Max Z_p = 0.11
E_v = 1.0
V_{ot} = (V_{ou})/(E_v) = 1135 cfm
Designed OA = 6900 cfm

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied

AHU-6 [Appendix F]:

AHU-6 serves the kitchen located in the cellar of the building. AHU-6 is a 100% outdoor air unit capable of operating under (2) speeds. The installation of a variable speed fan was incorporated due to the idea that the kitchen would only operate for a short amount of time on peak demand throughout the day. It was designed to conserve energy by not having to operate the air handler at part load through the majority of the time. The large

volume of air exhausted from the kitchen hoods required that this air handler be a 100% outdoor air system because there would not have been enough recirculated air.

AHU-6

Max Z_p = [Not Needed per ASHRAE 62.1 section 6.2.4]
E_v = [Not Needed per ASHRAE 62.1 section 6.2.4]
$V_{ot} = (V_{ou}) = (V_{oz}) = 702$ cfm
Designed OA = 5200 cfm or 2600 cfm @ half speed

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied for both operating speeds

AHU-7 [Appendix G]:

AHU-7 serves primarily the first floor with the exception of the classrooms, main lobby and main corridor. Predominately the first floor contains administration's offices and other like spaces therefore; these spaces were served by one air handler. AHU-7 is the only air handling unit not in the mechanical penthouse on the top level, but rather located in the cellar level.

AHU- 7

Max Z_p = 0.26
E_v = 0.8
$V_{ot} = (V_{ou})/(E_v) = 964$ cfm
Designed OA = 3800 cfm

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied

AHU-8 [Appendix H]:

AHU-8 serves the student cafeteria located in the cellar level. This unit is another single zone serving only the student dining area. Due to the large volume of occupants occupying this space it was ideal to isolate this space from the rest of the building. This limited the ability for contaminants to be recirculated throughout the building

AHU-8

Max Z_p = [Not Needed per ASHRAE 62.1 section 6.2.3]
E_v = [Not Needed per ASHRAE 62.1 section 6.2.3]
$V_{ot} = (V_{ou}) = (V_{oz}) = 2536$ cfm
Designed OA = 3360 cfm

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied

AHU-9 [Appendix I]:

AHU-9 distributes air to the remaining spaces in the cellar. The remaining cellar spaces are mostly building utility systems rooms such as the boiler rooms. There are a few student occupied spaces such as student organizations. The cellar with the exception of the cafeteria and kitchen required less outdoor air due to the fact that the occupants are relatively low in the cellar.

AHU- 9

Max $Z_p = 0.24$
$E_v = 0.9$
$V_{ot} = (V_{ou})/(E_{v)} = 898$ cfm
Designed OA = 2200 cfm

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied

AHU-10 [Appendix J]:

AHU-10 is the final air handler and it serves the orchestra room. Due to the relatively high concentration of people in one space it was ideal to, as well, isolate this space from the remainder of the building. This was to allow for more control of the temperature within the space.

AHU-10

Max Z_p = [Not Needed per ASHRAE 62.1 section 6.2.3]
E_v = [Not Needed per ASHRAE 62.1 section 6.2.3]
$V_{ot} = (V_{ou}) = (V_{oz}) = 745$ cfm
Designed OA = 1050 cfm

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied

6.0 VENTILATION RATE vs. INDOOR AIR QUALITY

The Ventilation Rate Procedure (VRP) determines the required fresh outdoor air based on the occupancy level and floor level. VRP predetermines that the majority of the contaminants within a building occur from the occupants. It then accounts for contaminants based off of the space type and designates a certain percentage of volume of air per square feet and establishes that value along with the occupant value as the required outdoor air. VRP also adds correction factors to account for different types of ways that air is distributed through out the building. For instance, ceiling supply air versus floor supply air. VRP also allows for a diversity factor which reduces the required outdoor based on the notion the space in question will not be at its maximum designed occupant long for an extensive time. Then VRP takes this corrected value and requires that the system's requirement be designed at the maximum outdoor air space within that system.

