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Mechanical Technical Report 1

ASHRAE Standard 62.1 Ventilation Report

The Bloomberg Tower
731 Lexington Avenue
New York, NY 10022

Faculty Advisor: Dr. Jelena Srebric

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1.0 Executive Summary

ASHRAE Standard 62-2004 and all current addenda, set forth minimum outdoor air (OA) requirements for all indoor spaces occupied by people. The purpose of this report is to determine whether or not the amount of OA supplied to the occupied spaces of the Bloomberg Tower at 731 Lexington Avenue satisfies these requirements.

The Bloomberg Tower is 1.4 million square feet total, with this area being distributed between a 55 story tower and an 8-story building (east building) connected by an oval atrium. The scope of this report will include the office spaces in the tower occupied by Bloomberg LP and CitiGroup. Because of the size of the building, Dr. Srebric recommended analyzing main supply risers instead of individual air handling units. In order to do this, three supply risers were considered: SA-2, SA-7, and SA-12. Supply risers SA-2 & 7 are served by three 100,000 CFM air handling units while SA-12 is served by three additional 21,200 CFM units. Each of these risers supplied approximately one quarter of each floor, as each floor is served by four risers distributing the same amount of supply air.

Each floor was divided into four equal quarters (zones), each quarter having similar space characteristics. Upon completing the required OA for each of these zones, it was found that approximately 12,490 CFM is required, while 40,986 CFM is being supplied. One reason for this significant difference is the stringency of the NYC Building Code, the code used for design, as compared to that of ASHRAE 62-2004. Therefore all of the spaces considered were well within compliance of the ASHRAE code.

2.0 Building Data

The Bloomberg Tower is a multi-use building that houses retail stores, Bloomberg LP Headquarters, CitiGroup Offices, and residential condos. As stated previously, not all portions of the building were considered in this compliance check. The retail areas located on the Ground level of both the tower and east building along with the second floor of the tower are not yet fitted with their air handling units, and were therefore excluded from all calculations. The residential portion of the tower (floors 31-55) is not served by air handlers either, but rather utilizes hopper windows for OA ventilation. A hopper window, by definition, is a window that tilts inward at the top, pivoting from the bottom rail; this is in compliance with NYC Building Codes.

The system, as analyzed by the methods described in the executive summary, is arranged such that: the SA riser chosen is served by three air handling units and this riser in turn serves the north-east quadrant of each of the floors (from floors 3-28). As seen in the example below, see Figure 1.

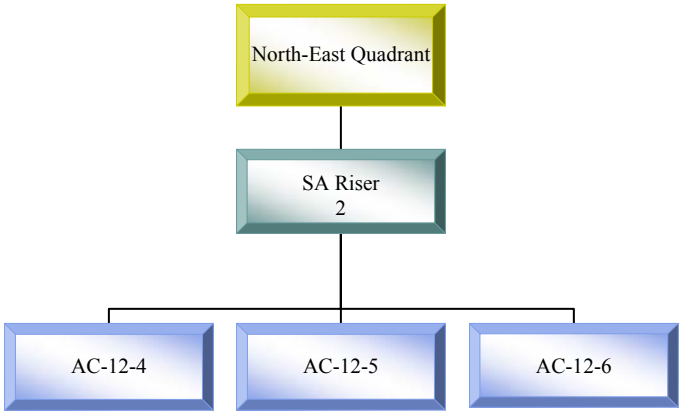
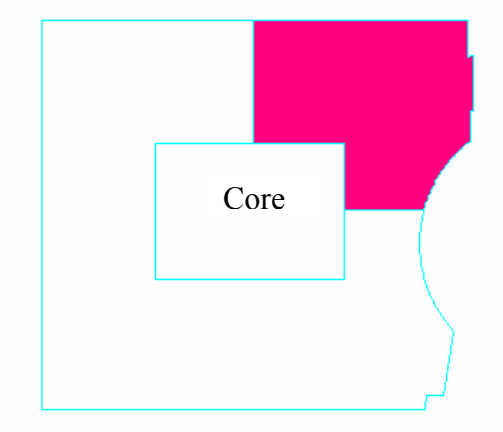


