

ASHRAE STANDARD 62 VENTILATION REPORT

LANDSCAPE BUILDING
AT
JANELIA FARM
HOWARD HUGHES MEDICAL INSTITUE
ASHBURN, VIRGINIA

PREPARED FOR
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MEHCANICAL OPTION
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EXECUTIVE SUMMARY

This report examines if air handling units 1 & 2 of the Landscape Building at Janelia Farm Research Campus is compliant with AHRAE Standard 6.21-2004 ventilation requirements at design conditions.

The Landscape Building is a 546,436 square foot world-class biomedical research facility owned by Howard Hughes Medical Institute. It is currently beginning its third year of construction in Ashburn, Virginia located 45 minutes outside of Washington, D.C. The building is divided into Zones A through G on three different levels.

The building is supplied with 90% outdoor air by both a variable air volume (VAV) system as well as a constant volume system (CAV) supported by 15 air handling units and 5 chillers. Each air handling unit has a capacity of 45,000 cfm of which 100% is outdoor air. This is because the majority of spaces in the building cannot receive recirculated air due to the threat of contamination from laboratory spaces.

One unique feature of the mechanical system is all the air handlers serve one 132x120 plenum that then is distributed throughout the building. AHUs 1 & 2 are isolated from the rest of the system by mechanical dampers located in the main plenum. AHU 4 – 15 collectively serve the remainder of the building. AHU 3 acts as a back up air handler capable of supplying air to either zone.

Air handling units 1 & 2 have been chosen for analysis. This decision was based upon the following considerations. All 15 air handlers provide a total of 675,000 cfm to the building at design load. Analyzing a system of this size is beyond the scope of this report. There are two zones in the building, one served by AHUs 1 & 2 with 90,000 cfm and one by AHU 4-15 with 540,000 cfm. It is impossible to distinguish which air handler serves which space in this large zone. As AHUs 1 & 2 only serve Zone A & B on all three levels and are isolated from the majority of the system, it is possible to determine if the air handlers meet AHRAE 62.1-2004 ventilation requirements.

After following the zone calculation procedure outlined in section 6.2.2, it was determined that air handling units are compliant with AHRAE 62.1-2004 ventilation requirements. They require approximately 88,000 cfm and have a capacity of 90,000 cfm. The difference can be accounted for by assumptions made during analysis. Information such as occupancy and use could not always be determined from known information and therefore had to be assumed.

All assumptions can be found on page 4 and all information was obtained from mechanical and architectural drawings, as well as the actual mechanical ventilation calculations when possible.

ASSUMPTIONS

ASSUMPTIONS MADE APPLYING ASHRAE STANDARD 62

- Local air quality during occupied hours is acceptable for ventilation.
- Exhaust stacks are sufficiently far from outdoor air intake to ensure acceptable ventilation air.
- The zone air distribution effectiveness (E_z) is 1.0. It is unknown what value was used during design, so a value of 1.0 will be used for the sake of being conservative.
- The occupant diversity factor (D) is assumed to be 1.0 due to unknown design parameters and in the desire to be conservative.
- Smoking is not permitted in the Landscape Building.
- The default occupancy density shall be used with the actual occupancy density is unknown.
- Unlisted occupancies as per Note 6 from Table 6.1 :
 - Room F168 – Painter Work Area & Storage can be approximated as an Art Classroom as the functions are similar.
 - Break room and Lounges can be considered Lobby/Prefunction spaces.
 - Room V109 – Part Repair can be considered similar to school Wood/Metals Shops.
 - Room V111 – Procedure Room and others like it can be considered Science Laboratories due to similar function and occupancy.
 - Room V113 – Laundry can be approximated as a Coin-Operated Laundry.
 - Room V192 – Staging has functions similar to that of Science Laboratories.
 - Toilets were assumed to have an $R_a = 0.25$ or 0.12 and no occupancy.
 - Locker rooms have the same ventilation characteristics as toilets.
 - Kitchens receive 15cfm/person with an occupancy of 20 people/1000 square feet according to ASHRAE 2003 Applications Handbook. Chapter 31.
 - Room H168/H1169 – Potwash/Hot Prep has an occupancy of 6 people according to the architect.
 - GS194D – Mechanical has an $R_a = 0.25$ and no occupancy.
 - Conference rooms have an occupancy of 18 people according to architect.
 - Cold rooms have no occupancy.
- Spaces that are not considered for ventilation include, but are not limited to:
 - Most mechanical equipment rooms.
 - Elevator shafts.
 - All stairs except feature stairs.
 - Janitor closets and closets.

PROCEDURE

Part I - Zone Calculation

Step One

Determine the breathing zone outdoor airflow (V_{bz}) from the following equation:

$$V_{bz} = R_p P_z + R_a A_z \quad (6.1)$$

Where:

A_z = zone floor area: the next occupiable floor area of the zone.

P_z = zone population: the largest number of people expected to occupy the zone during typical hours.

R_p = outdoor airflow rate required per person as determined from Table 6.1.

R_a = outdoor airflow rate required per unit area as determined from Table 6.1.

The majority of occupancies are not known for the Landscape Building. Therefore, default values for occupancy density from Table 6-1 are being used. This is in accordance with Note 4.

Step Two

Determine the zone air distribution effectiveness (E_z) using Table 6.2. For this report, the effectiveness is assumed to be equal to 1.0.

Step Three

Determine the design zone outdoor airflow (V_{oz}), i.e., the amount of outdoor air that must be provided.

$$V_{oz} = V_{bz} / E_z \quad (6.2)$$

Step Four

Determine the zone primary outdoor air fraction (Z_p), i.e., the system ventilation efficiency.

