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The Hilton Baltimore Convention Center Hotel



Mechanical Technical Report #1

ASHRAE Standard 62.1: Ventilation Compliance Evaluation

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October 5, 2006

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1.0 Executive Summary:

In the report, the Ventilation Rate Procedure from ASHRAE Standard 62.1-2004 is used to determine whether The Hilton Baltimore Convention Center Hotel (HBCCH) in downtown Baltimore, MD complies with the prescribed ventilation requirements. The HBCCH is comprised of two separate buildings, East and West, connected by a walking bridge which spans Eutaw Street. The lower three levels of the East Building and lower four levels of the West Building make up the East Podium and West Podium. The podiums are the public spaces of the HBCCH, housing ballrooms, meeting rooms, a restaurant, a pool, prefunction spaces, and offices. Two guest room towers, one 19 stories tall and one 21 stories tall, sit atop the West Podium.

Eight air handling units and one pool air conditioning unit, ranging in size from 4,000 to 48,500 cfm, deliver the supply air to 203,700 sq. ft. of space in the East Podium and West Podium. The minimum amount of outdoor air to these nine systems varies from 3,000 to 28,000 cfm. A more comprehensive summary of the building mechanical systems can be found in Section 2.0 of this report.

As found in Section 5.0 of this report, eight of the nine systems analyzed meet ASHRAE Standard 62.1-2004. The only system that does not meet the standard is AHU 8. All other systems supply more than the minimum required amount of outdoor air. Ventilation effectiveness values, E_v , ranged from 0.41 to 0.70. This span of values is most likely due to the HBCCH having large, high occupancy spaces supplied by variable air volume systems. Due to the rather low range of E_v values, V_{ot} was significantly greater than $\sum V_{oz}$ in all nine cases.

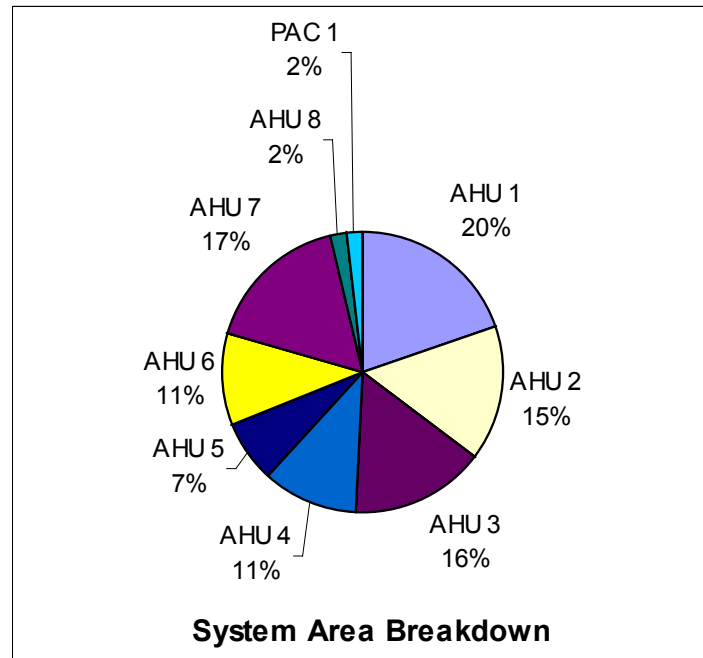


2.0 Building Mechanical System Summary

As stated in Section 1.0, the HBCCH consists of two main podiums with two guest room towers sitting atop the West Podium. This report will focus on the East Podium and West Podium, approximately 203,700 sq. ft. of space. The podiums are served by nine separate systems, eight air handling units and one pool air conditioning unit. The area breakdown of these systems can be seen in Graph 1 (below).

AHU 1: Located in the West Podium mezzanine level mechanical room, this AHU serves the ground and mezzanine levels of the West Podium. The unit is balanced to supply 31,000 cfm of air, with a minimum of 14,000 cfm of outdoor air. AHU 1 will be an indoor built-up variable volume unit with; an economizer section, filters, HW preheat coil, chilled water cooling coil, dual plenum supply fans, discharge plenum, and sound attenuators. Supply and relief fans will have variable frequency drives.

AHU 2: Located in the East Podium mezzanine level mechanical room, this AHU serves the ground level of the East Podium. The unit is balanced to supply 31,000 cfm of air, with a minimum of 24,000 cfm of outdoor air. AHU 2 will be an indoor variable volume unit with an economizer section, filters, HW preheat coil, chilled water cooling coil, plenum supply fan, discharge plenum, and sound attenuators. Supply and relief fans will have variable frequency drives.



Graph 1: System Area Breakdown

AHU 3: Located in the West Podium third level mechanical room, this AHU serves the second level of the West Podium. The unit is balanced to supply 38,000 cfm of air, with a minimum of 16,000 cfm of outdoor air. AHU 3 will be an indoor variable volume unit,

with an economizer section, filters, HW preheat coil, chilled water cooling coil, plenum supply fan, discharge plenum, and sound attenuators. Supply and relief fans will have variable frequency drives.

AHU 4: Located on the roof of the East Podium second level, this AHU serves the second and third levels of the East Podium. The unit is balanced to supply 26,000 cfm of air, with a minimum of 11,000 cfm of outdoor air. AHU 4 will be an outdoor variable volume unit with; intake and relief louvers, economizer section with relief fan, filters, HW preheat coil, chilled water cooling coil, plenum supply fan, and discharge and return plenums. Supply and relief fans will have variable frequency drives.

AHU 5: Located on the roof of the East Podium second level, this AHU serves the second level and junior ballroom areas of the East Podium. The unit is balanced to supply 47,000 cfm of air, with a minimum of 25,000 cfm of outdoor air. AHU 5 will be an outdoor variable volume unit with; intake and relief louvers, economizer section with relief fan, filters, HW preheat coil, chilled water cooling coil, plenum supply fan, and discharge and return plenums. Supply and relief fans will have variable frequency drives.

AHU 6 and AHU 7: Located in the West Podium third level mechanical room, these units serve the grand ballroom and third level prefunction areas of the West Podium. The units are both balanced to supply 48,500 cfm of air, with a minimum of 28,000 cfm of outdoor air each. AHU 6 and 7 will be outdoor variable volume units with; intake and relief louvers, economizer section with relief fan, filters, HW preheat coil, chilled water cooling coil, plenum supply fan, and discharge and return plenums. Supply and relief fans will have variable frequency drives.

AHU 8: Located on the roof of the West Podium fourth level, this AHU serves the exercise areas on the fourth level of the West Podium. The unit is balanced to supply 4,000 cfm of air, with a minimum of 3,000 cfm of outdoor air. AHU 8 will be a constant volume unit, with an economizer section, filters, HW preheat coil, run-around hot water reheat coil, chilled water cooling coil, plenum supply fan, and discharge and return plenums.

PAC 1: Located in the pool equipment room on the fourth level of the West Podium, this unit serves the swimming pool and pool equipment room. The unit is balanced to supply 5,300 cfm of air, with a minimum of 4,300 cfm of outdoor air. PAC 1 will be an indoor packaged unit with ducted outdoor air, filter, refrigerant DX cooling coil, hot gas reheat coil, auxiliary heating coil and DX hot gas pool heater for heat reclaim.

The remainder of the spaces in the HBCCH receive outdoor air from four make up air units.

MAU 1 and MAU 2: These units, located on the roof of the guest towers, provide conditioned outdoor air to the guest room bathrooms, corridors and elevator lobbies in the guest room towers. These units are 100% outdoor air units which keep the guest rooms

properly ventilated. The remainder of the space load in the guest rooms is treated by fan coil units located in each room.

MAU 3 and MAU 4: These units serve the large kitchen areas in the podiums. MAU 3 is located in the East Podium, and it serves the Multi-Purpose Restaurant Kitchen. MAU 4, located in the West Podium, serves the main kitchen area serving the grand ballroom. These units are 100% outdoor air units.

Guest Room FCUs: The fan coil units in the guest rooms are 2-pipe vertical stacked, (high-rise) fan coil units. Chilled water will be distributed using vertical risers located in chases. The units will be equipped with electric resistance heat. The FCUs will be non-ducted concealed type to be located in drywall enclosures at the outside walls of the guest rooms. Return air will be through a louvered access door on the fan coil unit enclosure.

Due to the overall size of the HBCCH, only the West and East Podiums will be analyzed for this report. This means that nine total systems will be analyzed. These systems are AHUs 1-8 and PAC 1. This is a logical simplification considering these nine systems are the critical systems for a ventilation study on the HBCCH because they are VAV systems that are not 100% outdoor air units.

MAU 3 and MAU 4 will not be analyzed because they are scheduled to supply 100% outdoor air to kitchen spaces for the purpose of offsetting the many exhaust hoods. MAU 1 and MAU 2 supply 40 cfm of 100% outdoor air to the guest rooms, and the brief analysis shown below in Table 1 illustrates that the guest rooms require less than 40 cfm of outdoor air. It is therefore acceptable to not fully analyze these units in this report.

Room Size	Area	Occupancy	Ra	Rp	Vbz=Voz=Vot cfm
Double	260	4	0.06	5	36
King	315	2	0.06	5	29

Table 1: Guest Room Minimum Outdoor Air Calculation

3.0 Assumptions

ASHRAE Standard 62.1-2004 describes two separate methods for calculating the minimum amount of outdoor air required in a space. These methods are the “Ventilation Rate Procedure” method and the “Indoor Air Quality Procedure” method. The “Ventilation Rate Procedure” is used throughout this report, and a comparison of the two methods can be found in Section 6.0.

A number of space names in the HBCCH do not directly correlate with spaces listed in ASHRAE Standard 62.1-2004 Table 6-1. Assumptions and approximations were made whenever this situation occurred. With the help of industry consultants and faculty

recommendations, spaces were assigned an equivalent ASHRAE Standard 62.1-2004 space name and requirements. A summary of these assumptions and approximations can be seen in Table 2 (below).

HBCCH Space	Equivalent ASHRAE 62 Space Used
Ballroom	Multi-Purpose Assembly
Kitchen	Cafeteria
Exercise Room	Average of Health Club/Aerobics and Health Club/Weight Rooms
Pool	Swimming (Pool and Deck)
Electrical Room	Corridor
Elevator Machine Room	Storage Room
Toilets	Storage Room (for ventilation)

Table 2: Equivalent ASHRAE 62.1-2004 Spaces

One final assumption made was that variable occupancy would not be considered for this report. After consulting industry professionals, it was decided that there is a high likelihood for constant occupancy in the East Podium and West Podium. This constant occupancy is assumed because the conference center portions of the space and large prefunction and ballroom areas are often booked simultaneously by different organizations or customers. Furthermore, the restaurant is open to the public, so people other than hotel guests will be patrons.

4.0 Actual Design Outdoor Air Flow Rates:

The lower podiums of the HBCCH are served by eight separate air handling units and one pool air conditioning unit. Two of the building’s makeup air units also serve portions of the podiums, but they will not be considered for reasons previously stated. The air handlers being studied for this report are labeled AHU 1-8, and their characteristics can be seen in Table 3 (below). The characteristics of the pool air conditioning unit, PAC 1, can also be found in Table 3 (below).

The Ventilation Rate Procedure in ASHRAE Standard 62.1-2004 requires that each air handling unit be analyzed as a separate system, so the air flows listed in Table 3 (below) will be used in many of the calculations in Section 5.0 of this report. These air flows were extracted from the mechanical equipment schedules of the construction documents. Because each system is analyzed separately, the total design OA flow rate for the podiums is simply the sum of the nine system OA flow rates.

Equipment	Area Served	Scheduled Supply CFM	Scheduled Min OA CFM
AHU-1	West Podium Ground / Mezzanine Levels	31,000	14,000
AHU-2	East Podium Ground Level	31,000	24,000
AHU-3	West Podium Second Level	38,000	16,000
AHU-4	East Podium Second/Third Levels	26,000	11,000
AHU-5	East Podium Junior Ballroom / Prefunction	47,000	25,000
AHU-6	West Podium Grand Ballroom / Prefunction	48,500	26,000
AHU-7	West Podium Grand Ballroom / Prefunction	48,500	26,000
AHU-8	West Podium Exercise Area	4,000	3,000
PAC-1	West Podium Pool Area	5,300	4,300
	Totals:	279,300	149,300

Table 3: Individual System / Total Designed OA Flow Rates for East and West Podiums of The Hilton Baltimore Convention Center Hotel

5.0 Calculated Outdoor Air Flow Rates:

Once the actual outdoor air flow rate for each system in the lower podiums has been determined (Section 4.0), it can be compared to the minimum ventilation rate of acceptability. ASHRAE Standard 62.1-2004 denotes this minimum ventilation rate as V_{ot} , or the Outdoor Air Intake Flow. The Ventilation Rate Procedure found in ASHRAE Standard 62.1-2004 will be applied to the building’s systems in order to calculate V_{ot} for each of the nine systems analyzed in this report. A step by step guide to using the Ventilation Rate Procedure can be found in Appendix A of this report.

