

Mechanical Technical Report 1 ASHRAE Standard 62.1 Ventilation Compliance Evaluation



Straumann USA
Andover, MA

October 5, 2006

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1.0 Executive Summary

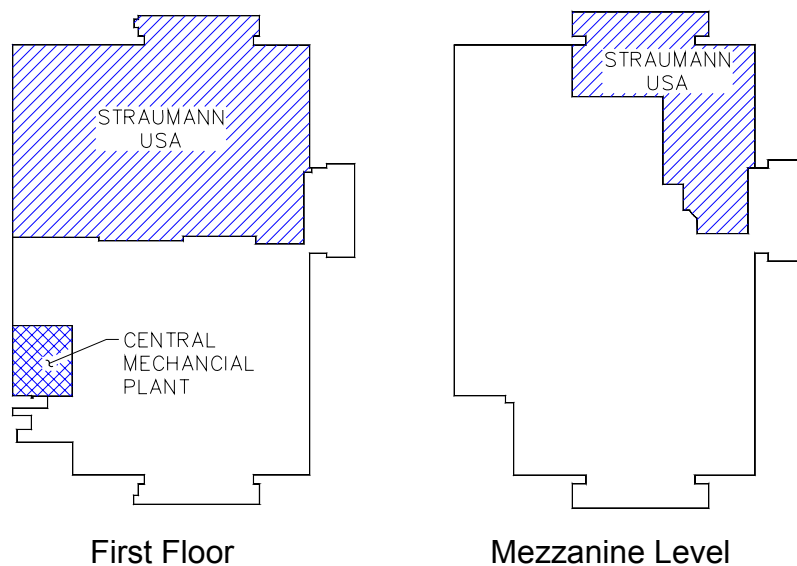
This report analyzes the amount of ventilation air supplied to the Straumann USA facility for compliance with ASHRAE Standard 62.1-2004. Straumann USA is a two story combination office/manufacturing building located in Andover, MA

Nine variable volume rooftop air handling units condition the air supplied to all but one of the spaces located in Straumann USA and range from 24,000 cfm - 33000 cfm. The auditorium for the facility is served by a constant volume 6,400 cfm air handling unit. The four air-handling units which serve the manufacturing space are not considered in this report since they may require additional ventilation requirements depending on processes that occur within that space.

The ventilation rate procedure was applied to the remaining six units of the facility. If a space did not directly fall into an occupancy category, it was assigned ventilation values of spaces with similar characteristics. Each of the units analyzed met and exceeded the required amount of ventilation air by at least 53%. Therefore, rooftop air handling units 1-6 all comply with ASHRAE Standard 62.1-2004.

2.0 Building Overview

The Straumann USA facility is located in Andover Massachusetts. Straumann USA occupies close to half of the 100 minuteman building. The entire building is 327,000 square feet and is owned by The Brickstone Companies. It is a two-story building featuring first floor and mezzanine levels. The Straumann facility occupies 153,000 square feet and is separated from the rest of the building by a firewall in order to comply with maximum floor area codes. The areas of the building Straumann USA occupies can be seen below in Figure 2.1.



Straumann USA Occupancy Locations
Figure 2.1

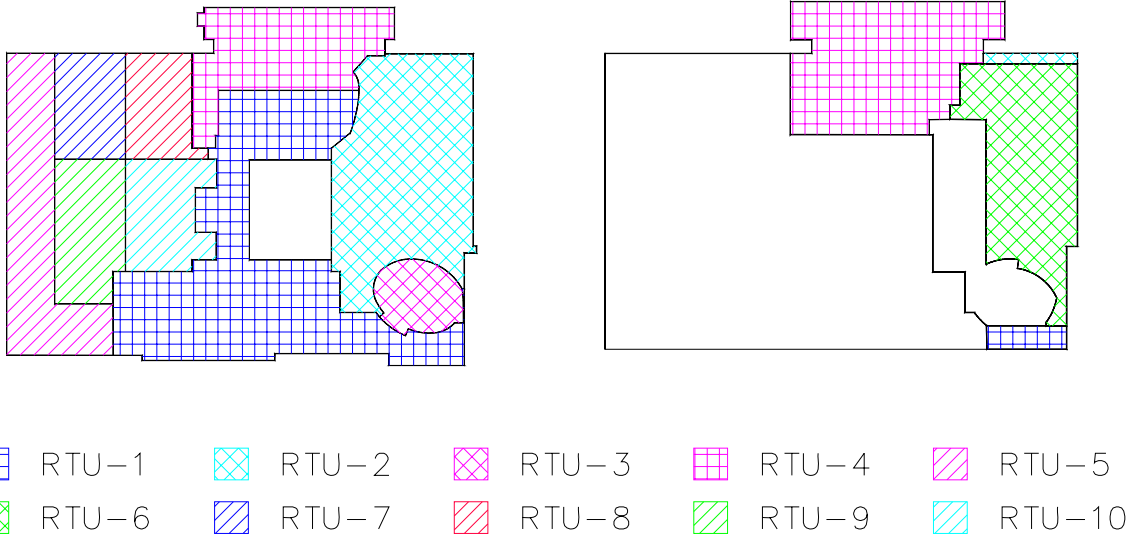
The Straumann USA facility features a variety of spaces. It is largely a combination office and light manufacturing building. However, other unique spaces include a dental operator suite, a dental training room, and an auditorium seating up to 95 people.

Straumann USA is served by 10 rooftop air handling units. Nine of the units are variable air volume ranging from 21,000 cfm to 33,000 cfm and the tenth unit that serves the auditorium area is a 6,400 cfm constant air volume unit. All 10 of the units condition air with a chilled water cooling coil and a steam heating coil. The central plant produces building chilled water and steam for the entire building not just the Straumann USA facility. Figure 2.1 shows the location of the central plant in the building.