The Indoor Air Procedure (IAP) takes a different approach and examines the contaminants directly. In order to perform the IAP it is required to the source of the contaminant, the concentration of the contaminant to the volume of air, and the desired acceptable concentration of contaminant. The IAP does take into account indoor air quality cleaning devices such as high-grade filters.

The IAP would most likely not be used for everyday purposes due to the complexity of the procedure. For instance, it is more difficult to determine the concentration of a contaminant versus measuring the square footage of a space. The IAP would only be used when studying high-grade labs and other buildings of that nature or if a deadly particle, such as anthrax, is released into a building. Then a more stringent analysis would be needed to evaluate the outdoor air requirement otherwise, for everyday purposes it is ideal to use the VRP method.

APPENDIX A

Air Handling Unit (AHU)	Total CFM	Min. OA CFM	OA %
AHU 1 [Classrooms & Misc.]	48000	26000	0.5417

				Actual Design		ASHRAE Table 6.2			
Rm No.	Room Name	A_z (Area, SF)	No. of Occupants	CFM	OA CFM	R_p, cfm/person	Ra, cfm/SF	$V_{bz} = V_{oz}$	Z_p
118	Classroom 3	743	35	1960	1062	10	0.12	439	0.22
120	Classroom 4	758	35	1880	1018	10	0.12	441	0.23
121	Classroom 2	773	35	1700	921	10	0.12	443	0.26
122	Classroom 1	782	35	1660	899	10	0.12	444	0.27
201	Computer Classroom	1207	35	1690	915	10	0.06	422	0.25
202	Staff infirmary	165	2	230	125	5	0.06	20	0.09
204	Guid. College/Voc.	213	3	350	190	5	0.06	28	0.08
204A	Office	115	1	315	171	5	0.06	12	0.04
204B	Conference	128	1	340	184	5	0.06	13	0.04
205	Teaching Aid Locker	218	3	720	390	5	0.06	28	0.04
207	Courtroom Distance Learning	1226	38	1880	1018	5	0.06	264	0.14
208	Resource Rm.	382	13	1035	561	10	0.12	176	0.17
210	Substitute Office	133	1	200	108	5	0.06	13	0.06
210A	Office	93	3	300	163	5	0.06	21	0.07
210B	Office/Conference	177	5	300	163	5	0.06	36	0.12
210C	Office	174	2	200	108	5	0.06	20	0.10
211	Supervisor Office	217	3	245	133	5	0.06	28	0.11
211A	Conference	209	6	450	244	5	0.06	43	0.09
213	Special Ed. Class	441	21	1400	758	10	0.12	263	0.19
213	Special Ed. Class	544	21	1400	758	10	0.12	275	0.20
219	Spch. Wrk. & Health Exam	339	19	770	417	10	0.12	231	0.30
220	Health Exam	367	19	1400	758	10	0.12	234	0.17
221	Classroom 7	735	35	1840	997	10	0.12	438	0.24
222	Classroom 6	773	35	1600	867	10	0.12	443	0.28
223	Classroom 5	783	35	1560	845	10	0.12	444	0.28
301	Forensics Science Lab	1299	36	1745	945	10	0.18	594	0.34
304	Teacher's Work Rm.	300	10	800	433	5	0.06	68	0.09
305	Conference	171	2	250	135	5	0.06	20	0.08
305B	Supervisor Office	159	2	560	303	5	0.06	20	0.03
306	Tri-facial Science Lab	1239	39	2200	1192	10	0.18	613	0.28
308	Science Prep.	1378	35	3100	1679	10	0.18	598	0.19
309	Science Demo Lab	859	36	2160	1170	10	0.18	515	0.24
310	Tri-facial Science Lab	1381	39	2040	1105	10	0.18	639	0.31
311	Science Demo Lab	837	36	2160	1170	10	0.18	511	0.24
318	Classroom 12	720	35	1960	1062	10	0.12	436	0.22
319	Classroom 11	735	35	1940	1051	10	0.12	438	0.23
320	Classroom 10	773	35	1800	975	10	0.12	443	0.25
321	Classroom 9	783	35	1860	1008	10	0.12	444	0.24
	Total			**48000**	**26000**			**V_{ot} = 13193 cfm**	