The following tables (Tables 4-12) for AHUs 1-8 and PAC 1 provide a summary of the values calculated on the zonal level. Note that the tables include the maximum value of Z_p for each of the nine systems analyzed. This is the critical value in the next step of the process in determining V_{ot} for each system.

AHU 1

Zone	Use	Area (sq. ft.)	Occupancy (# People)	OA Requirement (Voz, cfm)	Zp	Max Zp
Zone 1	Corridors	188	0	11.3	0.47	
Zone 2	Storage rooms	134	0	16.0	0.67	
Zone 3	Storage rooms	385	0	46.2	0.66	
Zone 4	Storage rooms	113	0	13.5	0.68	
Zone 5	Corridors	2384	0	143.0	0.66	
Zone 6	Storage rooms	501	0	60.2	0.27	
Zone 7	Office space	763	5	72.5	0.58	
Zone 8	Office space	116	1	11.0	0.52	
Zone 9	Office space	97	1	9.2	0.51	
Zone 10	Office space	106	1	10.1	0.56	
Zone 11	Office space	440	3	41.8	0.56	
Zone 12	Storage rooms	62	0	7.5	0.50	
Zone 13	Office space	57	0	5.4	0.36	
Zone 14	Office space	129	1	12.3	0.51	
Zone 15	Storage rooms	196	0	23.5	0.27	
Zone 16	Office space	107	1	10.2	0.56	
Zone 17	Office space	162	1	15.3	0.57	
Zone 18	Office space	94	1	8.9	0.59	
Zone 19	Corridors	311	0	18.6	0.20	
Zone 20	Office space	169	1	16.1	0.54	
Zone 21	Office space	113	1	10.7	0.51	
Zone 22	Office space	89	1	8.4	0.56	
Zone 23	Corridors	214	0	12.8	0.48	
Zone 24	Storage rooms	40	0	4.8	0.32	
Zone 25	Storage Spaces	606	12	72.7	0.40	
Zone 26	Corridors	308	0	18.5	0.47	
Zone 27	Office space	201	1	19.0	0.53	
Zone 28	Storage rooms	27	0	3.3	0.22	
Zone 29	Office space	127	1	12.0	0.57	
Zone 30	Corridors	422	0	25.3	0.50	
Zone 31	Corridors	232	0	13.9	0.46	
Zone 32	Office space	130	1	12.4	0.51	
Zone 33	Office space	131	1	12.5	0.52	
Zone 34	Office space	268	2	25.5	0.57	
Zone 35	Office space	181	1	17.2	0.57	
Zone 36	Office space	143	1	13.6	0.57	
Zone 37	Office space	143	1	13.6	0.57	
Zone 38	Office space	164	1	15.5	0.52	
Zone 39	Office space	157	1	14.9	0.55	
Zone 40	Office space	99	1	9.4	0.52	
Zone 41	Office space	270	2	25.6	0.57	
Zone 42	Office space	124	1	11.8	0.56	
Zone 43	Office space	270	2	25.6	0.57	
Zone 44	Storage rooms	279	0	33.5	0.67	

Zone 45	Office space	100	1	9.5	0.53	
Zone 46	Office space	128	1	12.1	0.51	
Zone 47	Office space	191	1	18.2	0.55	
Zone 48	Corridors	420	0	25.2	0.49	
Zone 49	Office space	680	5	64.6	0.57	
Zone 50	Storage rooms	160	0	19.2	0.64	
Zone 51	Corridors	239	0	14.3	0.32	
Zone 52	Corridors	527	0	31.6	0.14	
Zone 53	Lobbies/ prefunction (hotel, resort)	4051	122	1154.5	0.63	
Zone 54	Lobbies/ prefunction (hotel, resort)	4051	122	1154.5	0.63	
Zone 55	Lobbies/ prefunction (hotel, resort)	1423	43	405.5	0.63	
Zone 56	Corridors	223	0	13.4	0.41	
Zone 57	Corridors	1032	0	61.9	0.25	
Zone 58	Office space	136	1	12.9	0.48	
Zone 59	Office space	524	4	49.7	0.57	
Zone 60	Storage rooms	154	0	18.4	0.61	
Zone 61	Corridors	676	0	40.5	0.27	
Zone 62	Conference/ meeting	330	17	102.4	0.31	
Zone 63	Office space	118	1	11.2	0.12	
Zone 64	Office space	125	1	11.9	0.50	
Zone 65	Office space	79	1	7.5	0.50	
Zone 66	Corridors	845	0	50.7	0.65	
Zone 67	Office space	1534	11	145.7	0.68	
Zone 68	Storage rooms	2088	0	250.6	0.72	Max Zp
Zone 69	Office space	180	1	17.1	0.57	
Zone 70	Office space	182	1	17.3	0.68	
Zone 71	Corridors	739	0	44.3	0.28	
Zone 72	Corridors	195	0	11.7	0.39	
Zone 73	Corridors	210	0	12.6	0.42	
Zone 74	Lobbies/ prefunction (hotel, resort)	2015	60	574.4	0.63	
Zone 75	Office space	104	1	9.9	0.47	
Zone 76	Lobbies/ prefunction (hotel, resort)	1029	31	293.2	0.36	
Zone 77	Lobbies/ prefunction (hotel, resort)	1305	39	371.8	0.37	
Zone 78	Lobbies/ prefunction (hotel, resort)	1353	41	385.5	0.38	
Zone 79	Lobbies/ prefunction (hotel, resort)	654	20	186.3	0.37	
Zone 80	Corridors	325	0	19.5	0.50	
Zone 81	Corridors	405	0	24.3	0.35	
Zone 82	Corridors	182	0	10.9	0.61	
Zone 83	Restaurant dining rooms	315	22	221.9	0.50	
Totals:		40275	590	6872		

Table 4: AHU 1

AHU 2

Zone	Use	Area (sq. ft.)	Occupancy (# People)	OA Requirement (Voz, cfm)	Zp	Max Zp
Zone 1	Corridors	3000	0	180.0	0.90	Max Zp
Zone 2	Office space	1876	56	394.0	0.47	
Zone 3	Storage rooms	480	0	57.6	0.80	
Zone 4	Corridors	1285	0	77.1	0.66	
Zone 5	Office space	279	2	26.5	0.55	
Zone 6	Lobbies/ prefunction (hotel, resort)	1922	58	547.7	0.63	
Zone 7	Lobbies/ prefunction (hotel, resort)	1603	48	456.9	0.63	
Zone 8	Corridors	1183	0	71.0	0.54	
Zone 9	Corridors	736	0	44.2	0.09	
Zone 10	Conference/ meeting	454	23	140.6	0.31	
Zone 11	Conference/ meeting	804	40	249.1	0.31	
Zone 12	Conference/ meeting	514	26	159.5	0.31	
Zone 13	Conference/ meeting	593	30	183.8	0.31	
Zone 14	Conference/ meeting	379	19	117.4	0.31	
Zone 15	Conference/ meeting	354	18	109.8	0.31	
Zone 16	Conference/ meeting	475	24	147.3	0.31	
Zone 17	Conference/ meeting	448	22	138.7	0.31	
Zone 18	Conference/ meeting	503	25	156.0	0.31	
Zone 19	Conference/ meeting	467	23	144.8	0.31	
Zone 20	Conference/ meeting	967	48	299.6	0.31	
Zone 21	Conference/ meeting	1009	50	312.9	0.31	
Zone 22	Corridors	831	0	49.8	0.08	
Zone 23	Lobbies/ prefunction (hotel, resort)	1643	49	468.3	0.55	
Zone 24	Lobbies/ prefunction (hotel, resort)	802	24	228.5	0.26	
Zone 25	Conference/ meeting	817	41	253.3	0.31	
Zone 26	Lobbies/ prefunction (hotel, resort)	836	25	238.1	0.26	
Zone 27	Conference/ meeting	1600	80	496.0	0.31	
Zone 28	Restaurant dining rooms	847	59	597.1	0.50	
Zone 29	Restaurant dining rooms	649	45	457.2	0.50	

Zone 30	Restaurant dining rooms	1749	122	1232.8	0.50	
Zone 31	Restaurant dining rooms	1514	106	1067.4	0.50	
Zone 32	Restaurant dining rooms	710	50	500.6	0.50	
Totals:		31327	1114	9604		

Table 5: AHU 2

AHU 3

Zone	Use	Area (sq. ft.)	Occupancy (# People)	OA Requirement (Voz, cfm)	Zp	Max Zp
Zone 1	Corridors	1456	0	87.3	0.66	
Zone 2	Corridors	58	0	3.5	0.23	
Zone 3	Corridors	58	0	3.5	0.23	
Zone 4	Corridors	88	0	5.3	0.35	
Zone 5	Corridors	80	0	4.8	0.03	
Zone 6	Storage rooms	109	0	13.1	0.09	
Zone 7	Corridors	196	0	11.8	0.65	
Zone 8	Corridors	2160	0	129.6	0.66	
Zone 9	Office space	185	1	17.5	0.53	
Zone 10	Storage rooms	486	0	58.4	0.65	
Zone 11	Corridors	58	0	3.5	0.23	
Zone 12	Corridors	92	0	5.5	0.37	
Zone 13	Corridors	525	0	31.5	0.50	
Zone 14	Lobbies/ prefunction (hotel, resort)	2319	70	660.9	0.63	
Zone 15	Lobbies/ prefunction (hotel, resort)	2623	79	747.6	0.63	
Zone 16	Lobbies/ prefunction (hotel, resort)	3691	111	1051.8	0.63	
Zone 17	Lobbies/ prefunction (hotel, resort)	3416	102	973.4	0.63	
Zone 18	Storage rooms	1163	0	139.6	0.47	
Zone 19	Storage rooms	1272	0	152.7	0.73	Max Zp
Zone 20	Conference/ meeting	769	38	238.2	0.31	
Zone 21	Office space	858	6	81.5	0.20	
Zone 22	Corridors	2043	0	122.6	0.22	
Zone 23	Lobbies/ prefunction (hotel, resort)	934	28	266.1	0.40	
Zone 24	Lobbies/ prefunction (hotel, resort)	2047	61	583.5	0.62	
Zone 25	Lobbies/ prefunction (hotel, resort)	768	23	218.7	0.39	
Zone 26	Lobbies/ prefunction (hotel, resort)	843	25	240.3	0.29	
Zone 27	Lobbies/ prefunction (hotel, resort)	823	25	234.5	0.27	

Zone 28	Lobbies/ prefunction (hotel, resort)	1465	44	417.4	0.35	
Zone 29	Lobbies/ prefunction (hotel, resort)	1343	40	382.8	0.35	
Totals:		31924	654	6887		