Table 2.1 breaks down the type of areas each rooftop unit serves and lists the size of each unit. Figure 2.2 displays the location of each zone within the building.

	Max CFM	Areas Served
RTU-1	33,000	First floor manufacturing support areas and mezzanine level server room
RTU-2	33,000	First floor office and dental operatory areas
RTU-3	6,400	First floor auditorium
RTU-4	33,000	First floor and mezzanine office areas
RTU-5	21,000	First floor manufacturing support areas
RTU-6	21,000	Mezzanine office areas
RTU-7	33,000	Manufacturing area
RTU-8	33,000	Manufacturing area
RTU-9	33,000	Manufacturing area
RTU-10	33,000	Manufacturing area

Spaces Served by Each Rooftop Air Handling Unit
Table 2.1



Rooftop Air Handling Unit Zones
Figure 2.2

3.0 Analysis and Assumptions

According to section 2.2 of ASHARE Standard 62.1-2004, “additional requirements for laboratory, industrial, and other spaces may be dictated by workplace and other standards, as well as by the processes occurring within the space.” Since rooftop units 7-10 serve the manufacturing area, this analysis does not calculate the ventilation rate for these units. Specific processes occurring in this space are not currently known and may require a different set of ventilation design guidelines. This report analyzes rooftop units 1-6 for compliance with ASHRAE Standard 62.1-2004. Many spaces that are directly adjacent to the manufacturing area do not fall into an occupancy category listed in Table 6-1 of ASHRAE Standard 62.1-2004. For the purpose of this analysis any space with this problem will use one of the following classifications. If the design drawings specify the space is an “office area” then it is assumed to have the ventilation rates of the office space listed in ASHRAE Standard 62.1-2004. However, if the space is listed on the design documents as a “common area” it is assumed that a higher ventilation rate is necessary for these areas. Most of the areas in question, that have the “common area” designation, are either special storage areas or laboratory areas. Since these spaces would probably require a greater ventilation rate than a standard office space, the following values are assigned: $R_p = 10$ cfm/person and $R_a = 0.12$ cfm/ft². All other spaces can be directly associated with an occupancy category listed in Table 6-1 of ASHRAE Standard 62.1-2004.

The design occupancy for each space is determined by the design drawings provided by H.F. Lenz. For more details about each space refer to the space characteristic tables in Appendix A. This analysis also assumes the E_z value for each space is 1.0 since all ventilation air is supplied from overhead diffusers.

In order to calculate Z_p it is necessary to obtain the value of the Zone Primary Airflow (V_{pz}). In the situation where a single VAV box serves a single space, the minimum airflow through the box is used. However, when a VAV box serves multiple spaces a weighted average is used. This analysis assumes that when the VAV box reduces to its minimum setting, the ratio of supply air to the spaces stays the same as the ratio of design airflow to each space. For example, if a VAV box serves space 1 with 450 cfm and space 2 with 550 cfm at design conditions, spaces 1 and 2 will receive 135 cfm and 165 cfm respectively when the VAV box reduces to a minimum setting of 300 cfm. This keeps the ratio of supply air to spaces 1 (45%) and 2 (55%) constant.

The original design combines several open, undivided areas into one space when determining the ventilation requirements. The main area where this happens is the breakout space. The breakout space is comprised of the display, concierge, food service and seating areas. This analysis will consider each space separately in order to select the most appropriate R_p and R_a values for each occupancy. A problem arises when trying to calculate the Z_p value. Since the original design did not separate these spaces, determining the minimum primary air to each location may provide unrealistic Z_p

values. To avoid this, a single Z_p value will be calculated for the entire area. Refer to Appendix C for a summary of Z_p values.

The diversity factor for each unit in this analysis is 1. This is a conservative assumption, but the possibility does exist that every space that a single rooftop unit serves could see full occupancy at the same time.

Below, Table 2 summarizes the required ventilation rates for each rooftop unit and compares them to the actual amount of ventilation air that is supplied.

	ASHRAE Standard 62.1-2004 Ventilation Requirements (V_{ot}) (CFM)	Design Ventilation (CFM)	Nominal OA (Σv_{oz}) (CFM)	Critical Z_p Value	Compliance with ASHRAE Standard 62.1-2001
RTU-1	4299	9900	2580	0.54	Yes
RTU-2	3953	9900	2372	0.54	Yes
RTU-3	1096	6400	877	0.27	Yes
RTU-4	4009	9900	2406	0.47	Yes
RTU-5	2957	6300	1774	0.47	Yes
RTU-6	1996	6300	1397	0.38	Yes

Summary of Findings
Table 3.1

This analysis confirms every zone in the Straumann USA facility meets and exceeds the requirements of ASHRAE Standard 62.1-2004 by at least 53%. Refer to Appendix C for a complete space breakdown of ventilation air requirements, and refer to Appendix B for a description of the way the ventilation rate procedure is applied. The results in Table 3.1 show the significance of the Z_p value on a VAV system. The Z_p value adjusts the airflow to each space to meet the requirements of the critical space. For a standard VAV system, all air is supplied at the same ratio of ventilation and return air. The critical Z_p value specifies the percentage of ventilation air a unit must supply. If one space requires 54% ventilation air, then the overall ventilation rate is increased so that all other spaces receive more ventilation than required in order to provide the proper amount of ventilation air to the critical space. A high critical Z_p value can result in almost doubling the amount of ventilation air a space requires, as is seen in the difference between the Σv_{oz} nominal values and the V_{ot} required ventilation rate. If a direct outdoor air unit is considered as a replacement for any of these zones, the reduction of required ventilation air is at least 20%.