Figure 1

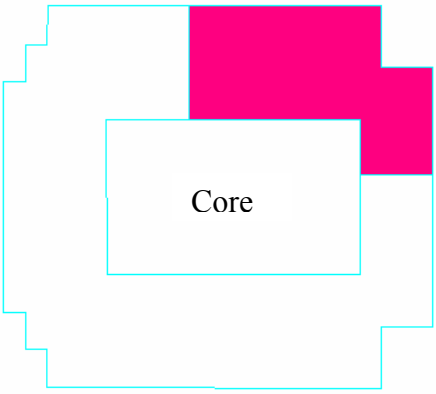
Figure 2 shows the areas on each floor plan served by each SA Riser analyzed. On floors 3-10, this area was approximately 34000 SF/floor, while on floors 13-28 this accounted for about 3500 SF/floor. Thus far, this building contains 24 air-handling or ventilating units. Additional units will be installed as portions of the building are leased and tenant-fit outs are completed. Information about the existing units in the building is discussed further in this section.

Figure 2

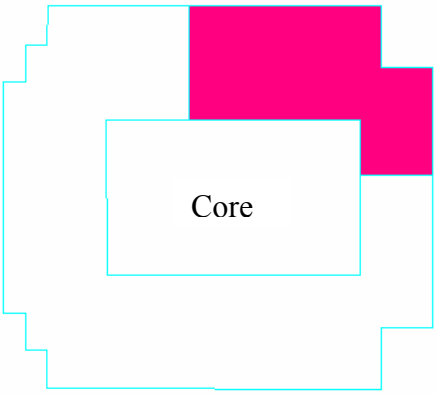
SA-2 serves these highlighted areas on floors 3-10:



SA-7 serves this highlighted area on floors 14-20:



SA-12 continues with the areas highlighted from floors 21-28:



AC-12-4 thru 6
These units are located on the 12th floor. This floor is a mechanical supply floor and is located directly above the mechanical return floor, floor 11. AC units 4-6 serve supply air risers 2&7. Each of these units has a capacity of approximately 100,000 CFM. Each unit also has the capacity for 100% OA, although on hot/humid days the units may use only 30% OA. This minimum of 30% OA is the amount of air used for comparison to the ASHRAE requirements. (AC-12-1 thru 3 are identical to 4 thru 6)

AC-29-4 thru 6
Serving SA-12, these units are located in the 29th floor, which is another dedicated mechanical floor. According to the AHU schedule, they have a capacity of 21200 CFM and are also capable of being 100% OA. As with AC-12-4 thru 6, these units contain an air and steam side pre-heating coil, an air and water side cooling coil, and a fan. Air is distributed from the units, to the supply air riser, and is then ducted to fan powered boxes. Distribution to each space is through ceiling diffusers. (AC-29-1 thru 3 are identical to 4 thru 6)

HV-SC-3-4
Although this unit is not considered as part of this study, this unit provides heating and ventilation only to the loading dock areas located on Lower Level 3 of the tower. The unit is located on this level and supplies 15000 CFM of 100% OA. As per Std. 62, there is no occupancy requirement for this area therefore it was not considered for this assignment.

HV-SC-3-1 Thru 3
Located in Lower Level 3 of both the tower and east building, these units provide heating and ventilation to the remainder of the areas no covered by HV-SC-3-4. These areas again are unoccupied areas as defined by Std. 62, being mainly storage areas. Having capacities of 11800, 10050, and 8000 CFM, respectively, 100% OA is provided.

AC-8-1 & 2
Serving floors 3-7 in the East Building, which is entirely Bloomberg LP office space, the capacity of each unit is 107,000 CFM. Distribution to these floors is the same as described above with units AC-29-4 Thru 6.