APPENDIX B

	Air Handling Unit (AHU)	Total CFM	Min. OA CFM	OA %
	AHU 2 [Classrooms & Misc.]	19000	9000	0.4737

				Actual Design		ASHRAE Table 6.2			
Rm No.	Room Name	A_z (Area, SF)	No. of Occupants	CFM	OA CFM	R_p, cfm/person	Ra, cfm/SF	$V_{bz} = V_{oz}$	Z_p
312	Vestibule	258	4	200	95	5	0.06	35	0.18
312A	Conference	247	1	400	189	5	0.06	20	0.05
312B	Records Rm.	142	6	400	189	5	0.06	39	0.10
312C	Office	142	3	235	111	5	0.06	24	0.10
312D	Office	142	1	230	109	5	0.06	14	0.06
312E	Office	142	1	235	111	5	0.06	14	0.06
313	Science Demo Lab	856	36	2040	966	10	0.18	514	0.25
402	Teacher's Workshop	300	10	640	303	5	0.06	68	0.11
404	Crime Lab	1289	35	1550	734	10	0.18	582	0.38
406	Computer Classroom	1178	35	1370	649	10	0.12	491	0.36
407	Large Book Storage	330	3	200	95	0	0.12	40	0.20
409	Art studio	1380	35	2125	1007	10	0.18	598	0.28
410	Superintendent Office Sec.	186	2	220	104	5	0.06	21	0.10
410A	Superintendent Office	179	2	450	213	5	0.06	21	0.05
412	Vestibule	233	2	200	95	5	0.06	24	0.12
412A	Conference	247	6	400	189	5	0.06	45	0.11
412B	Guidance Records	142	3	400	189	5	0.06	24	0.06
412C	Office	142	1	235	111	5	0.06	14	0.06
412D	Office	142	3	230	109	5	0.06	24	0.10
412E	Guidance Office	150	3	240	114	5	0.06	24	0.10
416	Language Lab	720	35	1580	748	10	0.12	436	0.28
417	Classroom 15	735	35	1905	902	10	0.12	438	0.23
418	Classroom 14	773	35	1600	758	10	0.12	443	0.28
419	Classroom 13	783	35	1585	751	10	0.12	444	0.28
501	Health Instructor Office	363	3	330	156	5	0.06	37	0.11
	Total			**19000**	**9000**			**V_{ot} = 6630 cfm**	

APPENDIX C

	Air Handling Unit (AHU)	Total CFM	Min. OA CFM	OA %
	AHU 3 [Gymnasium]	18500	7500	0.4054

				Actual Design		ASHRAE Table 6.2		
Rm No.	Room Name	A_z (Area, SF)	No. of Occupants	CFM	OA CFM	R_p, cfm/person	Ra, cfm/SF	$V_{bz} = V_{oz}$
517	Gymnasium	8255	500	18500	7500	7.5	0.06	4245
	Total			**18500**	**7500**			**$V_{ot} = V_{oz}$ = 4245 cfm**

APPENDIX D

Air Handling Unit (AHU)	Total CFM	Min. OA CFM	OA %
AHU 4 [Library]	3400	1020	0.3000

				Actual Design		ASHRAE Table 6.2			
Rm No.	Room Name	A_z (Area, SF)	No. of Occupants	CFM	OA CFM	R_p, cfm/person	Ra, cfm/SF	$V_{bz} = V_{oz}$	Z_p
209	Library	2069	68	2495	749	5	0.12	588	0.24
209A	Law Collection Rm.	150	2	315	95	5	0.06	19	0.06
209B	Tech. Center	156	1	220	66	5	0.06	14	0.07
209C	Librarian Workshop	116	1	110	33	5	0.06	12	0.11
209D	Librarian Office	126	1	150	45	5	0.06	13	0.08
209E	Audio/Visual Station	90	2	110	33	5	0.06	15	0.14
	Total			**3400**	**1020**			**V_{ot} = 735 cfm**	