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

Where V_{pz} is the zone primary airflow to the zone from the air handling unit. For VAV systems, V_{pz} is the minimum expected airflow. The maximum Z_p represents the critical space.

Step Five

Determine the system ventilation efficiency (E_v) using Table 6.3 and Appendix A when necessary.

Step Six

Determine the uncorrected outdoor air intake (V_{ou}) from the following equation:

$$V_{ou} = D \sum_{\text{all zones}} R_p P_z + \sum_{\text{all zones}} R_a A_z \quad (6.6)$$

Where D is the occupant diversity factor which takes variations in occupancy into consideration within the system.

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

P_s is the system population which is defined as the maximum simultaneous number of occupants in the area served by the system. In this case, the occupancy diversity is assumed to be 1.0 due to unknown design parameters and in the desire to be conservative.

Step Seven

Determine the design outdoor air intake flow (V_{ot}).

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

Part II - Zone Ventilation Efficiency Calculation – Single Zone

Step One

Determine maximum Z_p and the corresponding space. This space is known as the critical space.

Step Two

Determine the design zone outdoor airflow (V_{oz}) for the critical space.

Step Three

Determine the zone discharge airflow V_{dz} which is the expected discharge (supply airflow to the zone that includes primary airflow and locally recirculated airflow in cfm.

Step Four

Calculate the discharge outdoor air fraction (Z_d) for VAV systems. This is the minimum expected discharge airflow for design purposes.

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

Step Five

Calculate the system uncorrected outdoor air intake (V_{ou}). This equation is valid when the system ventilation efficiency $E_v = 1.0$.

$$V_{ou} = \Sigma R_p P_z + \Sigma R_a A_z$$

Step Six

Determine the system primary airflow (V_{ps}). This is the total primary airflow supplied to all zones served by the air handling unit.

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

Step Seven

Determine the average outdoor air fraction (X_s) where

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

Step Eight

Calculate the system ventilation efficiency (E_{vz}) from the following equation:

$$E_{vz} = 1 + X_s - Z_d \tag{A-1}$$

SAMPLE CALCULATION

CALCULATION FOR THE CRITICAL SPACE

The critical space for air handling units one and two is Room S193 EHS Treatment. This room is one room in the emergency health service cluster in Zone A on the first floor.

Part I - Zone Calculation

Step One

$$V_{bz} = R_p P_z + R_a A_z \quad (6.1)$$

Where:

$$A_z = 496 \text{ sf}$$

Dimensions taken from architectural drawings.

$$P_z = (\text{occupant density}/1000 \text{ sf}) \times A_z$$

$$P_z = (25 \text{ people} / 1000 \text{ sf}) \times (496 \text{ sf})$$

$$P_z = 12.4 \text{ people}$$

$$R_p = 10 \text{ cfm/person}$$

(Table 6.1)

$$R_a = 0.18 \text{ cfm/sf}$$

(Table 6.1)

$$V_{bz} = (10 \text{ cfm/person})(12.4 \text{ people}) + (0.18 \text{ cfm/sf})(496 \text{ sf})$$

$$V_{bz} = 213 \text{ cfm}$$

Step Two

For this report, the effectiveness is assumed to be equal to 1.0. The value used in the actual design is unknown so the most conservative value has been chosen. (Table 6.2)

Step Three

$$V_{oz} = V_{bz}/E_z \quad (6.2)$$

$$V_{oz} = 213 \text{ cfm}/1.0$$

$$V_{oz} = 213 \text{ cfm}$$

Step Four

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

Where:

$$V_{oz} = 213 \text{ cfm}$$

$$V_{pz} = 225 \text{ cfm}$$

Value obtained from ventilation calculations provided by mechanical engineer.

$$Z_p = (213 \text{ cfm}) / (225 \text{ cfm})$$

$$Z_p = 0.95$$

This Z_p is the maximum zone primary outdoor air fraction for all the spaces served by air handlers one and two. Therefore is it the critical space.

Step Five

The Z_p for Room S193 is greater than 0.55. Therefore Appendix A must be used to calculate the system ventilation efficiency (E_{vz}) according to Table 6-3. E_{vz} was found to be equal to 0.22. This calculation can be found below in Part II.

Step Six

$$V_{ou} = D \sum_{\text{all zones}} R_p P_z + \sum_{\text{all zones}} R_a A_z \quad (6.6)$$

$$V_{ou} = \sum V_{oz}$$

Where:

$$D = P_s / \sum_{\text{all zones}} P_z = 1.0$$

The occupancy diversity is assumed to be 1.0 due to unknown design parameters and in the desire to be conservative.

$$\sum V_{oz} = 19463 \text{ cfm}$$

(Calculations Page 46)

$$V_{ou} = 1.0(19463 \text{ cfm})$$

$$V_{ou} = 19463 \text{ cfm}$$

Step Seven

$$V_{ot} = V_{ou} / E_v \quad (A-1)$$

$$V_{ot} = (19463 \text{ cfm}) / (0.22)$$

$$V_{ot} = 88,059 \text{ cfm}$$

This calculation shows that $\sum V_{oz} < V_{ot}$

Part II - Zone Ventilation Efficiency Calculation – Single Zone

Step One

$$(Z_p)_{\max} = 0.95 \quad (\text{Step Four – Part I})$$

Step Two

$$V_{oz} = 213 \text{ cfm} \quad (\text{Step Three – Part I})$$

Step Three

$$V_{dz} = 225 \text{ cfm}$$

This value was obtained from ventilation calculations provided by mechanical engineer.