AC-GR-1, AC-LL-1-1, AHU-LL-1-2
All of these units serve lobby areas in different portions of the building. The capacities are 5000, 7500, and 5000 CFM respectively. Approximately 30% OA is supplied to the lobby spaces.

AHU-12-7, AHU-21-1, AHU 29-9
Provide service to Elevator MER Rooms with capacities of 6000, 4000, and 4500 CFM.

3.0 Analysis and Assumptions

Since all of the areas considered are speculative office space/Bloomberg office space, and CitiGroup office space, all of the occupancy values were taken from Table 6-1 of Std. 62-2004. The mechanical drawings provided by Flack+Kurtz also contained the values for the number of people per space. Since only one quarter of each floor area was examined, only one quarter of the given population was applied to each zone. A general listing of the areas and number of people per riser is given below:

SA 2

SPACES SERVED	FLOOR	Supply CFM	AREA (SF)	# PPL
BLP OFFICE	3 TOWER	14200	8410	105
BLP OFFICE	4 TOWER	15000	15941	199
BLP OFFICE	5 TOWER	15000	16078	202
BLP OFFICE	6 TOWER	11000	10774	135
BLP OFFICE	7 TOWER	10125	5121	64
BLP OFFICE	8 TOWER	7100	4000	50
BLP OFFICE	9 TOWER	7100	3980	50
BLP OFFICE	10 TOWER	7100	3981	50

SA 7

SPACES SERVED	FLOOR	Supply CFM	AREA (SF)	# PPL
BLP OFFICE	13 TOWER	6000	3347	42
BLP OFFICE	14 TOWER	6000	3347	42
BLP OFFICE	15 TOWER	6000	3347	42
BLP OFFICE	16 TOWER	6000	3347	42
BLP OFFICE	17 TOWER	6000	3347	42
BLP OFFICE	18 TOWER	6000	3347	42
BLP OFFICE	19 TOWER	6000	3347	42

SA 12

SPACES SERVED	FLOOR	Supply CFM	AREA (SF)	# PPL
CITIGROUP	20 TOWER	4000	3347	42
CITIGROUP	21 TOWER	3500	3347	42
CITIGROUP	22 TOWER	3500	3347	42
CITIGROUP	23 TOWER	3500	3347	42
CITIGROUP	24 TOWER	3500	3347	42
CITIGROUP	25 TOWER	3500	3347	42
CITIGROUP	26 TOWER	3500	3347	42
CITIGROUP	27 TOWER	3500	3347	42
CITIGROUP	28 TOWER	2000	3347	42

The spaces served by SA-12 are broken down further in Appendix A. These spaces included conference rooms, open office space, executive suites, and offices of several sizes. Since these spaces and all other spaces examined are ceiling supplied, E_z=1.0, according to Table 6-3, for all calculations.

Some additional assumptions were made while calculating the design and required OA rate. A diversity factor of 1.0 was applied to all calculations. The office spaces examined belong to two of the leading financial companies in the world. The idea that these spaces would be used for short durations and the population density would fluctuate greatly was dismissed. Being located in New York City and housing company headquarters for the firms mentioned above, the Bloomberg Tower will experience high occupant density for an above average time period (i.e. the average workday will longer than 9am-5pm and consistent use of conference areas is likely).

The underlying assumption of this report is that since the building is served by four core risers, each supplying the same amount of air, the compliance of one quadrant may be calculated and used as a model of the compliance of the remaining three spaces. Upon further inspection of the architectural floor plans, slight variations may occur since the other three quadrants contain spaces such as kitchens, restrooms, waiting areas, and copy rooms. Table 6-1 shows that CFM/person and CFM/SF requirements differ for these spaces as compared to offices.

As stated in the executive summary, all of the spaces were determined to be compliant with Std. 62. Tables of these results are shown below for quick reference. A full spreadsheet showing the calculations in their entireties is located in Appendix A.