Table 6: AHU 3

AHU 4

Zone	Use	Area (sq. ft.)	Occupancy (# People)	OA Requirement (Voz, cfm)	Zp	Max Zp
Zone 1	Storage rooms	1004	20	120.5	0.35	
Zone 2	Storage rooms	30	0	3.6	0.24	
Zone 3	Corridors	1376	0	82.5	0.66	
Zone 4	Storage rooms	288	0	34.5	0.69	
Zone 5	Storage rooms	229	0	27.5	0.25	
Zone 6	Storage rooms	58	0	6.9	0.46	
Zone 7	Storage rooms	102	0	12.3	0.27	
Zone 8	Storage rooms	28	0	3.4	0.23	
Zone 9	Corridors	65	0	3.9	0.26	
Zone 10	Corridors	65	0	3.9	0.26	
Zone 11	Corridors	65	0	3.9	0.26	
Zone 12	Corridors	65	0	3.9	0.26	
Zone 13	Lobbies/ prefunction (hotel, resort)	1074	32	306.1	0.63	
Zone 14	Lobbies/ prefunction (hotel, resort)	1395	42	397.7	0.63	
Zone 15	Lobbies/ prefunction (hotel, resort)	1245	37	354.9	0.63	
Zone 16	Lobbies/ prefunction (hotel, resort)	1250	38	356.3	0.63	
Zone 17	Storage	979	20	117.4	0.39	
Zone 18	Lobbies/ prefunction (hotel, resort)	683	20	194.7	0.63	
Zone 19	Conference/ meeting	456	23	141.3	0.31	
Zone 20	Conference/ meeting	615	31	190.7	0.31	
Zone 21	Conference/ meeting	418	21	129.5	0.31	
Zone 22	Conference/ meeting	472	24	146.4	0.31	
Zone 23	Conference/ meeting	739	37	229.2	0.31	
Zone 24	Corridors	322	0	19.3	0.13	
Zone 25	Conference/ meeting	460	23	142.6	0.31	
Zone 26	Lobbies/ prefunction (hotel, resort)	934	28	266.1	0.40	
Zone 27	Lobbies/ prefunction (hotel, resort)	1009	30	287.7	0.37	
Zone 28	Lobbies/ prefunction (hotel, resort)	1415	42	403.3	0.38	

Zone 29	Lobbies/ prefunction (hotel, resort)	997	30	284.3	0.40	
Zone 30	Corridors	1335	0	80.1	0.33	
Zone 31	Corridors	928	0	55.7	0.08	
Zone 32	Corridors	335	0	20.1	0.33	
Zone 33	Storage rooms	80	0	9.6	0.64	
Zone 34	Storage rooms	108	0	13.0	0.52	
Zone 35	Storage rooms	56	0	6.7	0.45	
Zone 36	Corridors	266	0	16.0	0.66	
Zone 37	Storage rooms	994	0	119.3	0.75	Max Zp
Totals:		21942	498	4595		

Table 7: AHU 4

AHU 5

Zone	Use	Area (sq. ft.)	Occupancy (# People)	OA Requirement (Voz, cfm)	Zp	Max Zp
Zone 1	Multi-purpose assembly	1587	190	1047.5	0.37	Max Zp
Zone 2	Multi-purpose assembly	1532	184	1011.1	0.37	Max Zp
Zone 3	Multi-purpose assembly	1532	184	1011.3	0.37	Max Zp
Zone 4	Multi-purpose assembly	1136	136	749.9	0.37	Max Zp
Zone 5	Multi-purpose assembly	1775	213	1171.8	0.37	Max Zp
Zone 6	Multi-purpose assembly	1790	215	1181.3	0.37	Max Zp
Zone 7	Multi-purpose assembly	1141	137	753.1	0.37	Max Zp
Zone 8	Multi-purpose assembly	1580	190	1042.6	0.37	Max Zp
Zone 9	Multi-purpose assembly	1526	183	1007.0	0.37	Max Zp
Zone 10	Multi-purpose assembly	1486	178	980.8	0.37	Max Zp
Totals:		15085	1810	9956		

Table 8: AHU 5

AHU 6

Zone	Use	Area (sq. ft.)	Occupancy (# People)	OA Requirement (Voz, cfm)	Zp	Max Zp
Zone 1	Lobbies/ prefunction (hotel, resort)	1708	51	486.8	0.63	
Zone 2	Conference/ meeting	239	12	74.0	0.31	

Zone 3	Conference/ meeting	486	24	150.6	0.31	
Zone 4	Conference/ meeting	725	36	224.7	0.31	
Zone 5	Lobbies/ prefunction (hotel, resort)	245	7	69.7	0.63	
Zone 6	Storage rooms	390	0	46.8	0.80	Max Zp
Zone 7	Corridors	36	2	2.2	0.05	
Zone 8	Conference/ meeting	906	45	281.0	0.31	
Zone 9	Conference/ meeting	716	36	222.0	0.31	
Zone 10	Conference/ meeting	675	34	209.1	0.31	
Zone 11	Conference/ meeting	716	36	222.0	0.31	
Zone 12	Conference/ meeting	727	36	225.5	0.31	
Zone 13	Multi-purpose assembly	1532	184	1010.9	0.37	
Zone 14	Multi-purpose assembly	1328	159	876.2	0.37	
Zone 15	Multi-purpose assembly	1436	172	947.7	0.37	
Zone 16	Multi-purpose assembly	1325	159	874.4	0.37	
Zone 17	Multi-purpose assembly	1435	172	947.0	0.37	
Zone 18	Multi-purpose assembly	1324	159	874.1	0.37	
Zone 19	Multi-purpose assembly	1536	184	1014.0	0.37	
Zone 20	Multi-purpose assembly	1416	170	934.7	0.37	
Zone 21	Multi-purpose assembly	1285	154	848.2	0.37	
Zone 22	Multi-purpose assembly	1286	154	848.5	0.37	
Totals:		21471	1989	11390		

Table 9: AHU 6

AHU 7

Zone	Use	Area (sq. ft.)	Occupancy (# People)	OA Requirement (Voz, cfm)	Zp	Max Zp
Zone 1	Corridors	610	0	36.6	0.64	
Zone 2	Office space	172	1	16.3	0.54	
Zone 3	Office space	127	1	12.0	0.50	
Zone 4	Storage rooms	410	0	49.2	0.80	Max Zp
Zone 5	Storage rooms	701	0	84.1	0.80	Max Zp
Zone 6	Storage rooms	762	0	91.4	0.80	Max Zp
Zone 7	Corridors	667	0	40.0	0.67	
Zone 8	Storage rooms	396	0	47.6	0.80	Max Zp

Zone 9	Corridors	533	0	32.0	0.63	
Zone 10	Corridors	551	0	33.1	0.65	
Zone 11	Corridors	400	0	24.0	0.62	
Zone 12	Corridors	956	0	57.4	0.66	
Zone 13	Corridors	1035	0	62.1	0.65	
Zone 14	Corridors	984	0	59.0	0.66	
Zone 15	Office space	644	0	38.6	0.12	
Zone 16	Office space	678	0	40.7	0.12	
Zone 17	Corridors	844	0	50.7	0.50	
Zone 18	Lobbies/ prefunction (hotel, resort)	1609	48	458.5	0.63	
Zone 19	Lobbies/ prefunction (hotel, resort)	1888	57	538.2	0.63	
Zone 20	Corridors	151	0	9.0	0.38	
Zone 21	Corridors	144	0	8.7	0.41	
Zone 22	Corridors	527	0	31.6	0.30	
Zone 23	Office space	88	1	8.4	0.40	
Zone 24	Office space	96	1	9.1	0.38	
Zone 25	Office space	96	1	9.2	0.38	
Zone 26	Storage rooms	162	0	19.4	0.72	
Zone 27	Restaurant dining rooms	911	64	642.4	0.50	
Zone 28	Restaurant dining rooms	934	65	658.7	0.50	
Zone 29	Conference/ meeting	401	20	124.2	0.55	
Zone 30	Storage rooms	241	0	28.9	0.39	
Zone 31	Corridors	844	0	50.7	0.22	
Zone 32	Conference/ meeting	840	42	260.5	0.31	
Zone 33	Conference/ meeting	828	41	256.7	0.31	
Zone 34	Conference/ meeting	457	23	141.6	0.31	
Zone 35	Conference/ meeting	549	27	170.2	0.31	
Zone 36	Conference/ meeting	476	24	147.6	0.31	
Zone 37	Conference/ meeting	542	27	168.0	0.31	
Zone 38	Lobbies/ prefunction (hotel, resort)	1045	31	297.7	0.63	
Zone 39	Multi-purpose assembly	1327	159	875.8	0.37	
Zone 40	Multi-purpose assembly	1528	183	1008.7	0.37	
Zone 41	Multi-purpose assembly	1328	159	876.3	0.37	
Zone 42	Multi-purpose assembly	1429	171	942.9	0.37	
Zone 43	Multi-purpose assembly	1328	159	876.2	0.37	
Zone 44	Multi-purpose assembly	1428	171	942.5	0.37	
Zone 45	Multi-purpose assembly	1327	159	876.0	0.37	

Zone 46	Multi-purpose assembly	1529	183	1008.9	0.37	
Totals:		34522	1821	12221		

Table 10: AHU 7

AHU 8

Zone	Use	Area (sq. ft.)	Occupancy (# People)	OA Requirement (Voz, cfm)	Zp	Max Zp
Zone 1	Office space	568	4	54.1	0.39	
Zone 2	Health club	1364	34	761.8	0.93	Max Zp
Zone 3	Health club	1167	29	650.0	0.93	Max Zp
Totals:		3099	67	1466		

Table 11: AHU 8

PAC 1

Zone	Use	Area (sq. ft.)	Occupancy (# People)	OA Requirement (Voz, cfm)	Zp	Max Zp
Zone 1	Swimming Pool	3832	0	1839.4	0.37	Max Zp
Zone 2	Storage	193	0	23.2	0.08	
Totals:		4025	0	1863		

Table 12: PAC 1

The Ventilation Rate Procedure in ASHRAE Standard 62.1-2004, was applied to all nine of the systems being analyzed in this report. The results of the analysis are summarized below. Full calculation spreadsheets for each system can be found in Appendix B of this report.

AHU 1

Results for AHU 1	
Vot-Minimum OA intake for AHU 1	13,589 cfm
Percent OA Intake	44%
Max Zp for AHU 1	0.72
Ev	0.51
ΣVoz	6,872 cfm

The minimum amount of outdoor air required for the zones served by AHU 1 is 13,589 cfm, and the minimum amount of outdoor air intake scheduled for AHU 1 (Table 3) is 14,000 cfm.

Therefore,

AHU 1
Minimum OA flow > Required OA flow by ASHRAE Standard 62.1-2004
ASHRAE Standard 62.1-2004 is met by AHU 1

AHU 2

<u>Results for AHU 2</u>	
Vot-Minimum OA intake for AHU 2	23,435 cfm
Percent OA Intake	76%
Max Zp for AHU 2	0.90
Ev	0.41
ΣVoz	9,606 cfm

The minimum amount of outdoor air required for the zones served by AHU 2 is 23,435 cfm, and the minimum amount of outdoor air intake scheduled for AHU 2 (Table 3) is 24,000 cfm.

Therefore,

AHU 2
Minimum OA flow > Required OA flow by ASHRAE Standard 62.1-2004
ASHRAE Standard 62.1-2004 is met by AHU 2

AHU 3

<u>Results for AHU 3</u>	
Vot-Minimum OA intake for AHU 3	15,160 cfm
Percent OA Intake	40%
Max Zp for AHU 3	0.73
Ev	0.45
ΣVoz	6,887 cfm

The minimum amount of outdoor air required for the zones served by AHU 3 is 15,160 cfm, and the minimum amount of outdoor air intake scheduled for AHU 3 (Table 3) is 16,000 cfm.

Therefore,

AHU 3
Minimum OA flow > Required OA flow by ASHRAE Standard 62.1-2004
ASHRAE Standard 62.1-2004 is met by AHU 3

AHU 4

<u>Results for AHU 4</u>	
Vot-Minimum OA intake for AHU 4	10,657 cfm
Percent OA Intake	41%
Max Zp for AHU 4	0.69
Ev	0.43
ΣVoz	4,595 cfm

The minimum amount of outdoor air required for the zones served by AHU 4 is 10,657 cfm, and the minimum amount of outdoor air intake scheduled for AHU 4 (Table 3) is 11,000 cfm.

Therefore,

AHU 4
Minimum OA flow > Required OA flow by ASHRAE Standard 62.1-2004
ASHRAE Standard 62.1-2004 is met by AHU 4

AHU 5

<u>Results for AHU 5</u>	
Vot-Minimum OA intake for AHU 5	14,223 cfm
Percent OA Intake	30%
Max Zp for AHU 5	0.37
Ev	0.70
ΣVoz	9,956 cfm

The minimum amount of outdoor air required for the zones served by AHU 5 is 14,223 cfm, and the minimum amount of outdoor air intake scheduled for AHU 5 (Table 3) is 25,000 cfm.

Therefore,

AHU 5
Minimum OA flow > Required OA flow by ASHRAE Standard 62.1-2004
ASHRAE Standard 62.1-2004 is met by AHU 5

AHU 6

<u>Results for AHU 6</u>	
Vot-Minimum OA intake for AHU 6	26,193 cfm
Percent OA Intake	54%
Max Zp for AHU 6	0.80
Ev	0.43
ΣVoz	11,390 cfm

The minimum amount of outdoor air required for the zones served by AHU 6 is 26,193 cfm, and the minimum amount of outdoor air intake scheduled for AHU 1 (Table 3) is 28,000 cfm.