Step Four

$$\begin{aligned} Z_d &= V_{oz} / V_{dz} \\ Z_d &= (213 \text{ cfm}) / (225 \text{ cfm}) \\ Z_d &= 0.95 \end{aligned}$$

Step Five

$$\begin{aligned} V_{ou} &= \Sigma R_p P_z + \Sigma R_a A_z \\ V_{ou} &= 19463 \text{ cfm} \quad (\text{Step Six – Part I}) \end{aligned}$$

Step Six.

$$\begin{aligned} V_{ps} &= \Sigma V_{pz} \\ V_{ps} &= 113,088 \text{ cfm} \end{aligned}$$

Step Seven

$$\begin{aligned} X_s &= V_{ou} / V_{ps} \\ X_s &= (19463 \text{ cfm}) / (113,088 \text{ cfm}) \\ X_s &= 0.17 \end{aligned}$$

Step Eight

$$\begin{aligned} E_{vz} &= 1 + X_s - Z_d \\ E_{vz} &= 1 + 0.17 - 0.95 \\ E_{vz} &= 0.22 \end{aligned}$$

SPACE CHARACTERISTICS

DATA TAKEN FROM ARCHITECTURAL & MECHANICAL DRAWINGS

LEVEL ONE - PART I				
ZONE	ROOM	SPACE NAME	USE	SPACE AREA Az [SF]
A	C150	BACK CORRIDOR	CORRIDOR	3484
B	C171	BACK CORRIDOR	CORRIDOR	602
B	C172	CORRIDOR	CORRIDOR	448
B	C182	BACK CORRIDOR	CORRIDOR	912
A	C185D	MEN	TOILET	247
A	C193	BACK CORRIDOR	CORRIDOR	873
A	C194	BACK CORRIDOR	CORRIDOR	864
A	C199	BACK CORRIDOR	CORRIDOR	869
A	D195K	DOCK MGR.	OFFICE SPACE	109
A	D195	LOADING DOCK	SHIPPING/RECEIVING	735
C	F168	PAINTER WORK AREA AND STORAGE	ART CLASSROOM	234
C	F169	BUILDING SERVICE	OFFICE SPACE	1387
C	F170B	PLAN LAYOUT AND MGT. SPACE	OFFICE SPACE	115.5
C	F173/F173C	MEN TOILET/WOMEN TOILET	TOILET	552
B	F174	CENTRAL STORE	STORAGE	2956
B	F175	HAZMAT STORAGE	STORAGE	378
C	F177	BREAK ROOM	LOBBY/PREFUNCTION	277
B	F181	MEN	TOILET	143
B	F181A	MEN VEST	TOILET	60
B	F182	WOMEN	TOILET	143
B	F182A	WOMEN VEST	TOILET	60
A	GS194D	VACUUM MECH	MECHANICAL	286
B	H168/H169	POTWASH/HOTPREP	KITCHEN	751
B	H170/C172	SERVERY	CAFETERIA	1792
B	H170C	COLD PREP	KITCHEN	361
B	H171	OFFICE	OFFICE SPACE	110
B	H172A	PRIVATE DINNING	RESTAURANT DINNING ROOM	252
B	H173	CORRIDOR	CORRIDOR	260
B	H174	WAREWASH	KITCHEN	440
B	H175	CORRIDOR	CORRIDOR	336
B	H177	DIRTY STORAGE	STORAGE	324
B	H178	CATERING KITCHEN	KITCHEN	540

SPACE CHARACTERISTICS

LEVEL ONE - PART II				
ZONE	ROOM	SPACE NAME	USE	SPACE AREA Az [SF]
B	H181	DINING STORAGE	STORAGE	897
B	H183	WORKSTATIONS	OFFICE SPACE	728
B	H183C	OFFICE	OFFICE SPACE	182
B	H183D	OFFICE	OFFICE SPACE	182
B	H183E	LOUNGE	LOBBY/PREFUNCTION	144
B	H187	COMPUTER WORKROOM	COMPUTER LAB	902
A	H192	WORKSTATIONS	OFFICE SPACE	624
A	H192A	OFFICE	OFFICE SPACE	165
B	H192B	OFFICE	OFFICE SPACE	165
A	H192K	OFFICE	OFFICE SPACE	182
A	H192L	OFFICE	OFFICE SPACE	182
A	H192P	LOUNGE	LOBBY/PREFUNCTION	252
A	S190D195M	LAB OFFICE/MAIL	OFFICE SPACE	743.5
A	S191	EHS LAB	LABORATORY	420
A	S192	EHS WORKSPACE	LABORATORY	420
A	S193	EHS TREATMENT	LABORATORY	496
B	V101	CLEAN STORAGE	STORAGE	1120
A	V102	DIRTY STAGING	LABORATORY	2204
B	V104	FEEDING STORAGE	LABORATORY	340
B	V105	ANIMAL HOLDING	LABORATORY	340
A	V106	BEDDING STORAGE	STORAGE	348
A	V107	ANIMAL HOLDING	LABORATORY	204
A	V109	PART REPAIR	WOOD/METAL SHOP	108
A	V111	PROCEDURE ROOM	LABORATORY	187
A	V112	ANIMAL RECEIVING	LABORATORY	168
A	V113	LAUNDRY	COIN-OPERATED LAUNDRY	117
A	V115	AIR LOCK	CORRIDOR	66
A	V116	CHANGE LOCKER	TOILET	221
B	V120	STAGING	LABORATORY	274
B	V121	CLEAN STERILE	LABORATORY	278
A/B	V188	VIVARIUM CORRIDOR	CORRIDOR	1064
A	V192	STAGING	LABORATORY	324
A	V196	VIVARIUM LOADING BAY	SHIPPING/RECEIVING	600
A/B	V300	VIVARIUM CORRIDOR	CORRIDOR	612
A/B	V300C	ANIMAL QUAR	LABORATORY	104