	SA RISER 2		
SPACES SERVED	**FLOOR**	**Supplied OA CFM**	**Required OA CFM**
BLP OFFICE	3 TOWER	4260	1029.57
BLP OFFICE	4 TOWER	4500	1952.68
BLP OFFICE	5 TOWER	4500	1972.15
BLP OFFICE	6 TOWER	3300	1320.19
BLP OFFICE	7 TOWER	3037.5	627.275
BLP OFFICE	8 TOWER	2130	489.985
BLP OFFICE	9 TOWER	2130	488.815
BLP OFFICE	10 TOWER	2130	488.845

	SA RISER 7		
SPACES SERVED	FLOOR	Supplied OA CFM	Required OA CFM
BLP OFFICE	14 TOWER	1800	409.555
BLP OFFICE	15 TOWER	1800	409.555
BLP OFFICE	16 TOWER	1800	409.555
BLP OFFICE	17 TOWER	1800	409.555
BLP OFFICE	18 TOWER	1800	409.555
BLP OFFICE	19 TOWER	1800	409.555
BLP OFFICE	20 TOWER	1800	409.555

	SA RISER 12		
SPACES SERVED	FLOOR	Supplied OA CFM	Required OA CFM
CitiGroup Office	21 TOWER	345	214.3
CitiGroup Office	22 TOWER	215	139.6
CitiGroup Office	23 TOWER	210	110.4
CitiGroup Office	24 TOWER	295	127.7
CitiGroup Office	25 TOWER	270	101.2
CitiGroup Office	26 TOWER	320	184.2
CitiGroup Office	27 TOWER	187	76.2
CitiGroup Office	28 TOWER	556	298.4

4.0 Determination of Outdoor Air Flow Rates Required

Applying the Ventilation Rate Procedures from ASHRAE Std. 62-2004, the minimum OA intake flow rates were determined for each system. This procedure is outlined step-by-step below.

Step 1: Calculation of Breathing Zone Outdoor Air (V_{bz})

Applying equation 6-1 from 6.2.2.1:

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

Where the following variables are defined by Std. 62-2004:

> $\boldsymbol{V_{bz}}$ is the *outdoor are required in the breathing zone of the occupiable space* or spaces in a zone.
>
> $\boldsymbol{R_p}$ is the *outdoor airflow rate per person* as determined by ASHRAE Table 6-1.

$\boldsymbol{P_z}$ is the *zone population* or the largest number of people expected to occupy the zone during typical usage. If this number was unknown, it was estimated using the occupant density column of Table 6-1.

$\boldsymbol{R_A}$ is the *outdoor airflow rate required per unit area* based on the values in Table 6-1.

$\boldsymbol{A_z}$ is the *zone floor area* or net occupied area of the zone (ft^2).

Step 2: Calculation of the Zone Air Distribution Effectiveness *(E_z)*

E_z is found by using Table 6-2 of the code. In order to use this table, the zone air distribution configuration must be known. For the Bloomberg Tower, all conditioned air is distributed via a ceiling supply. From Table 6-2, from this configuration E_z=1.0.

Step 3: Calculation of the Zone Outdoor Air *(V_{oz})*

Applying equation 6-2 from 6.2.2.3:

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

Step 4: Determination of the Outdoor Air Intake Flow *(V_{ot})*

For this step the code is separated into three scenarios:

Single Zone Systems: When one air handler supplies outdoor air and recirculated air to a single zone:

$$V_{ot} = V_{oz}$$

100% Outdoor Air Systems: When one air handler provides 100% outdoor air to one or more zones.

$$V_{ot} = \Sigma_{\text{all zones}} V_{oz}$$

Multiple Zone Recirculating Systems: When one air handler provides mixed outdoor and returned air to more than one zone. In this case, V_{ot} must be determined by following the methods outlined in sections 6.2.5.1-6.2.5.4.

Step 5: Finding the Primary OA Fraction *(Z_p)*

Using equation 6-5 from 6.2.5.1:

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

Where V_{pz} is the *primary zone flowrate,* and includes both recirculated and outdoor air. For VAV systems this is the minimum expected primary airflow for design.