Therefore,

AHU 6
Minimum OA flow > Required OA flow by ASHRAE Standard 62.1-2004
ASHRAE Standard 62.1-2004 is met by AHU 6

AHU 7

<u>Results for AHU 7</u>	
Vot-Minimum OA intake for AHU 7	27,039 cfm
Percent OA Intake	56%
Max Zp for AHU 7	0.80
Ev	0.45
Σ Voz	12,221 cfm

The minimum amount of outdoor air required for the zones served by AHU 7 is 27,039 cfm, and the minimum amount of outdoor air intake scheduled for AHU 7 (Table 3) is 28,000 cfm.

Therefore,

AHU 7
Minimum OA flow > Required OA flow by ASHRAE Standard 62.1-2004
ASHRAE Standard 62.1-2004 is met by AHU 7

AHU 8

<u>Results for AHU 8</u>	
Vot-Minimum OA intake for AHU 8	3,366 cfm
Percent OA Intake	84%
Max Zp for AHU 8	0.93
Ev	0.44
Σ Voz	1,466 cfm

The minimum amount of outdoor air required for the zones served by AHU 8 is 3,366 cfm, and the minimum amount of outdoor air intake scheduled for AHU 8 (Table 3) is 3,000 cfm.

Therefore,

AHU 8
Minimum OA flow < Required OA flow by ASHRAE Standard 62.1-2004
ASHRAE Standard 62.1-2004 is not met by AHU 8

PAC 1

Results for PAC 1	
Vot-Minimum OA intake for PAC 1	2,661 cfm
Percent OA Intake	50%
Max Zp for PAC 1	0.37
Ev	0.70
ΣV_{oz}	1,863 cfm

The minimum amount of outdoor air required for the zones served by PAC 1 is 2,661 cfm, and the minimum amount of outdoor air intake scheduled for PAC 1 (Table 3) is 4,300 cfm.

Therefore,

PAC 1
Minimum OA flow > Required OA flow by ASHRAE Standard 62.1-2004
ASHRAE Standard 62.1-2004 is met by PAC 1

Now that all nine systems have been analyzed, a grand total for the portions of the HBCCH considered (the east and west podiums) in this report can be obtained. The minimum amount of outdoor air required by the podiums of the HBCCH is 136,323 cfm, and the minimum amount of outdoor air intake scheduled for these areas is 149,300 cfm (Table 3).

Therefore,

For the East Podium and West Podium of the HBCCH
Minimum OA flow > Required OA flow by ASHRAE Standard 62.1-2004
ASHRAE Standard 62.1-2004 is met by the building

6.0 Discussion:

The Ventilation Rate Procedure (VRP) found in ASHRAE Standard 62.1-2004 was the method used to determine the minimum acceptable amount of outdoor air for each system analyzed in the report.

The VRP method is a prescriptive procedure based on space type, occupancy, and floor area. The goal of the VRP method is to control indoor contaminant levels by supplying adequate amounts of fresh outdoor air. No monitoring of contaminant levels in the building is needed when the VRP method is used. Instead, the amount of outdoor air varies depending on the use of the space (high contaminant possibility results in high outdoor rates) and the occupancy (more people result in more required outdoor air).

The alternate method of determining the minimum acceptable amount of outdoor air required by a system is the Indoor Air Quality Procedure (IAQP) found in ASHRAE

Standard 62.1-2004. This method is based on an analysis of contaminant sources, contaminant concentration targets, and perceived acceptability targets. Essentially, contaminant levels in the space are monitored, and the amount of outdoor air required increases as the contaminant levels rise.

Both of these methods are acceptable under ASHRAE Standard 62.1-2004, but the VRP method is more commonly used in industry practice. The main reason the VRP is preferred is its simplicity compared to the IAQP. VRP parameters are based on CO₂ levels expected in spaces, while IAQP requires more complex monitoring of contaminants in the spaces throughout the life of the system. It is also difficult to use the IAQP because it's hard to find accurate and extensive information on indoor air pollutants and their harmful levels. ASHRAE Standard 62.1-2004 provides very limited information on this procedure. Due to these factors, the VRP is more straightforward and easier to use, making it the industry standard and therefore the standard for this report.

7.0 References:

1. ASHRAE Standard 62.1-2004, Section 6 and Appendix A, *Ventilation for Acceptable Indoor Air Quality*.
2. Southland Industries, Mechanical Drawings and Specifications.
3. Mike McLaughlin and Andrew Tech, Thesis Consultants, Southland Industries.
4. The Pennsylvania State University Architectural Engineering Department, Thesis Advisor: Dr. William Bahnfleth.
5. Past Thesis Technical Reports, e-Studio Archives, 2004-2005.

8.0 Appendix A – Ventilation Rate Procedure:

The following procedure was used in Section 5.0 of this report in order to apply the Ventilation Rate Procedure from ASHRAE Standard 62.1-2004 to the HBCCH.

Step 1: Each system is broken down into multiple zones which, when added, total the area of the complete system. Zones are determined according to spaces served and/or areas served by VAV or CAV boxes.

Step 2: The next step is to calculate the *Breathing Zone Outdoor Airflow*, V_{bz} , for each individual zone. This value is determined using ASHRAE Equation 6-1.

$$V_{bz} = R_p P_z + R_a A_z \quad \text{ASHRAE Equation 6-1}$$

Where $A_z =$ *zone floor area* or the net occupiable floor area of the zone (ft²).

$P_z =$ *zone population* or the largest number of people expected to occupy the zone during typical usage. When the actual number of occupants was unknown, the value is estimated using the Occupant Density found in ASHRAE Table 6-1.

$R_p =$ *outdoor airflow rate required per person* as determined from ASHRAE Table 6-1.

$R_a =$ *outdoor airflow rate required per unit area* as determined from ASHRAE Table 6-1.

Step 3: The *Zone Air Distribution Effectiveness*, E_z , is found next using ASHRAE Table 6-2. The supply air in the HBCCH is all ceiling supply of either cool or warm air, so all values of $E_z = 1.0$

Step 4: Each system's *Zone Outdoor Airflow*, V_{oz} , can now be determined using ASHRAE Equation 6-2.

$$V_{oz} = V_{bz} / E_z \quad \text{ASHRAE Equation 6-2}$$

The next step in the process to find V_{ot} varies depending on the type of system being analyzed. For single-zone systems $V_{ot} = V_{oz}$, and for 100% outdoor air systems $V_{ot} = \Sigma V_{oz}$ for all zones. None of the nine systems being analyzed in this report fit into either of these two categories; however, if MAUs 1-4 were included they would count as 100% outdoor air systems.

For multiple-zone recirculating systems (like the nine being analyzed in this report), V_{ot} is determined in accordance with Section 6.2.5.1 through 6.2.5.4 of ASHRAE Standard 62.1-2004.

Step 5: The next step is to calculate the *Primary Outdoor Air Fraction*, Z_p , using ASHRAE Equation 6-5.

$$Z_p = V_{oz} / V_{pz} \quad \text{ASHRAE Equation 6-5}$$

Where V_{pz} = the minimum expected primary airflow to the zone.

Step 6: Once the maximum value of Z_p is established, the *System Ventilation Efficiency*, E_v , can be determined in one of two ways.

When the maximum value of Z_p is less than or equal to 0.55, ASHRAE Table 6-3 can be used to obtain E_v . Of the nine systems being analyzed in this report, only AHU 5 and PAC 1 had a maximum Z_p low enough to use ASHRAE Table 6-3.

Appendix A of ASHRAE Standard 62.1-2004 must be used to determine E_v when the maximum Z_p value exceeds 0.55. The procedure outlined in Appendix A is used to calculate the *Zone Ventilation Efficiency*, E_{vz} , for each zone. The corresponding E_v value is then the minimum of all of the E_{vz} values. This process is a more precise method of calculating E_v since all zones are considered.

Step 7: Finding F_a , the fraction of supply air to the zone from sources outside the zone, is the first step in the Appendix A process.

$$F_a = E_p + (1-E_p)E_r$$

Where E_p = the primary air fraction to the zone ($E_p = 1$ in all cases for the HBCCH)

E_r = the fraction of secondary recirculated air to the zone (E_r does not need to be applied due to the fact that E_p always equals 1).

Step 8: The next step is to find F_b , the fraction of supply air to the zone from fully mixed primary air.

$$F_b = E_p$$

Step 9: F_c can now be determined using the equation below.

$$F_c = 1 - [(1 - E_z)(1 - E_r)(1 - E_p)]$$

Step 10: The final variables left to be calculated in order to solve for E_{vz} are X_s and Z_d . X_s , the average outdoor air fraction, is the fraction of outdoor air in the primary air flow at the primary air handler.

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

Where $V_{ou} = \Sigma V_{oz}$ for all zones of the system (note that as previously stated in Section 3.0 the diversity factor, D , is assumed to be 1 at all times in this report).

$$V_{ps} = \Sigma V_{pz} \text{ for all zones of the system.}$$

Z_d , the discharge outdoor air fraction, is the outdoor air fraction required in air discharged to the zone.

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

Where V_{dz} is the minimum discharge air flow for design purposes.

Step 11: Finally, The E_{vz} value for each zone can be calculated using ASHRAE Equation A-2, and the E_v value for the entire system can then be determined using ASHRAE Equation A-3.

$$E_{vz} = (F_a + X_s F_b - Z_d F_c) / F_a \quad \text{ASHRAE Equation A-2}$$

$$E_v = \text{minimum} (E_{vz}) \quad \text{ASHRAE Equation A-3}$$

Step 12: The last step in the process is to finally solve for V_{ot} . This value is calculated using ASHRAE Equation 6-8.

$$V_{ot} = V_{ou} / E_v \quad \text{ASHRAE Equation 6-8}$$

9.0 Appendix B – Calculation Spreadsheets:

AHU 1							
Zones							
Zones Served		Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Room #		107	112	113	111	107A	116
Space Type (In accordance with ASHRAE Table 6-1)		Corridors	Storage rooms	Storage rooms	Storage rooms	Corridors	Storage rooms
Az	Zone Floor Area (ft ²)	188	134	385	113	2384	501
Pz	Zone Population (# People)	0	0	0	0	0	0
Rp	People Outdoor Air Rate from ASHRAE Table 6-1(cfm/person)	0	0	0	0	0	0
Ra	Area Outdoor Air Rate from ASHRAE Table 6-1(cfm/ft ²)	0.06	0.12	0.12	0.12	0.06	0.12
Ez	Zone Air Distribution Effectiveness from ASHRAE Table 6-2	1.00	1.00	1.00	1.00	1.00	1.00
Pz*Rp		0.0	0.0	0.0	0.0	0.0	0.0
Az*Ra		11.3	16.0	46.2	13.5	143.0	60.2
Vbz	Breathing Zone Outdoor Airflow (Pz*Rp+Az*Ra), cfm	11.3	16.0	46.2	13.5	143.0	60.2
Voz	Zone Outdoor Airflow (Vbz/Ez), cfm	11.3	16.0	46.2	13.5	143.0	60.2
Vpz	Zone Primary Airflow (intake + recirculated from AHU), cfm	24	24	70	20	216	219
Zp	Zone Primary Outdoor Air Fraction (Voz/Vpz)	0.47	0.67	0.66	0.68	0.66	0.27
Appendix A							
Ep	Primary Air Fraction to the Zone	1.00	1.00	1.00	1.00	1.00	1.00
Er	Fraction of Secondary Recirculated Air	0.00	0.00	0.00	0.00	0.00	0.00
Fa	$Fa = Ep + (1 - Ep)Er$	1.00	1.00	1.00	1.00	1.00	1.00
Fb	$Fb = Ep$	1.00	1.00	1.00	1.00	1.00	1.00
Fc	$Fc = 1 - (1 - Ez)(1 - Er)(1 - Ep)$	1.00	1.00	1.00	1.00	1.00	1.00
Zd	Discharge Outdoor Air Fraction	0.47	0.67	0.66	0.68	0.66	0.27
Xs	Average Outdoor Air Fraction	0.22	**for all zones				
Evz	Zone Ventilation Efficiency	0.75	0.55	0.56	0.55	0.56	0.95
System							
	Max Zp of all zones	0.72					** Appendix A must be used to determine Ev
Ev	System Ventilation Efficiency = Min Evz	0.51					
Vou	Uncorrected Outdoor Air Intake (Σ all Vbz for system), cfm	6872					
Vot	Outdoor Air Intake (Vou/Ev), cfm	13589					
Vps	System Primary Airflow (Fan Airflow from AHU schedule), cfm	31000					
Σ Voz	Sum of all Voz for system	6872					
	Percent Outdoor Air Intake (Vot/Vps)	44					