SPACE CHARACTERISTICS

LEVEL TWO - PART I				
ZONE	ROOM	SPACE NAME	USE	SPACE AREA Az [SF]
A	C275	SERVICE CORRIDOR	CORRIDOR	940
A	C292A	CORRIDOR	CORRIDOR	710
A	C295	SERVICE CORRIDOR	CORRIDOR	420
C	L270	LABORATORY	LABORATORY	1020
C	L271	OPEN FLEX	OFFICE SPACE	90
C	L272	COPY SUPPLY	OFFICE SPACE	352
B	L273	CENTRAL SUPPLY	STORAGE	90
C	S270A	LARGE SUPPORT	LABORATORY	420
C	S270B	MEDIUM SUPPORT	LABORATORY	75
C	S270C	MEDIUM SUPPORT	LABORATORY	75
B	L275	LABORATORY	LABORATORY	2720
B	S275A	DARK ROOM	PHOTO STUDIO	90
B	S275B	SMALL COLD ROOM	LABORATORY	90
B	S275C	LARGE COLD ROOM	LABORATORY	160
B	S275D	SMALL SUPPORT	LABORATORY	100
B	S275E	SMALL SUPPORT	LABORATORY	100
B	S275F	MEDIUM SUPPORT	LABORATORY	160
B	S275G	MEDIUM SUPPORT	LABORATORY	160
B	S275H	SMALL SUPPORT	LABORATORY	100
B	S275J	SMALL SUPPORT	LABORATORY	100
B	S275K	LARGE SUPPORT	LABORATORY	441
B	S275M	MEDIUM SUPPORT	LABORATORY	120
B	S275N	MEDIUM SUPPORT	LABORATORY	120
A	L285	LABORATORY	LABORATORY	2720
B	L281	OPEN FLEX	OFFICE SPACE	90
B	L282	CENTRAL SUPPLY	STORAGE	90
B	L283	PANTRY	OFFICE SPACE	352
A	S285C	DARK ROOM	PHOTO STUDIO	90
A	S285D	SMALL COLD ROOM	LABORATORY	90

SPACE CHARACTERISTICS

LEVEL TWO- PART II				
ZONE	ROOM	SPACE NAME	USE	SPACE AREA [SF]
A	S285E	LARGE COLD ROOM	LABORATORY	189
A	S285F	MEDIUM SUPPORT	LABORATORY	210
A	S285G	MEDIUM SUPPORT	LABORATORY	210
A	L295	LABORATORY	LABORATORY	1428
A/B	V200	CORRIDOR	CORRIDOR	1040
B	V201	VIVARIUM VEST.	CORRIDOR	180
B	V202	PROCEDURE ROOM	LABORATORY	180
B	V203	ANIMAL HOLDING	LABORATORY	207
B	V204	ANIMAL HOLDING	LABORATORY	207
B	V205	ANIMAL HOLDING	LABORATORY	207
B	V206	ANIMAL HOLDING	LABORATORY	207
B	V207	ANIMAL HOLDING	LABORATORY	207
B	V208	ANIMAL HOLDING	LABORATORY	207
B	V209	SPECIAL PROCEDURE	LABORATORY	216
B	V210	PROCEDURE ROOM	LABORATORY	207
B	V212	ANIMAL HOLDING	LABORATORY	207
B	V213	ISOLATION SUITE	LABORATORY	270
B	V214	PROCEDURE ROOM	LABORATORY	198
B	V215	ANIMAL HOLDING	LABORATORY	207
B	V216	ANIMAL HOLDING	LABORATORY	207
B	V217	ANIMAL HOLDING	LABORATORY	207
A	V218	ANIMAL HOLDING	LABORATORY	306
A	V220	ANIMAL HOLDING	LABORATORY	306
A	V221	ANIMAL HOLDING	LABORATORY	207
A	V222	PROCEDURE ROOM	LABORATORY	180
A	V223	NECROPSY ROOM	LABORATORY	252
A	V224	WOMEN TOILET	TOILET	216
A	V225	MEN TOILET	TOILET	216
A	V227	VIVARIUM VEST.	CORRIDOR	424

SPACE CHARACTERISTICS

LEVEL THREE - PART I				
ZONE	ROOM	SPACE NAME	USE	SPACE AREA Az [SF]
C	C366B	WOMEN	TOILET	210
C	C367	CORRIDOR	CORRIDOR	859
C	C368B	MEN	TOILET	210
A	C375	SERVICE CORRIDOR	CORRIDOR	2670
B	C370	GLASS CORRIDOR	GLASS CORRIDOR	1708
B	L375	PANTRY	OFFICE SPACE	352
B	L376	OPEN FLEX	OFFICE SPACE	90
B	L378	CENTRAL SUPPLY	STORAGE	90
C	L370	LABORATORY	LABORATORY	2720
C	S370A	LARGE SUPPORT	LABORATORY	441
C	S370B	MEDIUM SUPPORT	LABORATORY	130
C	S370C	MEDIUM SUPPORT	LABORATORY	130
C	S370D	MEDIUM SUPPORT	LABORATORY	130
C	S370E	MEDIUM SUPPORT	LABORATORY	130
C	S370G	LARGE COLD ROOM	LABORATORY	147
C	S375	TISSUE CULTURE	LABORATORY	441
B	P370	OFFICE	OFFICE SPACE	704
B	P371	OFFICE	OFFICE SPACE	330
B	P372	OFFICE	OFFICE SPACE	330
B	P373	OFFICE	OFFICE SPACE	396
B	P374	CONFERENCE	CONFERENCE	572