Step 6: Finding the System Ventilation Efficiency *(E_v)*

After determining the maximum Z_p value, E_v was found to be 1.0 from Table 6-3 of Std. 62.

Step 7: Finding the Uncorrected OA Intake *(V_{ou})*

Applying Equation 6-6:

$$V_{ou}=D\Sigma_{allzones} R_p P_z + \Sigma_{allzones} R_A A_z$$

Where $D=P_s/\Sigma_{allzones} P_z$

Step 8: Finding the OA Intake Rate

Applying equation 6-8:

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

V_{ot} is the *design outdoor air intake flowrate*.

See Section 3.0 Analysis and Assumptions for spreadsheet results.

5.0 Discussion

ASHRAE Standard 62-2004 describes two methods for designing the ventilation system of a building: the Ventilation Rate Procedure and the Indoor Air Quality Procedure (IAQ). As seen in this report the Ventilation Rate Procedure was applied.

As described in the standard, the ventilation procedure is a prescriptive method in which the space type**,** number of occupants**,** and the net floor area are used to determine the required amount of outdoor air. This is the amount needed to keep the contaminant level in the space below an acceptable value, for any load condition. For this procedure these minimum contaminant levels are based upon the typical values for the type of space in question. This method utilizes dilution to keep CO_2 levels at specified level, which results in minimized levels for other space contaminants as well.

The IAQ Method on the other hand is a performance based method. For this method, it is necessary to know what contaminants are of concern, what their sources are, and what concentration of contaminants is perceived as acceptable. Once established, this level of acceptability must be maintained through modulations in ventilation, based in response to contaminant measurements (Bahnfleth 14). According to Std. 62-2004, this method allows for "credit" to be given if controls are used to reduce contaminants. Ultimately, this procedure may allow the opportunity for energy savings since the Ventilation Rate Method must always be conservative. However, since the Ventilation Rate Procedure is mapped out step by step in Std. 62-2004, it is easier to follow and therefore used more widely in practice.

It may be difficult to use the IAQ method when not all building information is known. For instance, in order to apply this method to the Bloomberg Tower, information on the building materials used (carpets, paints, finishes, etc.) would need to be supplied. Also, when applying this method, the building needs to be continuously monitored. Since this is the first skyscraper constructed in New York since the World Trade Center tragedy and terrorism is a concern, it would be beneficial for the Bloomberg tenants to adopt such a monitoring system.

6.0 References

ASHRAE Standard 62-2004**,** *Ventilation for Acceptable Indoor Air Quality.*

Dr. Bahnfleth, AE 552 class notes, *Design Criteria: Overview, Chemical Exposure, Fire.*

Flack+Kurtz, The Thornton Tomasetti Group, Bloomberg Tower Drawing set and Specifications.

The Pennsylvania State University, Dept. of Architectural Engineering, Previous thesis assignments, 2005.

7.0 Appendix A

SA-2 Compliance Calculations, Z_p, V_{ot}
SA-7 Compliance Calculations, Z_p, V_{ot}
SA-12 Compliance Calculations, Z_p, V_{ot}
Comparison Tables