4.0 Discussion

It is possible to provide acceptable ventilation rates to a space by following one of two methods. According to ASHRAE Standard 62.1-2004, either the Ventilation Rate Procedure, or the Indoor Air Quality Procedure can be used to provide proper ventilation to a building. The Ventilation Rate Procedure is a prescriptive approach in which space types, occupancy levels, and floor areas are the basis for determining the amount of ventilation air each space requires.

The Indoor Air Quality Procedure is a method which uses a performance based approach for specifying ventilation levels. This approach allows the designer to select the contaminants that will be monitored, the sources and strengths of contaminants that will be present in a space, acceptable levels of contaminants in a space, and the way in which to justify the design. Some contaminants, acceptable levels, and strengths of sources are listed in Appendix B of ASHRAE Standard 62.1-2004 however; these are only guidelines, not an exact way to provide compliance. The designer must be able to justify the basis for the design that is implemented. This could be accomplished in one of several ways including using previous designs that have been successful, a combination of contaminant monitoring and occupant evaluations, or some other way a designer may be able to justify.

Since the IAQ method is rather vague, and can be hard to justify, it is not typically used to prove compliance with ASHRAE Standard 62.1-2004. The ventilation rate could continually change depending on the strength and number of contaminant sources found in any one space. Being able to monitor levels and adjust ventilation rates to compensate for continual fluctuations does not yet seem to be a method that is commonly used in the industry at this time.

5.0 References

ANSI/ASHRAE, Standard 62.1 - 2004, Ventilation for Acceptable Indoor Air Quality.
American Society of Heating Refrigeration and Air Conditioning Engineers, Inc.
Atlanta, GA. 2004.

Straumann USA - plans and schedules. Construction Document Set. May 28, 2004

6.0 Appendix A - Space Characteristic Tables

AHU-1

Space Number	Space Name	Area	Occupancy	Rp	Ra	Design Occupancy
021	MCC	347	other/lab	10	0.12	1
022	Trovalistion	659	other/lab	10	0.12	4
023	Sand Blasting	308	other/lab	10	0.12	2
024	Washing	920	office	5	0.06	6
025	Clean Room	1885	other/lab	10	0.12	5
027	Sand Blasting	253	other/lab	10	0.12	2
028	Corridor	999	corridor	0	0.06	0
029	Corridor	469	corridor	0	0.06	0
030	Purified Water	427	other/lab	10	0.12	1
031	Final Washing	296	office	5	0.06	2
032	Storage	571	storage	0	0.12	1
033	Locker Room	173	health club	20	0.06	1
034	Packaging	2701	office	5	0.06	15
035	Office	167	office	5	0.06	1
036	Warehouse	2761	warehouse	0	0.06	10
038	Office	167	office	5	0.06	1
039	Promotional Storage	248	storage	0	0.12	0
040	Corridor	984	corridor	0	0.06	0
043	Measurement Dev. Mgt.	393	office	5	0.06	1
044	Measurement	117	office	5	0.06	1
045	Quality Assurance	1158	office	5	0.06	10
047	Tools Mgmt.	393	office	5	0.06	1
048	Corridor	861	corridor	0	0.06	0
050	Corridor	932	corridor	0	0.06	0
055	Secondary Manuf. Oper.	1947	office	5	0.06	16
056	Laser Engrav.	417	office	5	0.06	3
057	Control Robot	367	other/lab	10	0.12	3
058	Open Office	1302	office	5	0.06	10
059	Meeting Room	412	conference/meeting	5	0.06	16
060	Storage	140	storage	0	0.12	1
063	Storage	1520	storage	0	0.12	1
157	AV Storage	224	storage	0	0.12	0
T04	SE Men	262	toilet			4
T05	SE Women	240	toilet			4
M43	Corridor	293	corridor	0	0.06	0
M44	Lab	187	office	5	0.06	0
M45	Server Room	528	office	5	0.06	0
M49	MER	268	office	5	0.06	0

AHU-2

Space Number	Space Name	Area	Occupancy	Rp	Ra	Design Occupancy
116	Corridor	260	corridor	0	0.06	0
124	Corridor	275	corridor	0	0.06	0
125	Waiting	332	reception area	5	0.06	4
126	Reception	326	reception area	5	0.06	2
127	Dressing	160	office	5	0.06	1
128	Diagnostic Business Office	191	corridor	5	0.06	2
130	Recovery	104	office	5	0.06	2
131	Corridor	325	corridor	0	0.06	0
132	Diagnostic	206	office	5	0.06	2
133	Vacuum Pump room	74	office	5	0.06	0
135	Diagnostic Xray	97	office	5	0.06	1
136	Consultation Office	208	office	5	0.06	2
137	Meeting Room	1000	conference/meeting	5	0.06	20
138	Corridor	280	corridor	0	0.06	0
139	Clean Sterilization	97	office	5	0.06	1
140	Dental Operator	233	office	5	0.06	3
141	Reading Room	147	office	5	0.06	1
142	Clean Sterilization	97	office	5	0.06	1
143	Dental Operator	237	office	5	0.06	3
144	Corridor	269	corridor	0	0.06	0
145	Meeting Room	145	conference/meeting	5	0.06	13
147	Tech	560	office	5	0.06	5
148	Storage	285	storage	0	0.12	0
149	Corridor	236	corridor	0	0.06	0
150	Prep	580	office	5	0.06	4
152	Casting	154	office	5	0.06	0
153	Simulation Lab	1750	office	5	0.06	14
154	Corridor	311	corridor	0	0.06	0
155	Storage	130	storage	0	0.12	0
160	Corridor	769	corridor	0	0.06	0
161	Corridor	981	corridor	0	0.06	0
162	Library	582	library	5	0.12	10
163	Break-out Area	2839	reception area	5	0.06	40
164	Food Service	858	dining	7.5	0.18	25
165	Pantry	181	dining	7.5	0.18	0
166	Concierge	511	reception area	5	0.06	20
167	Seating Alcove	296	reception area	5	0.06	10
168	Display	120	reception area	5	0.06	5
169	Corridor	1557	corridor	0	0.06	0
170	Stor. Lit.	122	storage	0	0.12	0
171	Events Coord.	750	office	5	0.06	4
172	Office	132	office	5	0.06	2
175	AV Closet	12	storage	0	0.12	0
T06	Existing SW Women	379	toilet			6
T07	Existing SW Men	407	toilet			7
T09	NW Men	308	toilet			5
T10	NW Women	332	toilet			5
T11	Janitor	42	storage	0	0.12	0
T12	Men's Shower	311	toilet			0
T13	Women's Shower	248	toilet			0