SPACE CHARACTERISTICS

LEVEL THREE - PART II				
ZONE	ROOM	SPACE NAME	USE	SPACE AREA Az [SF]
B	P375	OFFICE	OFFICE SPACE	396
B	P376	OFFICE	OFFICE SPACE	330
B	P377	OFFICE	OFFICE SPACE	330
B	L380	LABORATORY	LABORATORY	2816
A	L386	OPEN FLEX	OFFICE SPACE	90
A	L387	COPY SUPPLY	OFFICE SPACE	352
A	L388	CENTRAL SUPPLY	STORAGE	90
B	S380A	CHEMISTRY LAB	LABORATORY	483
B	S380B	CHEMISTRY LAB	LABORATORY	483
B	S380C	CHEMISTRY LAB	LABORATORY	483
B	S380D	CHEMISTRY LAB	LABORATORY	483
A	S380E	CHEMISTRY LAB	LABORATORY	483
A	S388	CHEMISTRY LAB	LABORATORY	483
A	L390	LABORATORY	LABORATORY	960
A	S390B	LARGE COLD ROOM	LABORATORY	147
A	S390C	MEDIUM SUPPORT ROOM	LABORATORY	130
A	P380	OFFICE	OFFICE SPACE	704
A	P381	OFFICE	OFFICE SPACE	330
A	P382	OFFICE	OFFICE SPACE	330
A	P383	OFFICE	OFFICE SPACE	396
A	P384	CONFERENCE	CONFERENCE	572
A	P386	OFFICE	OFFICE SPACE	396
A	P387	OFFICE	OFFICE SPACE	330
A	P388	OFFICE	OFFICE SPACE	330

OUTDOOR AIR REQUIREMENTS

BASED ON TABLE 6-1 ASHRAE STANDARD 62.1-2004

Zone	Room	Space Name	Use	Supply Air [CFM]	Space Area Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [#/#1000 sf]	Breathing Zone Outdoor Airflow Vbz [cfm]	Zone Outdoor Airflow Voz [cfm]
A	C150	BACK CORRIDOR	CORRIDOR	2540	3484	0	0	0.06	0	209	209
B	C171	BACK CORRIDOR	CORRIDOR	500	602	0	0	0.06	0	36	36
B	C172	CORRIDOR	CORRIDOR	5340	448	0	0	0.06	0	27	27
B	C182	BACK CORRIDOR	CORRIDOR	1000	912	0	0	0.06	0	55	55
A	C185D	MEN	TOILET	275	247	0	0	0.25	0	62	62
A	C193	BACK CORRIDOR	CORRIDOR	500	873	0	0	0.06	0	52	52
A	C194	BACK CORRIDOR	CORRIDOR	500	864	0	0	0.06	0	52	52
A	C199	BACK CORRIDOR	CORRIDOR	300	869	0	0	0.06	0	52	52
A	D195K	DOCK MGR	OFFICE SPACE	250	109	1	5	0.06	5	9	9
A	D195	LOADING DOCK	SHIPPING/ RECEIVING	1875	735	0	0	0.12	0	88	88
C	F168	PAINTER WORK AREA AND STORAGE	ART CLASSROOM	300	234	5	10	0.18	20	89	89
C	F169	BUILDING SERVICE	OFFICE SPACE	2790	1387	7	5	0.06	5	118	118
C	F170B	PLAN LAYOUT AND MGT. SPACE	OFFICE SPACE	650	115.5	1	5	0.06	5	10	10

OUTDOOR AIR REQUIREMENTS

Zone	Room	SpaceName	Use	Supply Air [CFM]	Space Area/Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [#1000sf]	Breathing Zone Outdoor Airflow/Wz [cfm]	Zone Outdoor Airflow/Wz [cfm]
C	F173 F173C	MEN TOILET WOMEN TOILET	TOILET	200	552	0	0	0.12	0	66	66
B	F174	CENTRAL STORE	STORAGE	5340	2956	0	0	0.12	0	355	355
B	F175	HAZMAT STORAGE	STORAGE	500	378	0	0	0.12	0	45	45
C	F177	BREAKROOM	LOBBY/ PREFUNCTION	250	277	8	7.5	0.06	30	79	79
B	F181	MEN	TOILET	300	143	0	0	0.25	0	36	36
B	F181A	MEN VEST	TOILET	350	60	0	0	0.25	0	15	15
B	F182	WOMEN	TOILET	300	143	0	0	0.25	0	36	36
B	F182A	WOMEN VEST	TOILET	350	60	0	0	0.25	0	15	15
A	G519D	VACUUM MECH	MECHANICAL	300	286	0	0	0.25	0	72	72
B	H168/ H169	POTWASH/ HOT PREP	KITCHEN	900	751	6	15	0.06	20	135	135
B	H170/ C172	SERVERY	CAFETERIA	4000	1792	45	7.5	0.12	25	551	551

OUTDOOR AIR REQUIREMENTS

Zone	Room	SpaceName	Use	Supply Air [CFM]	Space Area/Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [#/1000sf]	Breathing Zone Outdoor Airflow/Wz [cfm]	Zone Outdoor Airflow/Wz [cfm]
B	H170C	COLDPREP	KITCHEN	500	361	7	15	0	20	108	108
B	H171	OFFICE	OFFICESPACE	225	110	1	5	0.06	5	9	9
B	H172A	PRIVATE DINING	RESTAURANT DINING ROOM	600	252	8	7.5	0.06	30	72	72
B	H173	CORRIDOR	CORRIDOR	250	260	0	0	0.06	0	16	16
B	H174	WAREWASH	KITCHEN	1000	440	9	15	0	20	132	132
B	H175	CORRIDOR	CORRIDOR	750	336	0	0	0.06	0	20	20
B	H177	DIRTY STORAGE	STORAGE	150	324	0	0	0.12	0	39	39
B	H178	CATERING KITCHEN	KITCHEN	1800	540	11	15	0	20	162	162
B	H181	DINING STORAGE	STORAGE	2000	897	0	0	0.12	0	108	108
B	H183	WORKSTATIONS	OFFICESPACE	2400	728	4	5	0.06	5	62	62
B	H183C	OFFICE	OFFICESPACE	360	182	1	5	0.06	5	15	15