SA 2

						ASHRAE TABLE 6-2							
SPACES SERVED	**FLOOR**	**Supply CFM**	**SF**	**Pz (From dwgs)**	**CFM/PER**	**CFM/SF**	**RpPz**	**RaAz**	**TOTAL OA CFM REQUIRED $V_{bz}=V_{oz}$**	**Z_P**	**E_V**	**V_{ou}**	**V_{ot}**
BLP OFFICE	3 TOWER	14200	8410	105	5	0.06	525	504.6	1030	0.07	1.0	8369.5	8369.5
BLP OFFICE	4 TOWER	15000	15941	199	5	0.06	996	956.4	1953	**0.13**	1.0	8369.5	8369.5
BLP OFFICE	5 TOWER	15000	16078	202	5	0.06	1008	964.7	1972	**0.13**	1.0	8369.5	8369.5
BLP OFFICE	6 TOWER	11000	10774	135	5	0.06	674	646.4	1320	0.12	1.0	8369.5	8369.5
BLP OFFICE	7 TOWER	10125	5121	64	5	0.06	320	307.3	627	0.06	1.0	8369.5	8369.5
BLP OFFICE	8 TOWER	7100	4000	50	5	0.06	250	240.0	490	0.07	1.0	8369.5	8369.5
BLP OFFICE	9 TOWER	7100	3980	50	5	0.06	250	238.8	489	0.07	1.0	8369.5	8369.5
BLP OFFICE	10 TOWER	7100	3981	50	5	0.06	250	238.8	489	0.07	1.0	8369.5	8369.5
totals			**68284**	**855**			**4273**	**4097.0**					**66956.1**

SA 7

						ASHRAE TABLE 6-2							
SPACES SERVED	**FLOOR**	**Supply CFM**	**SF**	**Pz (From dwgs)**	**CFM/PER**	**CFM/SF**	**RpPz**	**RaAz**	**TOTAL OA CFM REQUIRED V_{bz}**	**Z_P**	**E_V**	**V_{ou}**	**V_{ot}**
BLP OFFICE	14 TOWER	6000	3347	42	5	0.06	209	200.8	410	**0.07**	1.0	2866.9	2866.9
BLP OFFICE	15 TOWER	6000	3347	42	5	0.06	209	200.8	410	0.07	1.0	2866.9	2866.9
BLP OFFICE	16 TOWER	6000	3347	42	5	0.06	209	200.8	410	0.07	1.0	2866.9	2866.9
BLP OFFICE	17 TOWER	6000	3347	42	5	0.06	209	200.8	410	0.07	1.0	2866.9	2866.9
BLP OFFICE	18 TOWER	6000	3347	42	5	0.06	209	200.8	410	0.07	1.0	2866.9	2866.9
BLP OFFICE	19 TOWER	6000	3347	42	5	0.06	209	200.8	410	0.07	1.0	2866.9	2866.9
BLP OFFICE	20 TOWER	6000	3347	42	5	0.06	209	200.8	410	0.07	1.0	2866.9	2866.9
totals			**23427**	**292**			**1461**	**1405.6**					**20068.2**