AHU-3

Space Number	Space Name	Area	Occupancy	Rp	Ra	Design Occupancy
158	Auditorium	1875	auditorium	5	0.06	150
159	Control Room	153	office	5	0.06	1

AHU-4

Space Number	Space Name	Area (sq ft)	Occupancy	Rp	Ra	Design Occupancy
M01	Lobby	593	main entry lobby	5	0.06	4
M02	Board Room	553	conference/meeting	5	0.06	27
M03	Reception	515	reception area	5	0.06	3
M04	Chariman Office	274	office	5	0.06	2
M05	COO Office	275	office	5	0.06	1
M06	Administrative	272	office	5	0.06	1
M07	CEO Office	542	office	5	0.06	2
M08	Exhibition Area	672	reception area	5	0.06	8
M09	Pantry	108	office	5	0.06	2
M11	Legal Office	172	office	5	0.06	1
M12	VP office	172	office	5	0.06	1
M13	VP office	172	office	5	0.06	1
M14	Copy/Equipment	156	office	5	0.06	1
M15	Corridor	977	corridor	0	0.06	0
M16	Open Office	3103	office	5	0.06	21
M17	Meeting Room	357	conference/meeting	5	0.06	10
M19	Coats	148	office	5	0.06	2
M20	Office	164	office	5	0.06	1
M21	Office	164	office	5	0.06	1
M22	Open Office	2868	office	5	0.06	25
M23	Operations Manager Office	198	office	5	0.06	1
M23A	Accounting Office	198	office	5	0.06	1
M24	Office	162	office	5	0.06	1
M25	Electric Room	135	storage	0	0.12	0
061	Coffee Station	352	office	5	0.06	3
101	Main Lobby	1767	main entry lobby	5	0.06	8
102	Reception	395	reception area	5	0.06	8
103	Reception Office	157	reception area	5	0.06	1
104	Alcove	131	reception area	5	0.06	0
105	Open Office	745	office	5	0.06	11
106	Office	165	office	5	0.06	1
107	Office	246	office	5	0.06	1
108	Copy/File Area	508	office	5	0.06	0
109	Meeting Room	240	conference/meeting	5	0.06	12
110	Meeting Room	464	conference/meeting	5	0.06	22
111	Alcove	312	reception area	5	0.06	2
112	Corridor	1255	corridor	0	0.06	0
113	Corridor	319	corridor	0	0.06	0
114	First Aid	290	office	5	0.06	1
115	Alcove	361	reception area	5	0.06	3
117	Mail	212	office	5	0.06	2
118	Print Room	315	office	5	0.06	6
119	Server Room	556	storage	0	0.12	1
120	Tel/Data	167	storage	0	0.12	0
121	Electrtric Room	146	storage	0	0.12	0
122	Corridor	97	corridor	0	0.06	1
123	Coats/Luggage	274	reception area	5	0.06	2
T01	Existing SE Men	354				5
T02	Existing SE Women	359				4

AHU-5

Space Number	Space Name	Area	Occupancy	Rp	Ra	Design Occupancy
002	Prototyping & Engin. Workshop	2299	other/lab	10	0.12	19
003	Office	782	office	5	0.06	6
004	Corridor	131	corridor	0	0.06	0
005	Meeting Room	272	conference/meeting	5	0.06	10
006	Meeting Room	264	conference/meeting	5	0.06	10
007	Raw Material Stock & Prep	554	other/lab	10	0.12	9
008	Holding Warehouse	667	warehouse	0	0.06	0
009	Tel/Data	263	storage	0	0.12	0
010	Oil Storage	776	other/lab	10	0.12	6
011	Shipping Dock	587	shipping/receiving	0	0.12	4
012	Receiving Office	248	office	5	0.06	3
013	Trash	361	other/lab	10	0.12	0
014	Acid Storage	262	other/lab	10	0.12	0
015	Receiving Dock	841	shipping/receiving	0	0.12	6
016	Entry Vestibule	324	main entry lobby	5	0.06	0
017	Men's Locker	826	health club	20	0.06	8
018	Women's Locker	761	health club	20	0.06	6
020	Corridor	659	corridor	0	0.06	0

AHU-6

Space Number	Space Name	Area (sq ft)	Occupancy	Rp	Ra	Design Occupancy
M15	Corridor	529	corridor	0	0.06	0
M26	Coffee Area	326	office	5	0.06	4
M28	Copy/Equipment	256	office	5	0.06	1
M29	Storage	150	storage	0	0.12	0
M30	Tele/Data	189	storage	0	0.12	0
M31	Office	213	office	5	0.06	1
M32	Office	169	office	5	0.06	1
M33	Office	169	office	5	0.06	1
M34	Office	169	office	5	0.06	1
M35	Office	169	office	5	0.06	1
M36	Office	165	office	5	0.06	1
M37	Office	166	office	5	0.06	1
M38	Office	166	office	5	0.06	1
M39	Open Office	5869	office	5	0.06	54
M40	Open Office	3929	office	5	0.06	31
M41	Meeting Room	179	conference/meeting	5	0.06	6
M42	Meeting Room	263	conference/meeting	5	0.06	8
M43	Corridor	534	corridor	0	0.06	0
T14	Existing SW Women	302	no sa required			
T15	Existing SW Men	304	no sa required			

7.0 Appendix B - Ventilation Rate Procedure

This analysis uses the following procedure to calculate the ventilation requirements for each system in order to comply with ASHRAE Standard 62.1-2004. In this calculation zone refers to an individual space and entire system refers to all spaces a single rooftop air handler serves.