OUTDOOR AIR REQUIREMENTS

Zone	Room	SpaceName	Use	Supply Air [CFM]	Space Area/Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [#1000sf]	Breathing Zone Outdoor Airflow/Wz [cfm]	Zone Outdoor Airflow/Wz [cfm]
B	H183D	OFFICE	OFFICESPACE	360	182	1	5	0.06	5	15	15
B	H183E	LOUNGE	LOBBY/ REFUNCTION	480	144	4	7.5	0.06	30	41	41
B	H187	COMPUTER WORKROOM	COMPUTER LAB	1600	902	23	10	0.12	25	334	334
A	H192	WORKSTATIONS	OFFICESPACE	1800	624	3	5	0.06	5	53	53
A	H192A	OFFICE	OFFICESPACE	360	165	1	5	0.06	5	14	14
B	H192B	OFFICE	OFFICESPACE	360	165	1	5	0.06	5	14	14
A	H192K	OFFICE	OFFICESPACE	360	182	1	5	0.06	5	15	15
A	H192L	OFFICE	OFFICESPACE	360	182	1	5	0.06	5	15	15
A	H192P	LOUNGE	LOBBY/ REFUNCTION	480	252	8	7.5	0.06	30	72	72
A	S190D1 95M	LABOFFICE/MIL	OFFICESPACE	250	7435	4	5	0.06	5	63	63
A	S191	EH-SLAB	LABORATORY	900	420	11	10	0.18	25	181	181

OUTDOOR AIR REQUIREMENTS

Zone	Room	SpaceName	Use	Supply Air [CFM]	Space Area/Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density #/1000sf	Breathing Zone Outdoor Airflow/Voz [cfm]	Zone Outdoor Airflow/Voz [cfm]
A	S192	E-SWORKSPACE	LABORATORY	1000	420	11	10	0.18	25	181	181
A	S193	E-STREATMENT	LABORATORY	900	466	12	10	0.18	25	213	213
B	V101	CLEANSTORAGE	STORAGE	3200	1120	0	0	0.12	0	134	134
A	V102	DIRTYSTAGING	LABORATORY	4500	2204	55	10	0.18	25	948	948
B	V104	FEEDINGSTORAGE	LABORATORY	750	340	9	10	0.18	25	146	146
B	V105	ANIMALHOLDING	LABORATORY	400	340	9	10	0.18	25	146	146
A	V106	BEDDINGSTORAGE	STORAGE	750	348	0	0	0.12	0	42	42
A	V107	ANIMALHOLDING	LABORATORY	500	204	5	10	0.18	25	88	88
A	V109	PARTREPAIR	WOODMETAL SHOP	250	108	2	10	0.18	20	41	41
A	V111	PROCEDURE ROOM	LABORATORY	800	187	5	10	0.18	25	80	80
A	V112	ANIMAL RECEIVING	LABORATORY	450	168	4	10	0.18	25	72	72

OUTDOOR AIR REQUIREMENTS

Zone	Room	SpaceName	Use	SupplyAir [CFM]	Space AreaAz [SF]	Design Occupancy Pz [people]	People Outdoor Air RateRp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [#/1000sf]	Breathing Zone Outdoor AirflowWz [cfm]	Zone Outdoor AirflowWz [cfm]
A	V113	LAUNDRY	COINOPERATED LAUNDRY	200	117	2	75	0.06	20	25	25
A	V115	AIRLOCK	CORRIDOR	150	66	0	0	0.06	0	4	4
A	V116	CHANGEROOM	TOILET	400	221	0	0	0.25	0	55	55
B	V120	STAGING	LABORATORY	1000	274	7	10	0.18	25	118	118
B	V121	CLEANSTERILE	LABORATORY	1600	278	7	10	0.18	25	120	120
AB	V188	VIVARIUM CORRIDOR	CORRIDOR	550	1064	0	0	0.06	0	64	64
A	V192	STAGING	LABORATORY	750	324	8	10	0.18	25	139	139
A	V196	VIVARIUMLOADING BAY	SHIPPING RECEIVING	750	600	0	0	0.12	0	72	72
AB	V300	VIVARIUM CORRIDOR	CORRIDOR	100	612	0	0	0.06	0	37	37
AB	V300C	ANIMALQUAR	LABORATORY	150	104	3	10	0.18	25	45	45
A	C275	SERVICE CORRIDOR	CORRIDOR	4800	940	0	0	0.06	0	56	56