Zone 7	Zone 8	Zone 9	Zone 10	Zone 11	Zone 12	Zone 13	Zone 14	Zone 15	Zone 16	Zone 17
117	118	119	120	121	122	123	124	125	126	127
Office space	Office space	Office space	Office space	Office space	Storage rooms	Office space	Office space	Storage rooms	Office space	Office space
763	116	97	106	440	62	57	129	196	107	162
5	1	1	1	3	0	0	1	0	1	1
5	5	5	5	5	0	5	5	0	5	5
0.06	0.06	0.06	0.06	0.06	0.12	0.06	0.06	0.12	0.06	0.06
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
26.7	4.1	3.4	3.7	15.4	0.0	2.0	4.5	0.0	3.7	5.7
45.8	7.0	5.8	6.4	26.4	7.5	3.4	7.7	23.5	6.4	9.7
72.5	11.0	9.2	10.1	41.8	7.5	5.4	12.3	23.5	10.2	15.3
72.5	11.0	9.2	10.1	41.8	7.5	5.4	12.3	23.5	10.2	15.3
126	21	18	18	75	15	15	24	87	18	27
0.58	0.52	0.51	0.56	0.56	0.50	0.36	0.51	0.27	0.56	0.57
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.58	0.52	0.51	0.56	0.56	0.50	0.36	0.51	0.27	0.56	0.57
0.65	0.70	0.71	0.66	0.66	0.72	0.86	0.71	0.95	0.66	0.65

Zone 18	Zone 19	Zone 20	Zone 21	Zone 22	Zone 23	Zone 24	Zone 25	Zone 26	Zone 27	Zone 28
104	139	131	132	133	137	190	138	1M05A	1M07	1M08
Office space	Corridors	Office space	Office space	Office space	Corridors	Storage rooms	Storage Spaces	Corridors	Office space	Storage rooms
94	311	169	113	89	214	40	606	308	201	27
1	0	1	1	1	0	0	12	0	1	0
5	0	5	5	5	0	0	0	0	5	0
0.06	0.06	0.06	0.06	0.06	0.06	0.12	0.12	0.06	0.06	0.12
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.3	0.0	5.9	3.9	3.1	0.0	0.0	0.0	0.0	7.0	0.0
5.6	18.6	10.2	6.8	5.3	12.8	4.8	72.7	18.5	12.0	3.3
8.9	18.6	16.1	10.7	8.4	12.8	4.8	72.7	18.5	19.0	3.3
8.9	18.6	16.1	10.7	8.4	12.8	4.8	72.7	18.5	19.0	3.3
15	93	30	21	15	27	15	182	39	36	15
0.59	0.20	0.54	0.51	0.56	0.48	0.32	0.40	0.47	0.53	0.22
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.59	0.20	0.54	0.51	0.56	0.48	0.32	0.40	0.47	0.53	0.22
0.63	1.02	0.69	0.71	0.66	0.75	0.90	0.82	0.75	0.69	1.00

Zone 29	Zone 30	Zone 31	Zone 32	Zone 33	Zone 34	Zone 35	Zone 36	Zone 37	Zone 38	Zone 39
1M09	1M10A	1M10C	1M12	1M13	1M14	1M15	1M16	1M17	1M18	1M19
Office space	Corridors	Corridors	Office space	Office space	Office space	Office space	Office space	Office space	Office space	Office space
127	422	232	130	131	268	181	143	143	164	157
1	0	0	1	1	2	1	1	1	1	1
5	0	0	5	5	5	5	5	5	5	5
0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.4	0.0	0.0	4.6	4.6	9.4	6.3	5.0	5.0	5.7	5.5
7.6	25.3	13.9	7.8	7.9	16.1	10.8	8.6	8.6	9.8	9.4
12.0	25.3	13.9	12.4	12.5	25.5	17.2	13.6	13.6	15.5	14.9
12.0	25.3	13.9	12.4	12.5	25.5	17.2	13.6	13.6	15.5	14.9
21	51	30	24	24	45	30	24	24	30	27
0.57	0.50	0.46	0.51	0.52	0.57	0.57	0.57	0.57	0.52	0.55
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.57	0.50	0.46	0.51	0.52	0.57	0.57	0.57	0.57	0.52	0.55
0.65	0.72	0.76	0.71	0.70	0.66	0.65	0.66	0.66	0.70	0.67

Zone 40	Zone 41	Zone 42	Zone 43	Zone 44	Zone 45	Zone 46	Zone 47	Zone 48	Zone 49	Zone 50
1M20	1M21	1M22	1M06	1M24	1M28	1M29	1M30	1M32	1M31	1M05
Office space	Office space	Office space	Office space	Storage rooms	Office space	Office space	Office space	Corridors	Office space	Storage rooms
99	270	124	270	279	100	128	191	420	680	160
1	2	1	2	0	1	1	1	0	5	0
5	5	5	5	0	5	5	5	0	5	0
0.06	0.06	0.06	0.06	0.12	0.06	0.06	0.06	0.06	0.06	0.12
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	9.4	4.3	9.4	0.0	3.5	4.5	6.7	0.0	23.8	0.0
6.0	16.2	7.4	16.2	33.5	6.0	7.7	11.5	25.2	40.8	19.2
9.4	25.6	11.8	25.6	33.5	9.5	12.1	18.2	25.2	64.6	19.2
9.4	25.6	11.8	25.6	33.5	9.5	12.1	18.2	25.2	64.6	19.2
18	45	21	45	50	18	24	33	51	114	30
0.52	0.57	0.56	0.57	0.67	0.53	0.51	0.55	0.49	0.57	0.64
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.52	0.57	0.56	0.57	0.67	0.53	0.51	0.55	0.49	0.57	0.64
0.70	0.65	0.66	0.65	0.55	0.69	0.72	0.67	0.73	0.66	0.58

Zone 51	Zone 52	Zone 53	Zone 54	Zone 55	Zone 56	Zone 57	Zone 58	Zone 59	Zone 60	Zone 61
1M10B	1M26	135C	135E	136A	105	108	155	150	161A	107C
Corridors	Corridors	prefunction (hotel)	prefunction (hotel)	prefunction (hotel)	Corridors	Corridors	Office space	Office space	Storage rooms	Corridors
239	527	4051	4051	1423	223	1032	136	524	154	676
0	0	122	122	43	0	0	1	4	0	0
0	0	7.5	7.5	7.5	0	0	5	5	0	0
0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.12	0.06
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.0	0.0	911.4	911.4	320.2	0.0	0.0	4.8	18.3	0.0	0.0
14.3	31.6	243.0	243.0	85.4	13.4	61.9	8.2	31.4	18.4	40.5
14.3	31.6	1154.5	1154.5	405.5	13.4	61.9	12.9	49.7	18.4	40.5
14.3	31.6	1154.5	1154.5	405.5	13.4	61.9	12.9	49.7	18.4	40.5
45	222	1,823	1,823	640	33	249	27	87	30	150
0.32	0.14	0.63	0.63	0.63	0.41	0.25	0.48	0.57	0.61	0.27
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.32	0.14	0.63	0.63	0.63	0.41	0.25	0.48	0.57	0.61	0.27
0.90	1.08	0.59	0.59	0.59	0.82	0.97	0.74	0.65	0.61	0.95

Zone 62	Zone 63	Zone 64	Zone 65	Zone 66	Zone 67	Zone 68	Zone 69	Zone 70	Zone 71	Zone 72
151	152	153	154	106	115	140	141	142	107B	B204
conference/ meeting	Office space	Office space	Office space	Corridors	Office space	Storage rooms	Office space	Office space	Corridors	Corridors
330	118	125	79	845	1534	2088	180	182	739	195
17	1	1	1	0	11	0	1	1	0	0
5	5	5	5	0	5	0	5	5	0	0
0.06	0.06	0.06	0.06	0.06	0.06	0.12	0.06	0.06	0.06	0.06
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
82.6	4.1	4.4	2.8	0.0	53.7	0.0	6.3	6.4	0.0	0.0
19.8	7.1	7.5	4.8	50.7	92.0	250.6	10.8	10.9	44.3	11.7
102.4	11.2	11.9	7.5	50.7	145.7	250.6	17.1	17.3	44.3	11.7
102.4	11.2	11.9	7.5	50.7	145.7	250.6	17.1	17.3	44.3	11.7
330	90	24	15	78	215	350	30	25	156	30
0.31	0.12	0.50	0.50	0.65	0.68	0.72	0.57	0.68	0.28	0.39
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.31	0.12	0.50	0.50	0.65	0.68	0.72	0.57	0.68	0.28	0.39
0.91	1.10	0.73	0.72	0.57	0.54	0.51	0.65	0.54	0.94	0.83

Zone 73	Zone 74	Zone 75	Zone 76	Zone 77	Zone 78	Zone 79	Zone 80	Zone 81	Zone 82	Zone 83
B107	135A	109	135B	135D	135F	136B	1M03	1M05B	1M04	1M11
Corridors	prefunction (hotel)	Office space	prefunction (hotel)	prefunction (hotel)	prefunction (hotel)	prefunction (hotel)	Corridors	Corridors	Corridors	restaurant dining room
210	2015	104	1029	1305	1353	654	325	405	182	315
0	60	1	31	39	41	20	0	0	0	22
0	7.5	5	7.5	7.5	7.5	7.5	0	0	0	7.5
0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.18
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.0	453.4	3.6	231.5	293.5	304.4	147.1	0.0	0.0	0.0	165.3
12.6	120.9	6.2	61.7	78.3	81.2	39.2	19.5	24.3	10.9	56.7
12.6	574.4	9.9	293.2	371.8	385.5	186.3	19.5	24.3	10.9	221.9
12.6	574.4	9.9	293.2	371.8	385.5	186.3	19.5	24.3	10.9	221.9
30	907	21	804	1,005	1,014	510	39	69	18	441
0.42	0.63	0.47	0.36	0.37	0.38	0.37	0.50	0.35	0.61	0.50
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.42	0.63	0.47	0.36	0.37	0.38	0.37	0.50	0.35	0.61	0.50
0.80	0.59	0.75	0.86	0.85	0.84	0.86	0.72	0.87	0.61	0.72

AHU 2 Zones		Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Zones Served							
Room #		1M91	179G	185	173	162	179F
Space Type (In accordance with ASHRAE Table 6-1)		Corridors	Office space	Storage rooms	Corridors	Office space	prefunction (hotel)
Az Zone Floor Area (ft ²)		3000	1876	480	1285	279	1922
Pz Zone Population (# People)		0	56	0	0	2	58
Rp People Outdoor Air Rate from ASHRAE Table 6-1 (cfm/person)		0	5	0	0	5	7.5
Ra Area Outdoor Air Rate from ASHRAE Table 6-1 (cfm/ft ²)		0.06	0.06	0.12	0.06	0.06	0.06
Ez Zone Air Distribution Effectiveness from ASHRAE Table 6-2		1.00	1.00	1.00	1.00	1.00	1.00
Pz*Rp		0.0	281.4	0.0	0.0	9.8	432.4
Az*Ra		180.0	112.6	57.6	77.1	16.8	115.3
Vbz Breathing Zone Outdoor Airflow (Pz*Rp+Az*Ra), cfm		180.0	394.0	57.6	77.1	26.5	547.7
Voz Zone Outdoor Airflow (Vbz/Ez), cfm		180.0	394.0	57.6	77.1	26.5	547.7
Vpz Zone Primary Airflow (intake + recirculated from AHU), cfm		200	844	72	117	48	865
Zp Zone Primary Outdoor Air Fraction (Voz/Vpz)		0.90	0.47	0.80	0.66	0.55	0.63
Appendix A							
Ep Primary Air Fraction to the Zone		1.00	1.00	1.00	1.00	1.00	1.00
Er Fraction of Secondary Recirculated Air		0.00	0.00	0.00	0.00	0.00	0.00
Fa Fa = Ep + (1 - Ep)*Er		1.00	1.00	1.00	1.00	1.00	1.00
Fb Fb = Ep		1.00	1.00	1.00	1.00	1.00	1.00
Fc Fc = 1 - (1 - Ez)*(1 - Er)*(1 - Ep)		1.00	1.00	1.00	1.00	1.00	1.00
Zd Discharge Outdoor Air Fraction		0.90	0.47	0.80	0.66	0.55	0.63
Xs Average Outdoor Air Fraction		0.31	**For all zones				
Evz Zone Ventilation Efficiency		0.41	0.84	0.51	0.65	0.76	0.68
System							
Max Zp of all zones		0.90	** Appendix A must be used to determine Ev				
Ev System Ventilation Efficiency = Min Evz		0.41					
Vou Uncorrected Outdoor Air Intake (Σ all Vbz for system), cfm		9604					
Vot Outdoor Air Intake (Vou/Ev), cfm		23435					
Vps System Primary Airflow (Fan Airflow from AHU schedule), cfm		31000					
ΣVoz Sum of all Voz for system		9604					
Percent Outdoor Air Intake (Vot/Vps)		76					