1. Calculate the breathing zone outdoor air flow for each zone

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

R_p = Outdoor air rate per person - select utilizing Table 6-1 of ASHRAE Standard 62.1-2004 and the occupancy type.

P_z = Zone Population based - use population on H.F. Lenz design documents

R_a = Outdoor airflow rate per unit area - select utilizing Table 6-1 of ASHRAE Standard 62.1-2004 and the occupancy type.

A_z = Zone floor area - use H.F. Lenz design documents.

2. Calculate the zone outdoor airflow.

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

E_z = Zone air distribution effectiveness - select using Table 6-2 of ASHRAE Standard 62.1-2004. Use $E_z = 1.0$ for this analysis. Refer to section ?? for more details of this assumption.

3. Calculate the occupant diversity for each zone. For this analysis, it is assumed all spaces could be fully occupied. Refer to the section ?? for more details on this assumption.

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

P_s = System population - the total population the system serves.

This analysis assumes $P_s = \sum_{\text{all zones}} P_z$, so $D = 1$.

4. Calculate the uncorrected outdoor air intake for the entire system.

$$V_{ou} = D \sum_{\text{all zones}} R_p P_z + \sum_{\text{all zones}} R_a A_z$$

5. Calculate the primary outdoor air fraction for each zone.

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

V_{pz} = Zone primary airflow - for a VAV system like V_{pz} is the minimum expected primary airflow to a zone. Refer to H.F. Lenz VAV and FPB minimum settings to obtain this value.

6. Calculate the entire system ventilation efficiency.

E_v = function of maximum Z_p

Use Table 6-3 of ASHRAE Standard 62.1-2004 and the maximum zone Z_p value for the entire system. All maximum zone Z_p values for these calculation fall within the limits of table 6-3 so the equations of Appendix A in ASHRAE Standard 62.1-2004 are not necessary for this analysis. If the maximum Z_p value for any zone is greater than 0.55 then it would be necessary to use the Appendix A equations in ASHRAE Standard 62.1-2004 to calculate E_v .

7. Calculate the outdoor air intake for the entire system.

$$V_{ot} = \frac{V_{ou}}{E_v}$$

8.0 Appendix C - Ventilation Calculations

RTU-1

Space Number	Space Name	Area	Occupancy	Rp	Ra	Vpz	Design Occupancy	Vbz	Voz	Ez	Zp	Notes
021	MCC	347	other/lab	10	0.12	230	1	51.64	51.64	1.00	0.22	
022	Trovalistion	659	other/lab	10	0.12	230	4	119.08	119.08	1.00	0.52	
023	Sand Blasting	308	other/lab	10	0.12	145	2	56.96	56.96	1.00	0.39	
024	Washing	920	office	5	0.06	255	6	85.20	85.20	1.00	0.33	
025	Clean Room	1885	other/lab	10	0.12		5	276.20	276.20	1.00	0.00	
027	Sand Blasting	253	other/lab	10	0.12		2	50.36	50.36	1.00	0.00	
028	Corridor	999	corridor	0	0.06	230	0	59.94	59.94	1.00	0.26	
029	Corridor	469	corridor	0	0.06	145	0	28.14	28.14	1.00	0.19	
030	Purified Water	427	other/lab	10	0.12	145	1	61.24	61.24	1.00	0.42	
031	Final Washing	296	office	5	0.06	80	2	27.76	27.76	1.00	0.35	
032	Storage	571	storage	0	0.12	145	1	68.52	68.52	1.00	0.47	
033	Locker Room	173	health club	20	0.06	80	1	30.38	30.38	1.00	0.38	
034	Packaging	2701	office	5	0.06	720	15	237.06	237.06	1.00	0.33	
035	Office	167	office	5	0.06	80	1	15.02	15.02	1.00	0.19	
036	Warehouse	2761	warehouse	0	0.06	880	10	165.66	165.66	1.00	0.19	
038	Office	167	office	5	0.06	80	1	15.02	15.02	1.00	0.19	
039	Promotional Storage	248	storage	0	0.12	80	0	29.76	29.76	1.00	0.37	
040	Corridor	984	corridor	0	0.06	605	0	59.04	59.04	1.00	0.10	
043	Measurement Dev. Mgt.	393	office	5	0.06	145	1	28.58	28.58	1.00	0.20	
044	Measurement	117	office	5	0.06	80	1	12.02	12.02	1.00	0.15	
045	Quality Assurance	1158	office	5	0.06	360	10	119.48	119.48	1.00	0.33	
047	Tools Mgmt.	393	office	5	0.06	145	1	28.58	28.58	1.00	0.20	
048	Corridor	861	corridor	0	0.06	775	0	51.66	51.66	1.00	0.07	
050	Corridor	932	corridor	0	0.06	620	0	55.92	55.92	1.00	0.09	
055	Secondary Manuf. Oper.	1947	office	5	0.06	650	16	196.82	196.82	1.00	0.30	
056	Laser Engrav.	417	office	5	0.06	145	3	40.02	40.02	1.00	0.28	
057	Control Robot	367	other/lab	10	0.12	145	3	74.04	74.04	1.00	0.51	
058	Open Office	1302	office	5	0.06	450	10	128.12	128.12	1.00	0.28	