OUTDOOR AIR REQUIREMENTS

Zone	Room	SpaceName	Use	Supply Air [CFM]	Space Area/Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [#/1000sf]	Breathing Zone Outdoor AirflowVoz [cfm]	Zone Outdoor AirflowVoz [cfm]
A	C292A	CORRIDOR	CORRIDOR	500	710	0	0	0.06	0	43	43
A	C295	SERVICE CORRIDOR	CORRIDOR	1600	420	0	0	0.06	0	25	25
C	L270	LABORATORY	LABORATORY	1800	1020	26	10	0.18	25	439	439
C	L271	OFFICE FLEX	OFFICE SPACE	550	90	0	5	0.06	5	8	8
C	L272	COPY SUPPLY	OFFICE SPACE	250	352	2	5	0.06	5	30	30
B	L273	CENTRAL SUPPLY	STORAGE	100	90	0	0	0.12	0	11	11
C	S270A	LARGE SUPPORT	LABORATORY	800	420	11	10	0.18	25	181	181
C	S270B	MEDIUM SUPPORT	LABORATORY	800	75	2	10	0.18	25	32	32
C	S270C	MEDIUM SUPPORT	LABORATORY	800	75	2	10	0.18	25	32	32
B	L275	LABORATORY	LABORATORY	4800	2720	68	10	0.18	25	1170	1170
B	S275A	DARK ROOM	PHOTO STUDIO	200	90	1	5	0.12	10	15	15

OUTDOOR AIR REQUIREMENTS

Zone	Room	Space Name	Use	Supply Air [CFM]	Space Area Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [#1000sf]	Breathing Zone Outdoor Airflow Vz [cfm]	Zone Outdoor Airflow Vz [cfm]
B	S275B	SMALL COLD ROOM	LABORATORY	50	90	0	10	0.18	25	16	16
B	S275C	LARGE COLD ROOM	LABORATORY	50	160	0	10	0.18	25	29	29
B	S275D	SMALL SUPPORT	LABORATORY	250	100	3	10	0.18	25	43	43
B	S275E	SMALL SUPPORT	LABORATORY	250	100	3	10	0.18	25	43	43
B	S275F	MEDIUM SUPPORT	LABORATORY	800	160	4	10	0.18	25	69	69
B	S275G	MEDIUM SUPPORT	LABORATORY	800	160	4	10	0.18	25	69	69
B	S275H	SMALL SUPPORT	LABORATORY	250	100	3	10	0.18	25	43	43
B	S275J	SMALL SUPPORT	LABORATORY	250	100	3	10	0.18	25	43	43
B	S275K	LARGE SUPPORT	LABORATORY	800	441	11	10	0.18	25	190	190
B	S275M	MEDIUM SUPPORT	LABORATORY	380	120	3	10	0.18	25	52	52
B	S275N	MEDIUM SUPPORT	LABORATORY	380	120	3	10	0.18	25	52	52

OUTDOOR AIR REQUIREMENTS

Zone	Room	Space Name	Use	Supply Air [CFM]	Space Area/Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [#1000sf]	Breathing Zone Outdoor Airflow/Voz [cfm]	Zone Outdoor Airflow/Voz [cfm]
A	L285	LABORATORY	LABORATORY	4800	2720	68	10	0.18	25	1170	1170
B	L281	OPEN FLEX	OFFICE SPACE	50	90	0	5	0.06	5	8	8
B	L282	CENTRAL SUPPLY	STORAGE	100	90	0	0	0.12	0	11	11
B	L283	PANTRY	OFFICE SPACE	250	352	2	5	0.06	5	30	30
A	S285C	DARK ROOM	PHOTO STUDIO	200	90	1	5	0.12	10	15	15
A	S285D	SMALL COLD ROOM	LABORATORY	50	90	2	0	0.18	25	16	16
A	S285E	LARGE COLD ROOM	LABORATORY	50	189	5	0	0.18	25	34	34
A	S285F	MEDIUM SUPPORT	LABORATORY	800	210	5	10	0.18	25	90	90
A	S285G	MEDIUM SUPPORT	LABORATORY	800	210	5	10	0.18	25	90	90
A	L285	LABORATORY	LABORATORY	2400	1428	36	10	0.18	25	614	614
A/B	V200	CORRIDOR	CORRIDOR	1200	1040	0	0	0.06	0	62	62

OUTDOOR AIR REQUIREMENTS

Zone	Room	Space Name	Use	Supply Air [CFM]	Space Area Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [#1000sf]	Breathing Zone Outdoor Airflow Vbz [cfm]	Zone Outdoor Airflow Vz [cfm]
B	V201	VIVARIUM EST.	CORRIDOR	300	180	0	0	0.06	0	11	11
B	V202	PROCEDURE ROOM	LABORATORY	800	180	5	10	0.18	25	77	77
B	V203	ANIMAL HOLDING	LABORATORY	650	207	5	10	0.18	25	89	89
B	V204	ANIMAL HOLDING	LABORATORY	650	207	5	10	0.18	25	89	89
B	V205	ANIMAL HOLDING	LABORATORY	650	207	5	10	0.18	25	89	89
B	V206	ANIMAL HOLDING	LABORATORY	650	207	5	10	0.18	25	89	89
B	V207	ANIMAL HOLDING	LABORATORY	650	207	5	10	0.18	25	89	89
B	V208	ANIMAL HOLDING	LABORATORY	650	207	5	10	0.18	25	89	89
B	V209	SPECIAL PROCEDURE	LABORATORY	800	216	5	10	0.18	25	93	93
B	V210	PROCEDURE ROOM	LABORATORY	800	207	5	10	0.18	25	89	89
B	V212	ANIMAL HOLDING	LABORATORY	650	207	5	10	0.18	25	89	89