APPENDIX E

Air Handling Unit (AHU)	Total CFM	Min. OA CFM	OA %
AHU 5 [Lobby & Corridor]	12000	6900	0.5750

				Actual Design		ASHRAE Table 6.2			
Rm No.	Room Name	A_z (Area, SF)	No. of Occupants	CFM	OA CFM	R_p, cfm/person	Ra, cfm/SF	$V_{bz} = V_{oz}$	Z_p
112	Corridor	1846	15	2430	1397	5	0.06	186	0.08
127	Main Hall	1055	10	1600	920	5	0.06	113	0.07
212	Corridor	2665	20	2430	1397	5	0.06	260	0.11
325	Corridor	2651	20	2390	1374	5	0.06	259	0.11
411	Corridor	2661	20	2430	1397	5	0.06	260	0.11
502	W. Corridor	326	2	360	207	5	0.06	30	0.08
513	E. Corridor	300	2	360	207	5	0.06	28	0.08
	Total			**12000**	**6900**			**V_{ot} = 1135 cfm**	

APPENDIX F

Air Handling Unit (AHU)	Total CFM	Min. OA CFM	OA %
AHU 6 [Kitchen]	5200/2600	5200/2600	1.0000

				Actual Design		ASHRAE Table 6.2		
Rm No.	Room Name	A_z (Area, SF)	No. of Occupants	CFM	OA CFM	R_p, cfm/person	Ra, cfm/SF	$V_{bz} = V_{oz}$
C16	Kitchen	3486	10	5200	5200	7.5	0.18	702
	Total			**5200**	**5200**			**$V_{ot} = V_{oz}$ = 702 cfm**

APPENDIX G

Air Handling Unit (AHU)	Total CFM	Min. OA CFM	OA %
AHU 7 [Administration]	12000	3800	0.3167

				Actual Design		ASHRAE Table 6.2			
Rm No.	Room Name	A_z (Area, SF)	No. of Occupants	CFM	OA CFM	R_p, cfm/person	Ra, cfm/SF	$V_{bz} = V_{oz}$	Z_p
101	Program Office	197	2	275	87	5	0.06	22	0.08
101A	Work Room	280	1	450	143	5	0.06	22	0.05
101B	Office	148	1	300	95	5	0.06	14	0.05
102	Medical Suite	129	1	250	79	5	0.06	13	0.05
102B	Office/Exam Room	110	1	300	95	5	0.06	12	0.04
102E	Wait Room	100	1	250	79	5	0.06	11	0.04
107	AP. AD. Secretary	260	5	550	174	5	0.06	41	0.07
108	AP. AD. Office	389	5	760	241	5	0.06	48	0.06
109	Conference	474	5	800	253	5	0.06	53	0.07
110	Principal Sec.	262	5	570	181	5	0.06	41	0.07
110A	Wait Room	93	3	200	63	5	0.06	21	0.10
111A	Principal's Office	461	1	800	253	5	0.06	33	0.04
128	Duplicate. Rm.	132	9	200	63	5	0.06	53	0.26
129	Teacher's Mail	143	1	200	63	5	0.06	14	0.07
130	Security Window Desk	127	1	150	48	5	0.06	13	0.08
130A	Security Change Rm.	96	1	150	48	5	0.06	11	0.07
130B	Security Change Rm.	96	1	150	48	5	0.06	11	0.07
131	General Office	305	1	600	190	5	0.06	23	0.04
131A	Wait & Reception	127	3	250	79	5	0.06	23	0.09
131B	Treasury Office	149	1	275	87	5	0.06	14	0.05
131C	Payroll Office	148	3	280	89	5	0.06	24	0.09
132	Lateness and Attendance	96	2	225	71	5	0.06	16	0.07
133	Student Support	110	3	250	79	5	0.06	22	0.09
133A	Records	67	1	150	48	5	0.06	9	0.06
133B	Dean	118	1	220	70	5	0.06	12	0.05
133C	Dean	118	1	220	70	5	0.06	12	0.05
134	Custodian Office	313	2	500	158	5	0.06	29	0.06
136	Parent Communication	195	1	280	89	5	0.06	17	0.06
137	AP. Guidance Sec.	220	1	320	101	5	0.06	18	0.06
141	AP. Guidance	350	2	600	190	5	0.06	31	0.05
142	N. Corridor	877	8	1475	467	5	0.06	93	0.06
	Total			**12000**	**3800**			**V_{ot} = 964 cfm**	