Space Number	Space Name	Area	Occupancy	Rp	Ra	Vpz	Design Occupancy	Vbz	Voz	Ez	Zp	Notes
059	Meeting Room	412	conference/meeting	5	0.06	195.7	16	104.72	104.72	1.00	0.54	Max Zp
060	Storage	140	storage	0	0.12	34.3	1	16.80	16.80	1.00	0.49	
063	Storage	1520	storage	0	0.12	360	1	182.40	182.40	1.00	0.51	
157	AV Storage	224	storage	0	0.12	145	0	26.88	26.88	1.00	0.19	
T04	SE Men	262	toilet			75	4	0.00	0.00	1.00	0.00	
T05	SE Women	240	toilet			75	4	0.00	0.00	1.00	0.00	
M43	Corridor	293	corridor	0	0.06	33	0	17.58	17.58	1.00	0.53	
M44	Lab	187	office	5	0.06	21	0	11.22	11.22	1.00	0.53	
M45	Server Room	528	office	5	0.06	60	0	31.68	31.68	1.00	0.53	
M49	MER	268	office	5	0.06	31	0	16.08	16.08	1.00	0.52	
$\Sigma R_p P_s$	615.00											
$\Sigma R_a A_z$	1964.58											
D	1											
Vou	2580											
Max Zp	0.54											
Ev	0.60											
Vot	4299											

RTU-2

Space Number	Space Name	Area	Occupancy	Rp	Ra	Vpz	Design Occupancy	Vbz	Voz	Ez	Zp	Notes
116	Corridor	260	corridor	0	0.06	55.8	0	15.60	15.60	1.00	0.28	
124	Corridor	275	corridor	0	0.06	230	0	16.50	16.50	1.00	0.07	
125	Waiting	332	reception area	5	0.06	330	4	39.92	39.92	1.00	0.12	
126	Reception	326	reception area	5	0.06	330	2	29.56	29.56	1.00	0.09	
127	Dressing	160	office	5	0.06	80	1	14.60	14.60	1.00	0.18	
128	Diagnostic Business Office	191	corridor	5	0.06	145	2	21.46	21.46	1.00	0.15	
130	Recovery	104	office	5	0.06	57	2	16.24	16.24	1.00	0.28	
131	Corridor	325	corridor	0	0.06	88.6	0	19.50	19.50	1.00	0.22	
132	Diagnostic	206	office	5	0.06	162.5	2	22.36	22.36	1.00	0.14	
133	Vacuum Pump room	74	office	5	0.06	84.4	0	4.44	4.44	1.00	0.05	
135	Diagnostic Xray	97	office	5	0.06	51.8	1	10.82	10.82	1.00	0.21	
136	Consultation Office	208	office	5	0.06	162.5	2	22.48	22.48	1.00	0.14	
137	Meeting Room	1000	conference/meeting	5	0.06	402.5	20	160.00	160.00	1.00	0.40	
138	Corridor	280	corridor	0	0.06	93.2	0	16.80	16.80	1.00	0.18	
139	Clean Sterilization	97	office	5	0.06	44.6	1	10.82	10.82	1.00	0.24	
140	Dental Operatory	233	office	5	0.06	145	3	28.98	28.98	1.00	0.20	
141	Reading Room	147	office	5	0.06	145	1	13.82	13.82	1.00	0.10	
142	Clean Sterilization	97	office	5	0.06	44.6	1	10.82	10.82	1.00	0.24	
143	Dental Operatory	237	office	5	0.06	230	3	29.22	29.22	1.00	0.13	
144	Corridor	269	corridor	0	0.06	145	0	16.14	16.14	1.00	0.11	
145	Meeting Room	145	conference/meeting	5	0.06	145	13	73.70	73.70	1.00	0.51	
147	Tech	560	office	5	0.06	325	5	58.60	58.60	1.00	0.18	
148	Storage	285	storage	0	0.12	80	0	34.20	34.20	1.00	0.43	
149	Corridor	236	corridor	0	0.06	80	0	14.16	14.16	1.00	0.18	
150	Prep	580	office	5	0.06	325	4	54.80	54.80	1.00	0.17	
152	Casting	154	office	5	0.06	80	0	9.24	9.24	1.00	0.12	
153	Simulation Lab	1750	office	5	0.06	600	14	175.00	175.00	1.00	0.29	
154	Corridor	311	corridor	0	0.06	100.4	0	18.66	18.66	1.00	0.19	
155	Storage	130	storage	0	0.12	44.6	0	15.60	15.60	1.00	0.35	
160	Corridor	769	corridor	0	0.06	289.1	0	46.14	46.14	1.00	0.16	
161	Corridor	981	corridor	0	0.06	390	0	58.86	58.86	1.00		
162	Library	582	library	5	0.12	230	10	119.84	119.84	1.00	0.29	