Zone 7	Zone 8	Zone 9	Zone 10	Zone 11	Zone 12	Zone 13	Zone 14	Zone 15	Zone 16	Zone 17
179D	1M90	1M92	165C	165A	165B	164	163F	163E	163D	163C
prefunction (hotel)	Corridors	Corridors	conference/ meeting	conference/ meeting	conference/ meeting	conference/ meeting	conference/ meeting	conference/ meeting	conference/ meeting	conference/ meeting
1603	1183	736	454	804	514	593	379	354	475	448
48	0	0	23	40	26	30	19	18	24	22
7.5	0	0	5	5	5	5	5	5	5	5
0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
360.7	0.0	0.0	113.4	200.9	128.6	148.2	94.7	88.6	118.8	111.9
96.2	71.0	44.2	27.2	48.2	30.9	35.6	22.7	21.3	28.5	26.9
456.9	71.0	44.2	140.6	249.1	159.5	183.8	117.4	109.8	147.3	138.7
456.9	71.0	44.2	140.6	249.1	159.5	183.8	117.4	109.8	147.3	138.7
721	132	500	454	804	514	593	379	354	475	448
0.63	0.54	0.09	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.63	0.54	0.09	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
0.68	0.77	1.22	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Zone 18	Zone 19	Zone 20	Zone 21	Zone 22	Zone 23	Zone 24	Zone 25	Zone 26	Zone 27	Zone 28
163B	163A	169B	169A	161	179C	179B	177	179E	178	183G
conference/ meeting	conference/ meeting	conference/ meeting	conference/ meeting	Corridors	prefunction (hotel)	prefunction (hotel)	conference/ meeting	prefunction (hotel)	conference/ meeting	restaurant dining room
503	467	967	1009	831	1643	802	817	836	1600	847
25	23	48	50	0	49	24	41	25	80	59
5	5	5	5	0	7.5	7.5	5	7.5	5	7.5
0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.18
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
125.8	116.8	241.6	252.3	0.0	369.7	180.4	204.3	188.0	400.0	444.7
30.2	28.0	58.0	60.6	49.8	98.6	48.1	49.0	50.1	96.0	152.5
156.0	144.8	299.6	312.9	49.8	468.3	228.5	253.3	238.1	496.0	597.1
156.0	144.8	299.6	312.9	49.8	468.3	228.5	253.3	238.1	496.0	597.1
503	467	967	1,009	600	846	894	817	927	1,600	1,186
0.31	0.31	0.31	0.31	0.08	0.55	0.26	0.31	0.26	0.31	0.50
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.31	0.31	0.31	0.31	0.08	0.55	0.26	0.31	0.26	0.31	0.50
1.00	1.00	1.00	1.00	1.23	0.76	1.05	1.00	1.05	1.00	0.81

Zone 29	Zone 30	Zone 31	Zone 32
183F	183I	183H	183E
restaurant dining	restaurant dining	restaurant dining	restaurant dining rooms
649	1749	1514	710
45	122	106	50
7.5	7.5	7.5	7.5
0.18	0.18	0.18	0.18
1.00	1.00	1.00	1.00
340.5	918.1	794.9	372.8
116.7	314.8	272.5	127.8
457.2	1232.8	1067.4	500.6
457.2	1232.8	1067.4	500.6
908	2,448	2,120	994
0.50	0.50	0.50	0.50
1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00
0.50	0.50	0.50	0.50
0.81	0.81	0.81	0.81

AHU 3 Zones		Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Zones Served							
Room #		210A	228	229	230	232	267
Space Type (In accordance with ASHRAE Table 6-1)		Corridors	Corridors	Corridors	Corridors	Corridors	Storage rooms
Az Zone Floor Area (ft ²)		1456	58	58	88	80	109
Pz Zone Population (# People)		0	0	0	0	0	0
Rp People Outdoor Air Rate from ASHRAE Table 6-1(cfm/person)		0	0	0	0	0	0
Ra Area Outdoor Air Rate from ASHRAE Table 6-1(cfm/ft ²)		0.06	0.06	0.06	0.06	0.06	0.12
Ez Zone Air Distribution Effectiveness from ASHRAE Table 6-2		1.00	1.00	1.00	1.00	1.00	1.00
Pz*Rp		0.0	0.0	0.0	0.0	0.0	0.0
Az*Ra		87.3	3.5	3.5	5.3	4.8	13.1
Vbz Breathing Zone Outdoor Airflow (Pz*Rp+Az*Ra), cfm		87.3	3.5	3.5	5.3	4.8	13.1
Voz Zone Outdoor Airflow (Vbz/Ez), cfm		87.3	3.5	3.5	5.3	4.8	13.1
Vpz Zone Primary Airflow (intake + recirculated from AHU), cfm		132	15	15	15	147	150
Zp Zone Primary Outdoor Air Fraction (Voz/Vpz)		0.66	0.23	0.23	0.35	0.03	0.09
Appendix A							
Ep Primary Air Fraction to the Zone		1.00	1.00	1.00	1.00	1.00	1.00
Er Fraction of Secondary Recirculated Air		0.00	0.00	0.00	0.00	0.00	0.00
Fa Fa = Ep + (1 - Ep)*Er		1.00	1.00	1.00	1.00	1.00	1.00
Fb Fb = Ep		1.00	1.00	1.00	1.00	1.00	1.00
Fc Fc = 1 - (1 - Ez)*(1 - Er)*(1 - Ep)		1.00	1.00	1.00	1.00	1.00	1.00
Zd Discharge Outdoor Air Fraction		0.66	0.23	0.23	0.35	0.03	0.09
Xs Average Outdoor Air Fraction		0.18	**for all zones				
Evz Zone Ventilation Efficiency		0.52	0.95	0.95	0.83	1.15	1.09
System							
Max Zp of all zones		0.73	** Appendix A must be used to determine Ev				
Ev System Ventilation Efficiency = Min Evz		0.45					
Vou Uncorrected Outdoor Air Intake (Σ all Vbz for system), cfm		6887					
Vot Outdoor Air Intake (Vou/Ev), cfm		15160					
Vps System Primary Airflow (Fan Airflow from AHU schedule), cfm		38000					
ΣVoz Sum of all Voz for system		6887					
Percent Outdoor Air Intake (Vot/Vps)		40					

Zone 7	Zone 8	Zone 9	Zone 10	Zone 11	Zone 12	Zone 13	Zone 14	Zone 15	Zone 16	Zone 17
210C	210B	218	219	235D	226	215	220B	220A	221B	221A
Corridors	Corridors	Office space	Storage rooms	Corridors	Corridors	Corridors	prefunction (hotel)	prefunction (hotel)	prefunction (hotel)	prefunction (hotel)
196	2160	185	486	58	92	525	2319	2623	3691	3416
0	0	1	0	0	0	0	70	79	111	102
0	0	5	0	0	0	0	7.5	7.5	7.5	7.5
0.06	0.06	0.06	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.0	0.0	6.5	0.0	0.0	0.0	0.0	521.8	590.2	830.4	788.5
11.8	129.6	11.1	58.4	3.5	5.5	31.5	139.1	157.4	221.4	204.9
11.8	129.6	17.5	58.4	3.5	5.5	31.5	660.9	747.6	1051.8	973.4
11.8	129.6	17.5	58.4	3.5	5.5	31.5	660.9	747.6	1051.8	973.4
18	195	33	90	15	15	63	1,044	1,180	1,661	1,537
0.65	0.66	0.53	0.65	0.23	0.37	0.50	0.63	0.63	0.63	0.63
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.65	0.66	0.53	0.65	0.23	0.37	0.50	0.63	0.63	0.63	0.63
0.53	0.52	0.65	0.53	0.95	0.81	0.68	0.55	0.55	0.55	0.55

Zone 18	Zone 19	Zone 20	Zone 21	Zone 22	Zone 23	Zone 24	Zone 25	Zone 26	Zone 27	Zone 28
211A	211B	212	213	214	230A	220D	220C	221D	221C	225A
Storage rooms	Storage rooms	conference/ meeti	Office space	Corridors	prefunction (hotel	prefunction (hotel	prefunction (hotel	prefunction (hotel	prefunction (hotel	prefunction (hotel
1163	1272	769	858	2043	934	2047	768	843	823	1465
0	0	38	6	0	28	61	23	25	25	44
0	0	5	5	0	7.5	7.5	7.5	7.5	7.5	7.5
0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.0	0.0	192.1	30.0	0.0	210.1	460.7	172.7	189.7	185.1	329.5
139.6	152.7	46.1	51.5	122.6	56.0	122.8	46.1	50.6	49.4	87.9
139.6	152.7	238.2	81.5	122.6	266.1	583.5	218.7	240.3	234.5	417.4
139.6	152.7	238.2	81.5	122.6	266.1	583.5	218.7	240.3	234.5	417.4
300	210	769	402	561	666	945	561	825	873	1,191
0.47	0.73	0.31	0.20	0.22	0.40	0.62	0.39	0.29	0.27	0.35
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.47	0.73	0.31	0.20	0.22	0.40	0.62	0.39	0.29	0.27	0.35
0.72	0.45	0.87	0.98	0.96	0.78	0.56	0.79	0.89	0.91	0.83

Zone 29

225B
prefunction (hotel, resort)
1343
40
7.5
0.06
1.00
302.2
80.6
382.8
382.8
1,098
0.35
1.00
0.00
1.00
1.00
1.00
0.35
0.83

		AHU 4					
		Zones					
Zones Served		Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Room #		244A	239D	239	242	243	239B
Space Type (In accordance with ASHRAE Table 6-1)		Storage rooms	Storage rooms	Corridors	Storage rooms	Storage rooms	Storage rooms
Az	Zone Floor Area (ft ²)	1004	30	1376	288	229	58
Pz	Zone Population (# People)	20	0	0	0	0	0
Rp	People Outdoor Air Rate from ASHRAE Table 6-1 (cfm/person)	0	0	0	0	0	0
Ra	Area Outdoor Air Rate from ASHRAE Table 6-1 (cfm/ft ²)	0.12	0.12	0.06	0.12	0.12	0.12
Ez	Zone Air Distribution Effectiveness from ASHRAE Table 6-2	1.00	1.00	1.00	1.00	1.00	1.00
Pz*Rp		0.0	0.0	0.0	0.0	0.0	0.0
Az*Ra		120.5	3.6	82.5	34.5	27.5	6.9
Vbz	Breathing Zone Outdoor Airflow (Pz*Rp+Az*Ra), cfm	120.5	3.6	82.5	34.5	27.5	6.9
Voz	Zone Outdoor Airflow (Vbz/Ez), cfm	120.5	3.6	82.5	34.5	27.5	6.9
Vpz	Zone Primary Airflow (intake + recirculated from AHU), cfm	345	15	126	50	111	15
Zp	Zone Primary Outdoor Air Fraction (Voz/Vpz)	0.35	0.24	0.66	0.69	0.25	0.46
		Appendix A					
Ep	Primary Air Fraction to the Zone	1.00	1.00	1.00	1.00	1.00	1.00
Er	Fraction of Secondary Recirculated Air	0.00	0.00	0.00	0.00	0.00	0.00
Fa	Fa = Ep + (1 - Ep)*Er	1.00	1.00	1.00	1.00	1.00	1.00
Fb	Fb = Ep	1.00	1.00	1.00	1.00	1.00	1.00
Fc	Fc = 1 - (1 - Ez)*(1 - Er)*(1 - Ep)	1.00	1.00	1.00	1.00	1.00	1.00
Zd	Discharge Outdoor Air Fraction	0.35	0.24	0.66	0.69	0.25	0.46
Xs	Average Outdoor Air Fraction	0.18	** for all zones				
Evz	Zone Ventilation Efficiency	0.83	0.94	0.52	0.49	0.93	0.71
		System					
Max Zp of all zones		0.69					
Ev	System Ventilation Efficiency = Min Evz	0.43					
Vou	Uncorrected Outdoor Air Intake (Σ all Vbz for system), cfm	4595					
Vot	Outdoor Air Intake (Vou/Ev), cfm	10657					
Vps	System Primary Airflow (Fan Airflow from AHU schedule), cfm	26000					
ΣVoz	Sum of all Voz for system	4595					
	Percent Outdoor Air Intake (Vot/Vps)	41					