SA 12

	SPACES SERVED	FLOOR	space	Supply CFM	Min OA Supplied to space	SF	Pz (From dwgs)	ASHRAE TABLE 6-2 CFM/PER	CFM/SF	RpPz	RaAz	TOTAL OA CFM REQUIRE D $V_{bz=}$ Voz	Z_p	Ev	V_{ou}	V_{ot}
	21-0-24	21	office "C"	300	20	140	1	5	0.06	5	8.4	13.4	**0.06**	1	1251.96	**1251.96**
	21-0-25	21	office "C"	300	20	140	1	5	0.06	5	8.4	13.4				
	21-0-26	21	office "C"	300	20	140	1	5	0.06	5	8.4	13.4				
	21-cr-08	21	conference	400	60	206	5	5	0.06	25	12.36	37.36				
Zone 1	21-0-27	21	office "B"	400	30	210	1	5	0.06	5	12.6	17.6				
	21-0-01	21	fileroom	200	30	215	1	5	0.06	5	12.9	17.9				
	21-0-04	21	fileroom	200	30	215	1	5	0.06	5	12.9	17.9				
	21-0-01	21	office "B"	460	30	210	1	5	0.06	5	12.6	17.6				
	21-cr-01	21	conference	470	85	206	8	5	0.06	40	12.36	52.36				
	21-0-02	21	office "C"	300	20	140	1	5	0.06	5	8.4	13.4				
	Totals			**3330**	**345**					**105**	**109.32**	**214.32**				
	22-0-01	22	office "C"	300	20	140	1	5	0.06	5	8.4	13.4	0.06			
	22-0-23	22	office "C"	300	20	140	1	5	0.06	5	8.4	13.4				
Zone 2	22-0-24	22	office "C"	300	20	140	1	5	0.06	5	8.4	13.4				
	22-0-25	22	office "C"	300	20	140	1	5	0.06	5	8.4	13.4				
	22-0-26	22	office "B"	400	30	210	1	5	0.06	5	12.6	17.6				
	22-cr-08	22	conference	400	85	206	8	5	0.06	40	12.36	52.36				
	22-cr-09	22	conference	420	20	100	2	5	0.06	10	6	16				
	Totals			**2420**	**215**					**75**	**64.56**	**139.56**				
	23-0-25	23	office	400	30	200	1	5	0.06	5	12	17	0.04			
	23-0-01	23	office "c"	260	20	140	1	5	0.06	5	8.4	13.4				
Zone 3	23-0-02	23	office "c"	260	20	140	1	5	0.06	5	8.4	13.4				
	23-0-03	23	office "c"	260	20	140	1	5	0.06	5	8.4	13.4				
	23-0-17	23	office	260	20	120	1	5	0.06	5	7.2	12.2				
	23-0-24	23	office "b"	460	30	210	1	5	0.06	5	1.8	6.8				
	23-WS-01	23	open work area	675	70	525	6	5	0.06	30	4.2	34.2				
	Totals			**2575**	**210**					**60**	**50.4**	**110.4**				
	24-0-05	24	office "C"	225	20	140	1	5	0.06	5	1.2	6.2	0.03			
	24-0-06	24	office "C"	225	20	140	1	5	0.06	5	1.2	6.2				
Zone 4	24-0-07	24	office "C"	225	20	140	1	5	0.06	5	1.2	6.2				
	24-0-08	24	office "B"	460	30	210	1	5	0.06	5	1.8	6.8				
	24-0-09	24	office "A"	460	30	210	1	5	0.06	5	1.8	6.8				
	24-0-10	24	office "A"	460	30	210	1	5	0.06	5	1.8	6.8				
	24-WS-01	24	open work area	1440	85	900	10	5	0.06	50	5.1	55.1				
	24-CR-01	24	conference	400	60	200	6	5	0.06	30	3.6	33.6				
	Totals			**3895**	**295**					**110**	**17.7**	**127.7**				
	25-0-01	25	office "c"	225	20	140	1	5	0.06	5	1.2	6.2	0.03			
	25-0-02	25	office "c"	225	20	140	1	5	0.06	5	1.2	6.2				
Zone 5	25-0-21	25	office "c"	225	20	140	1	5	0.06	5	1.2	6.2				
	25-0-22	25	office "c"	225	20	140	1	5	0.06	5	1.2	6.2				
	25-0-23	25	office "c"	225	20	140	1	5	0.06	5	1.2	6.2				
	25-0-24	25	office "B"	460	30	210	1	5	0.06	5	1.8	6.8				
	25-0-25	25	office "B"	460	30	210	1	5	0.06	5	1.8	6.8				
	25-CR-01	25	Conference	420	40	130	4	5	0.06	20	2.4	22.4				
	25-WS-01	25	open work area	660	70	525	6	5	0.06	30	4.2	34.2				
	Totals			**3125**	**270**					**85**	**16.2**	**101.2**				
	26-0-18	26	Office "C"	300	20	140	1	5	0.06	5	1.2	6.2	0.06			
	26-0-19	26	Office "C"	300	20	140	1	5	0.06	5	1.2	6.2				
Zone 6	26-0-20	26	Office "C"	300	20	140	1	5	0.06	5	1.2	6.2				
	26-0-01	26	Office "C"	300	20	140	1	5	0.06	5	1.2	6.2				
	26-CR-01	26	Conference	485	55	408	14	5	0.06	70	3.3	73.3				
	26-CR-05	26	Conference	420	85	206	8	5	0.06	40	5.1	45.1				
	26-0-21	26	office "B"	460	30	210	1	5	0.06	5	1.8	6.8				
	26-WS-01	26	open work area	660	70	525	6	5	0.06	30	4.2	34.2				
	Totals			**3225**	**320**					**165**	**19.2**	**184.2**				
	27-0-20	27	Office "C"	260	20	140	1	5	0.06	5	1.2	6.2	0.03			
	27-0-21	27	Office "C"	260	20	140	1	5	0.06	5	1.2	6.2				
Zone 7	27-0-22	27	Office "C"	260	20	140	1	5	0.06	5	1.2	6.2				
	27-0-02	27	Office "C"	260	20	140	1	5	0.06	5	1.2	6.2				
	27-0-03	27	Office "C"	260	20	140	1	5	0.06	5	1.2	6.2				
	27-CR-05	27	Conference	325	27	200	6	5	0.06	30	1.62	31.62				
	27-0-01	27	Office "B"	460	30	210	1	5	0.06	5	1.8	6.8				
	27-0-23	28	Office "B"	460	30	210	1	5	0.06	5	1.8	6.8				
	Totals			**2545**	**187**					**65**	**11.22**	**76.22**				
	28-0-01	28	Exec. Office	550	66	412	1	5	0.06	5	3.96	8.96	0.07			
	28-CR-10	28	Exec. Mtg Room	525	64	200	6	5	0.06	30	3.84	33.84				
Zone 8	28-A-04	28	Exec. Suite	325	40	425	3	5	0.06	15	2.4	17.4				
	28-CR-08	28	Client Conf. Rm.	980	118	420	20	5	0.06	100	7.08	107.08				
	28-CR-09	28	Client Conf. Rm.	980	118	420	20	5	0.06	100	7.08	107.08				
	28-0-02	28	Office "B"	400	50	210	1	5	0.06	5	3	8				
	28-0-03	28	Office "B"	400	50	210	1	5	0.06	5	3	8				
	28-0-04	28	Office "B"	400	50	210	1	5	0.06	5	3	8				
	Totals			**4560**	**556**	**14034**				**265**	**33.36**	**298.36**				