Space Number	Space Name	Area	Occupancy	Rp	Ra	Vpz	Design Occupancy	Vbz	Voz	Ez	Zp	Notes
163	Break-out Area	2839	reception area	5	0.06	780	40	370.34	370.34	1.00	0.54	Max Zp
164	Food Service	858	dining	7.5	0.18	390	25	341.94	341.94	1.00		
166	Concierge	511	reception area	5	0.06	195	20	130.66	130.66	1.00		
167	Seating Alcove	296	reception area	5	0.06	195	10	67.76	67.76	1.00		
168	Display	120	reception area	5	0.06	195	5	32.20	32.20	1.00		
165	Pantry	181	dining	7.5	0.18	80	0	32.58	32.58	1.00	0.41	
169	Corridor	1557	corridor	0	0.06	360	0	93.42	93.42	1.00	0.26	
170	Stor. Lit.	122	storage	0	0.12	80	0	14.64	14.64	1.00	0.18	
171	Events Coord.	750	office	5	0.06	230	4	65.00	65.00	1.00	0.28	
172	Office	132	office	5	0.06	80	2	17.92	17.92	1.00	0.22	
175	AV Closet	12	storage	0	0.12	57.5	0	1.44	1.44	1.00	0.03	
T06	Existing SW Women	379	toilet			75	6	0.00	0.00	1.00	0.00	
T07	Existing SW Men	407	toilet			75	7	0.00	0.00	1.00	0.00	
T09	NW Men	308	toilet			94.1	5	0.00	0.00	1.00	0.00	
T10	NW Women	332	toilet			94.1	5	0.00	0.00	1.00	0.00	
T11	Janitor	42	storage	0	0.12	37.6	0	5.04	5.04	1.00	0.13	
T12	Men's Shower	311	toilet				0					
T13	Women's Shower	248	toilet				0					
Σ RpPs		1047.50										
Σ RaAz		1324.32										
Vou		2372										
Max Zp		0.54										
Ev		0.60										
Vot		3953										

RTU-3

Space Number	Space Name	Area	Occupancy	Rp	Ra	Vpz	Design Occupancy	Vbz	Voz	Ez	Zp	Notes
158	Auditorium	1875	auditorium	5	0.06	3200	150	862.50	862.50	1.00	0.27	Max Zp
159	Control Room	153	office	5	0.06	350	1	14.18	14.18	1.00	0.04	
$\Sigma RpPs$	755.00											
$\Sigma RaAz$	121.68											
D	1											
Vou	877											
Max Zp	0.27											
Ev	0.8											
Vot	1096											

RTU-4

Space Number	Space Name	Area (sq ft)	Occupancy	Rp	Ra	Design Occupancy	Vbz	Voz	Ez	Zp	Notes
M01	Lobby	593	main entry lobby	5	0.06	4	55.58	55.58	1.00	0.38	
M02	Board Room	553	conference/meeting	5	0.06	27	168.18	168.18	1.00	0.47	Max Zp
M03	Reception	515	reception area	5	0.06	3	45.90	45.90	1.00	0.14	
M04	Chariman Office	274	office	5	0.06	2	26.44	26.44	1.00	0.14	
M05	COO Office	275	office	5	0.06	1	21.50	21.50	1.00	0.11	
M06	Administrative	272	office	5	0.06	1	21.32	21.32	1.00	0.11	
M07	CEO Office	542	office	5	0.06	2	42.52	42.52	1.00	0.18	
M08	Exhibition Area	672	reception area	5	0.06	8	80.32	80.32	1.00	0.37	
M09	Pantry	108	office	5	0.06	2	16.48	16.48	1.00		
M11	Legal Office	172	office	5	0.06	1	15.32	15.32	1.00	0.19	
M12	VP office	172	office	5	0.06	1	15.32	15.32	1.00	0.21	
M13	VP office	172	office	5	0.06	1	15.32	15.32	1.00	0.21	
M14	Copy/Equipment	156	office	5	0.06	1	14.36	14.36	1.00	0.18	
M15	Corridor	977	corridor	0	0.06	0	58.62	58.62	1.00	0.18	
M16	Open Office	3103	office	5	0.06	21	291.18	291.18	1.00	0.34	
M17	Meeting Room	357	conference/meeting	5	0.06	10	71.42	71.42	1.00	0.31	
M19	Coats	148	office	5	0.06	2	18.88	18.88	1.00	0.24	
M20	Office	164	office	5	0.06	1	14.84	14.84	1.00	0.20	
M21	Office	164	office	5	0.06	1	14.84	14.84	1.00	0.20	
M22	Open Office	2868	office	5	0.06	25	297.08	297.08	1.00	0.37	
M23	Operations Manager Office	198	office	5	0.06	1	16.88	16.88	1.00	0.33	
M23A	Accounting Office	198	office	5	0.06	1	16.88	16.88	1.00	0.24	
M24	Office	162	office	5	0.06	1	14.72	14.72	1.00	0.20	
M25	Electric Room	135	storage	0	0.12	0	16.20	16.20	1.00	0.11	
061	Coffee Station	352	office	5	0.06	3	36.12	36.12	1.00	0.25	
101	Main Lobby	1767	main entry lobby	5	0.06	8	146.02	146.02	1.00	0.18	
102	Reception	395	reception area	5	0.06	8	63.70	63.70	1.00	0.21	
103	Reception Office	157	reception area	5	0.06	1	14.42	14.42	1.00	0.10	
104	Alcove	131	reception area	5	0.06	0	7.86	7.86	1.00	0.00	
105	Open Office	745	office	5	0.06	11	99.70	99.70	1.00	0.22	

Space Number	Space Name	Area (sq ft)	Occupancy	Rp	Ra	Design Occupancy	Vbz	Voz	Ez	Zp	Notes
106	Office	165	office	5	0.06	1	14.90	14.90	1.00	0.10	
107	Office	246	office	5	0.06	1	19.76	19.76	1.00	0.11	
108	Copy/File Area	508	office	5	0.06	0	30.48	30.48	1.00	0.13	
109	Meeting Room	240	conference/meeting	5	0.06	12	74.40	74.40	1.00	0.45	
110	Meeting Room	464	conference/meeting	5	0.06	22	137.84	137.84	1.00	0.20	
111	Alcove	312	reception area	5	0.06	2	28.72	28.72	1.00	0.44	
112	Corridor	1255	corridor	0	0.06	0	75.30	75.30	1.00	0.31	
113	Corridor	319	corridor	0	0.06	0	19.14	19.14	1.00	0.00	
114	First Aid	290	office	5	0.06	1	22.40	22.40	1.00	0.15	
115	Alcove	361	reception area	5	0.06	3	36.66	36.66	1.00	0.25	
117	Mail	212	office	5	0.06	2	22.72	22.72	1.00	0.28	
118	Print Room	315	office	5	0.06	6	48.90	48.90	1.00	0.21	
119	Server Room	556	storage	0	0.12	1	66.72	66.72	1.00	0.00	
120	Tel/Data	167	storage	0	0.12	0	20.04	20.04	1.00	0.00	
121	Electric Room	146	storage	0	0.12	0	17.52	17.52	1.00	0.00	
122	Corridor	97	corridor	0	0.06	1	5.82	5.82	1.00	0.22	
123	Coats/Luggage	274	reception area	5	0.06	2	26.44	26.44	1.00	0.22	
T01	Existing SE Men	354				5	0.00	0.00	1.00	0.00	
T02	Existing SE Women	359				4	0.00	0.00	1.00	0.00	
Σ RpPs	1000.00										
Σ RaAz	1405.68										
D	1										
Vou	2406										
Max Zp	0.47										
Ev	0.60										
Vot	4009										