Zone 7	Zone 8	Zone 10	Zone 11	Zone 12	Zone 13	Zone 14	Zone 15	Zone 16	Zone 17	Zone 18
239A	239E	255	256	257	258	241G	241F	241B	241C	244B
Storage rooms	Storage rooms	Corridors	Corridors	Corridors	Corridors	prefunction (hotel)	prefunction (hotel)	prefunction (hotel)	prefunction (hotel)	Storage
102	28	65	65	65	65	1074	1395	1245	1250	979
0	0	0	0	0	0	32	42	37	38	20
0	0	0	0	0	0	7.5	7.5	7.5	7.5	0
0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.12
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.0	0.0	0.0	0.0	0.0	0.0	241.7	313.9	280.2	281.3	0.0
12.3	3.4	3.9	3.9	3.9	3.9	64.4	83.7	74.7	75.0	117.4
12.3	3.4	3.9	3.9	3.9	3.9	306.1	397.7	354.9	356.3	117.4
12.3	3.4	3.9	3.9	3.9	3.9	306.1	397.7	354.9	356.3	117.4
45	15	15	15	15	15	483	628	560	563	300
0.27	0.23	0.26	0.26	0.26	0.26	0.63	0.63	0.63	0.63	0.39
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.27	0.23	0.26	0.26	0.26	0.26	0.63	0.63	0.63	0.63	0.39
0.90	0.95	0.92	0.92	0.92	0.92	0.54	0.54	0.54	0.54	0.79

Zone 19	Zone 20	Zone 21	Zone 22	Zone 23	Zone 24	Zone 25	Zone 26	Zone 27	Zone 28	Zone 29
241H	235A	235B	234B	234A	233	232	231	230B	241A	241E
prefunction (hot	conference/ meeti	onference/ meeti	onference/ meeti	onference/ meeti	onference/ meeti	Corridors	onference/ meeti	prefunction (hot	prefunction (hot	prefunction (hot
683	456	615	418	472	739	322	460	934	1009	1415
20	23	31	21	24	37	0	23	28	30	42
7.5	5	5	5	5	5	0	5	7.5	7.5	7.5
0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
153.7	114.0	153.8	104.5	118.1	184.8	0.0	115.0	210.1	227.1	318.4
41.0	27.4	36.9	25.1	28.3	44.4	19.3	27.6	56.0	60.6	84.9
194.7	141.3	190.7	129.5	146.4	229.2	19.3	142.6	266.1	287.7	403.3
194.7	141.3	190.7	129.5	146.4	229.2	19.3	142.6	266.1	287.7	403.3
307	456	615	418	472	739	147	460	669	777	1,056
0.63	0.31	0.31	0.31	0.31	0.31	0.13	0.31	0.40	0.37	0.38
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.63	0.31	0.31	0.31	0.31	0.31	0.13	0.31	0.40	0.37	0.38
0.54	0.87	0.87	0.87	0.87	0.87	1.05	0.87	0.78	0.81	0.79

Zone 30	Zone 31	Zone 32	Zone 33	Zone 34	Zone 35	Zone 36	Zone 37	Zone 38
241D	350A	365	350B	351	352	353	355	354
prefunction (hot	Corridors	Corridors	Corridors	Storage rooms	Storage rooms	Storage rooms	Corridors	Storage rooms
997	1335	928	335	80	108	56	266	994
30	0	0	0	0	0	0	0	0
7.5	0	0	0	0	0	0	0	0
0.06	0.06	0.06	0.06	0.12	0.12	0.12	0.06	0.12
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
224.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
59.8	80.1	55.7	20.1	9.6	13.0	6.7	16.0	119.3
284.3	80.1	55.7	20.1	9.6	13.0	6.7	16.0	119.3
284.3	80.1	55.7	20.1	9.6	13.0	6.7	16.0	119.3
705	240	660	60	15	25	15	24	160
0.40	0.33	0.08	0.33	0.64	0.52	0.45	0.66	0.75
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.40	0.33	0.08	0.33	0.64	0.52	0.45	0.66	0.75
0.77	0.84	1.09	0.84	0.53	0.66	0.73	0.51	0.43

**AHU 5
Zones**

Zones Served	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Room #	240B	240D	240F	240I	240G	240H
Space Type (In accordance with ASHRAE Table 6-1)	li-purpose asser	ti-purpose asser	ti-purpose asser	ti-purpose asser	ti-purpose asser	ti-purpose asser
Az Zone Floor Area (ft ²)	1587	1532	1532	1136	1775	1790
Pz Zone Population (# People)	190	184	184	136	213	215
Rp People Outdoor Air Rate from ASHRAE Table 6-1(cfm/person)	5	5	5	5	5	5
Ra Area Outdoor Air Rate from ASHRAE Table 6-1(cfm/ft ²)	0.06	0.06	0.06	0.06	0.06	0.06
Ez Zone Air Distribution Effectiveness from ASHRAE Table 6-2	1.00	1.00	1.00	1.00	1.00	1.00
Pz*Rp	952.3	919.1	919.4	681.7	1065.2	1073.9
Az*Ra	95.2	91.9	91.9	68.2	106.5	107.4
Vbz Breathing Zone Outdoor Airflow (Pz*Rp+Az*Ra), cfm	1047.5	1011.1	1011.3	749.9	1171.8	1181.3
Voz Zone Outdoor Airflow (Vbz/Ez), cfm	1047.5	1011.1	1011.3	749.9	1171.8	1181.3
Vpz Zone Primary Airflow (intake + recirculated from AHU), cfm	2,857	2,757	2,758	2,045	3,196	3,222
Zp Zone Primary Outdoor Air Fraction (Voz/Vpz)	0.37	0.37	0.37	0.37	0.37	0.37

System

Max Zp of all zones	0.37
Ev System Ventilation Efficiency from ASHRAE Table 6-3	0.70
Vou Uncorrected Outdoor Air Intake (Σ all Vbz for system), cfm	9956
Vot Outdoor Air Intake (Vou/Ev), cfm	14223
Vps System Primary Airflow (Fan Airflow from AHU schedule), cfm	47000
Σ Voz Sum of all Voz for system	9956
Percent Outdoor Air Intake (Vot/Vps)	30

0.37
0.70
9956
14223
47000
9956
30

Zone 7	Zone 8	Zone 9	Zone 10
240J	240A	240C	240E
li-purpose asser	ti-purpose asser	ti-purpose asser	ti-purpose asser
1141	1580	1526	1486
137	190	183	178
5	5	5	5
0.06	0.06	0.06	0.06
1.00	1.00	1.00	1.00
684.6	947.8	915.4	891.7
68.5	94.8	91.5	89.2
753.1	1042.6	1007.0	980.8
753.1	1042.6	1007.0	980.8
2,054	2,843	2,746	2,675
0.37	0.37	0.37	0.37

		AHU 6 Zones					
Zones Served		Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Room #		326B	343A	343B	343C	326C	342
Space Type (In accordance with ASHRAE Table 6-1)		prefunction (hotconference/ meetionference/ meetionference/ meetii prefunction (hot					Storage rooms
Az	Zone Floor Area (ft^2)	1708	239	486	725	245	390
Pz	Zone Population (# People)	51	12	24	36	7	0
Rp	People Outdoor Air Rate from ASHRAE Table 6-1(cfm/person)	7.5	5	5	5	7.5	0
Ra	Area Outdoor Air Rate from ASHRAE Table 6-1(cfm/ft^2)	0.06	0.06	0.06	0.06	0.06	0.12
Ez	Zone Air Distribution Effectiveness from ASHRAE Table 6-2	1.00	1.00	1.00	1.00	1.00	1.00
	Pz*Rp	384.3	59.7	121.5	181.2	55.0	0.0
	Az*Ra	102.5	14.3	29.2	43.5	14.7	46.8
Vbz	Breathing Zone Outdoor Airflow (Pz*Rp+Az*Ra), cfm	486.8	74.0	150.6	224.7	69.7	46.8
Voz	Zone Outdoor Airflow (Vbz/Ez), cfm	486.8	74.0	150.6	224.7	69.7	46.8
Vpz	Zone Primary Airflow (intake + recirculated from AHU), cfm	769	239	486	725	110	58
Zp	Zone Primary Outdoor Air Fraction (Voz/Vpz)	0.63	0.31	0.31	0.31	0.63	0.80
		Appendix A					
Ep	Primary Air Fraction to the Zone	1.00	1.00	1.00	1.00	1.00	1.00
Er	Fraction of Secondary Recirculated Air	0.00	0.00	0.00	0.00	0.00	0.00
Fa	Fa = Ep + (1 - Ep)*Er	1.00	1.00	1.00	1.00	1.00	1.00
Fb	Fb = Ep	1.00	1.00	1.00	1.00	1.00	1.00
Fc	Fc = 1 - (1 - Ez)*(1 - Er)*(1 - Ep)	1.00	1.00	1.00	1.00	1.00	1.00
Zd	Discharge Outdoor Air Fraction	0.63	0.31	0.31	0.31	0.63	0.80
Xs	Average Outdoor Air Fraction	0.23	** for all zones				
Evs	Zone Ventilation Efficiency	0.60	0.92	0.92	0.92	0.60	0.43
		System					
	Max Zp of all zones	0.80					
Ev	System Ventilation Efficiency = Min Evz	0.43					
Vou	Uncorrected Outdoor Air Intake (Σ all Vbz for system), cfm	11390					
Vot	Outdoor Air Intake (Vou/Ev), cfm	26193					
Vps	System Primary Airflow (Fan Airflow from AHU schedule), cfm	48500					
ΣVoz	Sum of all Voz for system	11390					
	Percent Outdoor Air Intake (Vot/Vps)	54					

Zone 7	Zone 8	Zone 9	Zone 10	Zone 11	Zone 12	Zone 13	Zone 14	Zone 15	Zone 16	Zone 17
344	339	338B	338A	337B	337A	222A	222B	222E	222F	222I
Corridors	onference/	meetionference/	meetionference/	meetionference/	meetionference/	meetii	lti-purpose	asserrlti-purpose	asserrlti-purpose	asserrlti-purpose
36	906	716	675	716	727	1532	1328	1436	1325	1435
2	45	36	34	36	36	184	159	172	159	172
0	5	5	5	5	5	5	5	5	5	5
0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.0	226.6	179.1	168.7	179.1	181.8	919.0	796.6	861.5	794.9	860.9
2.2	54.4	43.0	40.5	43.0	43.6	91.9	79.7	86.2	79.5	86.1
2.2	281.0	222.0	209.1	222.0	225.5	1010.9	876.2	947.7	874.4	947.0
2.2	281.0	222.0	209.1	222.0	225.5	1010.9	876.2	947.7	874.4	947.0
43	906	716	675	716	727	2,757	2,390	2,585	2,385	2,583
0.05	0.31	0.31	0.31	0.31	0.31	0.37	0.37	0.37	0.37	0.37
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.05	0.31	0.31	0.31	0.31	0.31	0.37	0.37	0.37	0.37	0.37
1.18	0.92	0.92	0.92	0.92	0.92	0.87	0.87	0.87	0.87	0.87