	SA RISER 2		
SPACES SERVED	FLOOR	Minimum OA CFM supplied	TOTAL OA CFM REQUIRED Vbz=Voz
BLP OFFICE	3 TOWER	4260	1029.57
BLP OFFICE	4 TOWER	4500	1952.68
BLP OFFICE	5 TOWER	4500	1972.15
BLP OFFICE	6 TOWER	3300	1320.19
BLP OFFICE	7 TOWER	3037.5	627.275
BLP OFFICE	8 TOWER	2130	489.985
BLP OFFICE	9 TOWER	2130	488.815
BLP OFFICE	10 TOWER	2130	488.845

	SA RISER 7		
SPACES SERVED	FLOOR	Minimum OA CFM supplied	TOTAL OA CFM REQUIRED Vbz
BLP OFFICE	14 TOWER	1800	409.555
BLP OFFICE	15 TOWER	1800	409.555
BLP OFFICE	16 TOWER	1800	409.555
BLP OFFICE	17 TOWER	1800	409.555
BLP OFFICE	18 TOWER	1800	409.555
BLP OFFICE	19 TOWER	1800	409.555
BLP OFFICE	20 TOWER	1800	409.555

	SA RISER 12		
SPACES SERVED	FLOOR	Minimum OA CFM supplied	TOTAL OA CFM REQUIRED Vbz
CitiGroup Office	21 TOWER	345	214.3
CitiGroup Office	22 TOWER	215	139.6
CitiGroup Office	23 TOWER	210	110.4
CitiGroup Office	24 TOWER	295	127.7
CitiGroup Office	25 TOWER	270	101.2
CitiGroup Office	26 TOWER	320	184.2
CitiGroup Office	27 TOWER	187	76.2
CitiGroup Office	28 TOWER	556	298.4