APPENDIX H

Air Handling Unit (AHU)	Total CFM	Min. OA CFM	OA %
AHU 8 [Dining]	6000	3360	0.5600

			Actual Design		ASHRAE Table 6.2		
Rm No.	Room Name	A_z (Area, SF)	No. of Occupants	CFM	OA CFM	R_p, cfm/person	Ra, cfm/SF	$V_{bz} = V_{oz}$
C15	Student Dining	3466	255	6000	3360	7.5	0.18	2536
Total				**6000**	**3360**			**$V_{ot} = V_{oz}$ = 2536 cfm**

APPENDIX I

Air Handling Unit (AHU)	Total CFM	Min. OA CFM	OA %
AHU 9 [Plant Operations]	7200	2200	0.3056

			Actual Design		ASHRAE Table 6.2			
Rm No.	Room Name	A_z (Area, SF)	No. of Occupants	CFM	OA CFM	R_p, cfm/person	Ra, cfm/SF	$V_{bz} = V_{oz}$	Z_p
C01	Govt. Clubs Pub	504	12	1000	306	5	0.06	90	0.09
C01A	Office	100	1	150	46	5	0.06	11	0.07
C01B	Office	105	1	150	46	5	0.06	11	0.08
C06	W. Corridor	941	5	825	252	5	0.06	81	0.10
C09	Year Round Storage	336	1	250	76	5	0.06	25	0.10
C14	Student Store	167	1	235	72	5	0.06	15	0.06
C14A	Student St. Office	161	1	230	70	5	0.06	15	0.06
C17	Staff Lunch	602	20	1055	322	7.5	0.18	258	0.24
C23	Corridor	437	2	510	156	5	0.06	36	0.07
C31	Custod. Male Locker	91	1	125	38	5	0.06	10	0.08
C32	Custod. Shop/Storage	405	2	370	113	5	0.06	34	0.09
C33	Custod.Female Locker	91	1	125	38	5	0.06	10	0.08
C35	Furn. Storage	151	1	170	52	0	0.12	18	0.11
C36	Vault	485	1	440	134	5	0.06	34	0.08
C37	Vault Anter. Rm.	104	1	190	58	5	0.06	11	0.06
C38	N. Corridor	1074	5	975	298	5	0.06	89	0.09
C39	Receiving & Supply	469	1	400	122	0	0.12	56	0.14
Total				**7200**	**2200**			**V_{ot} = 898 cfm**	

APPENDIX J

Air Handling Unit (AHU)	Total CFM	Min. OA CFM	OA %
AHU 10 [Orchestra]	3100	1050	0.3387

			Actual Design		ASHRAE Table 6.2		
Rm No.	Room Name	A_z (Area, SF)	No. of Occupants	CFM	OA CFM	R_p, cfm/person	Ra, cfm/SF	$V_{bz} = V_{oz}$
401	Orchestra	1420	66	3100	1050	10	0.06	745
Total				**3100**	**1050**			**$V_{ot} = V_{oz}$ = 745 cfm**

8.0 REFERENCES

1) ASHRAE Standard 62.1-2004
2) Construction Documents of Bronx School for Law, Government & Justice
3) New York City Energy Code
4) New York City Construction Authority Design Standards