Zone 18	Zone 19	Zone 20	Zone 21	Zone 22
222J	222M	222N	222Q	222R
1324	1536	1416	1285	1286
159	184	170	154	154
5	5	5	5	5
0.06	0.06	0.06	0.06	0.06
1.00	1.00	1.00	1.00	1.00
794.6	921.8	849.7	771.1	771.4
79.5	92.2	85.0	77.1	77.1
874.1	1014.0	934.7	848.2	848.5
874.1	1014.0	934.7	848.2	848.5
2,384	2,765	2,549	2,313	2,314
0.37	0.37	0.37	0.37	0.37
1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00
0.37	0.37	0.37	0.37	0.37
0.87	0.87	0.87	0.87	0.87

**AHU 7
Zones**

Zones Served	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Room #	302	304	305	306	308A	308B
Space Type (In accordance with ASHRAE Table 6-1)	Corridors	Office space	Office space	Storage rooms	Storage rooms	Storage rooms
Az Zone Floor Area (ft ²)	610	172	127	410	701	762
Pz Zone Population (# People)	0	1	1	0	0	0
Rp People Outdoor Air Rate from ASHRAE Table 6-1(cfm/person)	0	5	5	0	0	0
Ra Area Outdoor Air Rate from ASHRAE Table 6-1(cfm/ft ²)	0.06	0.06	0.06	0.12	0.12	0.12
Ez Zone Air Distribution Effectiveness from ASHRAE Table 6-2	1.00	1.00	1.00	1.00	1.00	1.00
Pz*Rp	0.0	6.0	4.4	0.0	0.0	0.0
Az*Ra	36.6	10.3	7.6	49.2	84.1	91.4
Vbz Breathing Zone Outdoor Airflow (Pz*Rp+Az*Ra), cfm	36.6	16.3	12.0	49.2	84.1	91.4
Voz Zone Outdoor Airflow (Vbz/Ez), cfm	36.6	16.3	12.0	49.2	84.1	91.4
Vpz Zone Primary Airflow (intake + recirculated from AHU), cfm	57	30	24	62	105	114
Zp Zone Primary Outdoor Air Fraction (Voz/Vpz)	0.64	0.54	0.50	0.80	0.80	0.80

Appendix A

Ep Primary Air Fraction to the Zone	1.00	1.00	1.00	1.00	1.00	1.00
Er Fraction of Secondary Recirculated Air	0.00	0.00	0.00	0.00	0.00	0.00
Fa Fa = Ep + (1 - Ep)*Er	1.00	1.00	1.00	1.00	1.00	1.00
Fb Fb = Ep	1.00	1.00	1.00	1.00	1.00	1.00
Fc Fc = 1 - (1 - Ez)*(1 - Er)*(1 - Ep)	1.00	1.00	1.00	1.00	1.00	1.00
Zd Discharge Outdoor Air Fraction	0.64	0.54	0.50	0.80	0.80	0.80
Xs Average Outdoor Air Fraction	0.25	**For all zones				
Evs Zone Ventilation Efficiency	0.61	0.71	0.75	0.45	0.45	0.45

System

Max Zp of all zones	0.80	** Appendix A must be used to determine Ev
Ev System Ventilation Efficiency = Min Evz	0.45	
Vou Uncorrected Outdoor Air Intake (Σ all Vbz for system), cfm	12221	
Vot Outdoor Air Intake (Vou/Ev), cfm	27039	
Vps System Primary Airflow (Fan Airflow from AHU schedule), cfm	48500	
ΣVoz Sum of all Voz for system	12221	
Percent Outdoor Air Intake (Vot/Vps)	56	

Zone 7	Zone 8	Zone 9	Zone 10	Zone 11	Zone 12	Zone 13	Zone 14	Zone 15	Zone 16	Zone 17
317B	314	315A	315B	316A	316B	317C	317D	318	320	326
Corridors	Storage rooms	Corridors	Corridors	Corridors	Corridors	Corridors	Corridors	Office space	Office space	Corridors
667	396	533	551	400	956	1035	984	644	678	844
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	5	5	0
0.06	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40.0	47.6	32.0	33.1	24.0	57.4	62.1	59.0	38.6	40.7	50.7
40.0	47.6	32.0	33.1	24.0	57.4	62.1	59.0	38.6	40.7	50.7
40.0	47.6	32.0	33.1	24.0	57.4	62.1	59.0	38.6	40.7	50.7
60	59	51	51	39	87	96	90	322	339	102
0.67	0.80	0.63	0.65	0.62	0.66	0.65	0.66	0.12	0.12	0.50
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.67	0.80	0.63	0.65	0.62	0.66	0.65	0.66	0.12	0.12	0.50
0.59	0.45	0.62	0.60	0.64	0.59	0.61	0.60	1.13	1.13	0.76

Zone 18	Zone 19	Zone 20	Zone 21	Zone 22	Zone 23	Zone 24	Zone 25	Zone 26	Zone 27	Zone 28
335A	326A	307	309	317A	310	312	311	313	322A	322B
prefunction (hotel)	prefunction (hotel)	Corridors	Corridors	Corridors	Office space	Office space	Office space	Storage rooms	staurant dining	restaurant dining room
1609	1888	151	144	527	88	96	96	162	911	934
48	57	0	0	0	1	1	1	0	64	65
8	8	0	0	0	5	5	5	0	8	8
0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.12	0.18	0.18
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
361.9	424.9	0.0	0.0	0.0	3.1	3.4	3.4	0.0	478.4	490.5
96.5	113.3	9.0	8.7	31.6	5.3	5.8	5.8	19.4	164.0	168.2
458.5	538.2	9.0	8.7	31.6	8.4	9.1	9.2	19.4	642.4	658.7
458.5	538.2	9.0	8.7	31.6	8.4	9.1	9.2	19.4	642.4	658.7
724	850	24	21	105	21	24	24	27	1,276	1,308
0.63	0.63	0.38	0.41	0.30	0.40	0.38	0.38	0.72	0.50	0.50
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.63	0.63	0.38	0.41	0.30	0.40	0.38	0.38	0.72	0.50	0.50
0.62	0.62	0.88	0.84	0.95	0.85	0.87	0.87	0.53	0.75	0.75

Zone 29	Zone 30	Zone 31	Zone 32	Zone 33	Zone 34	Zone 35	Zone 36	Zone 37	Zone 38	Zone 39
323	324	325	327	328	329	330	331	332	335B	222C
conference/ meeti	Storage rooms	Corridors	conference/ meeti	conference/ meeti	conference/ meeti	conference/ meeti	conference/ meeti	conference/ meeti	conference/ meeti	conference/ meeti
401	241	844	840	828	457	549	476	542	1045	1327
20	0	0	42	41	23	27	24	27	31	159
5	0	0	5	5	5	5	5	5	8	5
0.06	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
100.2	0.0	0.0	210.1	207.0	114.2	137.3	119.0	135.5	235.0	796.2
24.0	28.9	50.7	50.4	49.7	27.4	32.9	28.6	32.5	62.7	79.6
124.2	28.9	50.7	260.5	256.7	141.6	170.2	147.6	168.0	297.7	875.8
124.2	28.9	50.7	260.5	256.7	141.6	170.2	147.6	168.0	297.7	875.8
225	75	228	840	828	457	549	476	542	474	2,389
0.55	0.39	0.22	0.31	0.31	0.31	0.31	0.31	0.31	0.63	0.37
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.55	0.39	0.22	0.31	0.31	0.31	0.31	0.31	0.31	0.63	0.37
0.70	0.87	1.03	0.94	0.94	0.94	0.94	0.94	0.94	0.62	0.89

Zone 40	Zone 41	Zone 42	Zone 43	Zone 44	Zone 45	Zone 46
222D	222G	222H	222K	222L	222O	222P
multi-purpose assembly	multi-purpose assembly	multi-purpose assembly	multi-purpose assembly	multi-purpose assembly	multi-purpose assembly	multi-purpose assembly
1528	1328	1429	1328	1428	1327	1529
183	159	171	159	171	159	183
5	5	5	5	5	5	5
0.06	0.06	0.06	0.06	0.06	0.06	0.06
1.00	1.00	1.00	1.00	1.00	1.00	1.00
917.0	796.7	857.2	796.5	856.8	796.3	917.2
91.7	79.7	85.7	79.7	85.7	79.6	91.7
1008.7	876.3	942.9	876.2	942.5	876.0	1008.9
1008.7	876.3	942.9	876.2	942.5	876.0	1008.9
2,751	2,390	2,571	2,390	2,570	2,389	2,751
0.37	0.37	0.37	0.37	0.37	0.37	0.37
1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.37	0.37	0.37	0.37	0.37	0.37	0.37
0.89	0.89	0.89	0.89	0.89	0.89	0.89

AHU 8			
Zones			
Zones Served	Zone 1	Zone 2	Zone 3
Room #	467	468A	468B
Space Type (In accordance with ASHRAE Table 6-1)	Office space	Health club	Health club
Az Zone Floor Area (ft ²)	568	1364	1167
Pz Zone Population (# People)	4	34	29
Rp People Outdoor Air Rate from ASHRAE Table 6-1(cfm/person)	5	20	20
Ra Area Outdoor Air Rate from ASHRAE Table 6-1(cfm/ft ²)	0.06	0.06	0.06
Ez Zone Air Distribution Effectiveness from ASHRAE Table 6-2	1.00	1.00	1.00
Pz*Rp	20.0	680.0	580.0
Az*Ra	34.1	81.8	70.0
Vbz Breathing Zone Outdoor Airflow (Pz*Rp+Az*Ra), cfm	54.1	761.8	650.0
Voz Zone Outdoor Airflow (Vbz/Ez), cfm	54.1	761.8	650.0
Vpz Zone Primary Airflow (intake + recirculated from AHU), cfm	138	818	700
Zp Zone Primary Outdoor Air Fraction (Voz/Vpz)	0.39	0.93	0.93
Appendix A			
Ep Primary Air Fraction to the Zone	1.00	1.00	1.00
Er Fraction of Secondary Recirculated Air	0.00	0.00	0.00
Fa Fa = Ep + (1 - Ep)*Er	1.00	1.00	1.00
Fb Fb = Ep	1.00	1.00	1.00
Fc Fc = 1 - (1 - Ez)*(1 - Er)*(1 - Ep)	1.00	1.00	1.00
Zd Discharge Outdoor Air Fraction	0.39	0.93	0.93
Xs Average Outdoor Air Fraction	0.37	**For all zones	
Evz Zone Ventilation Efficiency	0.97	0.44	0.44
System			
Max Zp of all zones	0.93	** Appendix A must be used to determine Ev	
Ev System Ventilation Efficiency = Min Evz	0.44		
Vou Uncorrected Outdoor Air Intake (Σ all Vbz for system), cfm	1466		
Vot Outdoor Air Intake (Vou/Ev), cfm	3366		
Vps System Primary Airflow (Fan Airflow from AHU schedule), cfm	4000		
ΣVoz Sum of all Voz for system	1466		
Percent Outdoor Air Intake (Vot/Vps)	84		

PAC 1		
Zones		
Zones Served	Zone 1	Zone 2
Room #	471	472
Space Type (In accordance with ASHRAE Table 6-1)	Swimming Pool	Storage
Az Zone Floor Area (ft ²)	3832	193
Pz Zone Population (# People)	0	0
Rp People Outdoor Air Rate from ASHRAE Table 6-1(cfm/person)	0	0
Ra Area Outdoor Air Rate from ASHRAE Table 6-1(cfm/ft ²)	0.48	0.12
Ez Zone Air Distribution Effectiveness from ASHRAE Table 6-2	1.00	1.00
Pz*Rp	0.0	0.0
Az*Ra	1839.4	23.2
Vbz Breathing Zone Outdoor Airflow (Pz*Rp+Az*Ra), cfm	1839.4	23.2
Voz Zone Outdoor Airflow (Vbz/Ez), cfm	1839.4	23.2
Vpz Zone Primary Airflow (intake + recirculated from AHU), cfm	5,000	300
Zp Zone Primary Outdoor Air Fraction (Voz/Vpz)	0.37	0.08
System		
Max Zp of all zones	0.37	
Ev System Ventilation Efficiency = Min Evz	0.70	
Vou Uncorrected Outdoor Air Intake (Σ all Vbz for system), cfm	1863	
Vot Outdoor Air Intake (Vou/Ev), cfm	2661	
Vps System Primary Airflow (Fan Airflow from AHU schedule), cfm	5300	
ΣVoz Sum of all Voz for system	1863	
Percent Outdoor Air Intake (Vot/Vps)	50	