RTU-5

Space Number	Space Name	Area	Occupancy	Rp	Ra	Vpz	Design Occupancy	Vbz	Voz	Ez	Zp	Notes
002	Prototyping & Engin. Workshop	2299	other/lab	10	0.12	1920	19	465.88	465.88	1.00	0.24	
003	Office	782	office	5	0.06	292.5	6	76.92	76.92	1.00	0.26	
004	Corridor	131	corridor	0	0.06	32.5	0	7.86	7.86	1.00	0.24	
005	Meeting Room	272	conference/meeting	5	0.06	175	10	66.32	66.32	1.00	0.38	
006	Meeting Room	264	conference/meeting	5	0.06	145	10	65.84	65.84	1.00	0.45	
007	Raw Material Stock & Prep	554	other/lab	10	0.12	343.3	9	156.48	156.48	1.00	0.46	
008	Holding Warehouse	667	warehouse	0	0.06	171.7	0	40.02	40.02	1.00	0.23	
009	Tel/Data	263	storage	0	0.12	145	0	31.56	31.56	1.00	0.22	
010	Oil Storage	776	other/lab	10	0.12	325	6	153.12	153.12	1.00	0.47	Max Zp
011	Shipping Dock	587	shipping/receiving	0	0.12	210	4	70.44	70.44	1.00	0.34	
012	Receiving Office	248	office	5	0.06	230	3	29.88	29.88	1.00	0.13	
013	Trash	361	other/lab	10	0.12	150	0	43.32	43.32	1.00	0.29	
014	Acid Storage	262	other/lab	10	0.12	172.5	0	31.44	31.44	1.00	0.18	
015	Receiving Dock	841	shipping/receiving	0	0.12	325	6	100.92	100.92	1.00	0.31	
016	Entry Vestibule	324	main entry lobby	5	0.06	230	0	19.44	19.44	1.00	0.08	
017	Men's Locker	826	health club	20	0.06	445	8	209.56	209.56	1.00	0.47	
018	Women's Locker	761	health club	20	0.06	445	6	165.66	165.66	1.00	0.37	
020	Corridor	659	corridor	0	0.06	145	0	39.54	39.54	1.00	0.27	
$\Sigma R_p P_s$	765.00											
$\Sigma R_a A_z$	1009.20											
D	1											
Vou	1774											
Max Zp	0.47											
Ev	0.60											
Vot	2957											

RTU-6

Space Number	Space Name	Area (sq ft)	Occupancy	Rp	Ra	Vpz	Design Occupancy	Vbz	Voz	Ez	Zp	Notes
M15	Corridor	529	corridor	0	0.06	179.4	0	31.74	31.74	1.00	0.18	
M26	Coffee Area	326	office	5	0.06	325	4	39.56	39.56	1.00	0.12	
M28	Copy/Equipment	256	office	5	0.06	145	1	20.36	20.36	1.00	0.14	
M29	Storage	150	storage	0	0.12	50.6	0	18.00	18.00	1.00	0.36	
M30	Tele/Data	189	storage	0	0.12	145	0	22.68	22.68	1.00	0.16	
M31	Office	213	office	5	0.06	50	1	17.78	17.78	1.00	0.36	
M32	Office	169	office	5	0.06	50	1	15.14	15.14	1.00	0.30	
M33	Office	169	office	5	0.06	48.3	1	15.14	15.14	1.00	0.31	
M34	Office	169	office	5	0.06	48.3	1	15.14	15.14	1.00	0.31	
M35	Office	169	office	5	0.06	48.3	1	15.14	15.14	1.00	0.31	
M36	Office	165	office	5	0.06	48.3	1	14.90	14.90	1.00	0.31	
M37	Office	166	office	5	0.06	48.3	1	14.96	14.96	1.00	0.31	
M38	Office	166	office	5	0.06	48.3	1	14.96	14.96	1.00	0.31	
M39	Open Office	5869	office	5	0.06	2035	54	622.14	622.14	1.00	0.31	
M40	Open Office	3929	office	5	0.06	1665	31	390.74	390.74	1.00	0.23	
M41	Meeting Room	179	conference/meeting	5	0.06	145	6	40.74	40.74	1.00	0.28	
M42	Meeting Room	263	conference/meeting	5	0.06	145	8	55.78	55.78	1.00	0.38	Max Zp
M43	Corridor	534	corridor	0	0.06	230	0	32.04	32.04	1.00	0.14	
T14	Existing SW Women	302	no sa required			72.5		0.00	0.00	1.00	0.00	
T15	Existing SW Men	304	no sa required			72.5		0.00	0.00	1.00	0.00	
ΣRpPs	560.00											
ΣRaAz	836.94											
D	1.00											
Vou	1397											
Max Zp	0.38											
Ev	0.7											
Vot	1996											