OUTDOOR AIR REQUIREMENTS

Zone	Room	SpaceName	Use	Supply Air [CFM]	Space Area/Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate/Pz [cfm/person]	Area Outdoor Air Rate/ Ra [cfm/sf]	Default Occupancy Density [#/1000sf]	Breathing Zone Outdoor Airflow/Voz [cfm]	Zone Outdoor Airflow/Voz [cfm]
B	V213	ISOLATIONSUITE	LABORATORY	1140	270	7	10	0.18	25	116	116
B	V214	PROCEDUREROOM	LABORATORY	800	198	5	10	0.18	25	85	85
B	V215	ANIMAL-HOLDING	LABORATORY	650	207	5	10	0.18	25	89	89
B	V216	ANIMAL-HOLDING	LABORATORY	650	207	5	10	0.18	25	89	89
B	V217	ANIMAL-HOLDING	LABORATORY	650	207	5	10	0.18	25	89	89
A	V218	ANIMAL-HOLDING	LABORATORY	950	306	8	10	0.18	25	132	132
A	V220	ANIMAL-HOLDING	LABORATORY	950	306	8	10	0.18	25	132	132
A	V221	ANIMAL-HOLDING	LABORATORY	650	207	5	10	0.18	25	89	89
A	V222	PROCEDUREROOM	LABORATORY	800	180	5	10	0.18	25	77	77
A	V223	NECROPSYROOM	LABORATORY	2300	252	6	10	0.18	25	108	108
A	V224	WOMENTOILET	TOILET	405	216	0	0	0.25	0	54	54

OUTDOOR AIR REQUIREMENTS

Zone	Room	Space Name	Use	Supply Air [CFM]	Space Area Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [#1000sf]	Breathing Zone Outdoor Airflow Vz [cfm]	Zone Outdoor Airflow Vz [cfm]
A	V225	MEN TOILET	TOILET	405	216	0	0	0.25	0	54	54
A	V227	VIVARIUM VEST.	CORRIDOR	600	424	0	0	0.06	0	25	25
C	C368B	WOMEN	TOILET	200	210	0	0	0.25	0	53	53
C	C367	CORRIDOR	CORRIDOR	400	859	0	0	0.06	0	52	52
C	C368B	MEN	TOILET	300	210	0	0	0.25	0	53	53
A	C375	SERVICE CORRIDOR	CORRIDOR	5600	2670	0	0	0.06	0	160	160
B	C370	GLASS CORRIDOR	GLASS CORRIDOR	970	1708	0	0	0.06	0	102	102
B	L375	PANTRY	OFFICE SPACE	250	352	2	5	0.06	5	30	30
B	L376	OPEN FLEX	OFFICE SPACE	50	90	0	5	0.06	5	8	8
B	L378	CENTRAL SUPPLY	STORAGE	100	90	0	0	0.12	0	11	11
C	L370	LABORATORY	LABORATORY	4800	2720	68	10	0.18	25	1170	1170

OUTDOOR AIR REQUIREMENTS

Zone	Room	Space Name	Use	Supply Air [CFM]	Space Area/Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Pp [cfm/person]	Area Outdoor Air Rate Pa [cfm/sf]	Default Occupancy Density [#1000sf]	Breathing Zone Outdoor Airflow Vz [cfm]	Zone Outdoor Airflow Vz [cfm]
C	S370A	LARGE SUPPORT	LABORATORY	400	441	11	10	0.18	25	190	190
C	S370B	MEDIUM SUPPORT	LABORATORY	400	130	3	10	0.18	25	56	56
C	S370C	MEDIUM SUPPORT	LABORATORY	400	130	3	10	0.18	25	56	56
C	S370D	MEDIUM SUPPORT	LABORATORY	800	130	3	10	0.18	25	56	56
C	S370E	MEDIUM SUPPORT	LABORATORY	800	130	3	10	0.18	25	56	56
C	S370G	LARGE COLD ROOM	LABORATORY	50	147	4	0	0.18	25	26	26
C	S375	TISSUE CULTURE	LABORATORY	2000	441	11	10	0.18	25	190	190
B	P370	OFFICE	OFFICE SPACE	540	704	4	5	0.06	5	60	60
B	P371	OFFICE	OFFICE SPACE	400	330	2	5	0.06	5	28	28
B	P372	OFFICE	OFFICE SPACE	400	330	2	5	0.06	5	28	28

OUTDOOR AIR REQUIREMENTS

Zone	Room	Space Name	Use	Supply Air [CFM]	Space Area Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [#1000sf]	Breathing Zone Outdoor Airflow Vbz [cfm]	Zone Outdoor Airflow Vz [cfm]
B	P373	OFFICE	OFFICE SPACE	700	386	2	5	0.06	5	34	34
B	P374	CONFERENCE	CONFERENCE	630	572	10	5	0.06	18	86	86
B	P375	OFFICE	OFFICE SPACE	700	386	2	5	0.06	5	34	34
B	P376	OFFICE	OFFICE SPACE	400	330	2	5	0.06	5	28	28
B	P377	OFFICE	OFFICE SPACE	400	330	2	5	0.06	5	28	28
B	L380	LABORATORY	LABORATORY	5400	2816	70	10	0.18	25	1211	1211
A	L386	OPEN FLEX	OFFICE SPACE	50	90	0	5	0.06	5	8	8
A	L387	COPY SUPPLY	OFFICE SPACE	250	352	2	5	0.06	5	30	30
A	L388	CENTRAL SUPPLY	STORAGE	100	90	0	0	0.12	0	11	11
B	S380A	CHEMISTRY LAB	LABORATORY	4500	483	12	10	0.18	25	208	208
B	S380B	CHEMISTRY LAB	LABORATORY	4500	483	12	10	0.18	25	208	208

OUTDOOR AIR REQUIREMENTS

Zone	Room	Space Name	Use	Supply Air [CFM]	Space Area/Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Pp [cfm/person]	Area Outdoor Air Rate Pa [cfm/sf]	Default Occupancy Density [#1000sf]	Breathing Zone Outdoor Airflow Wbz [cfm]	Zone Outdoor Airflow Wz [cfm]
B	S380C	CHEMISTRY/LAB	LABORATORY	4500	483	12	10	0.18	25	208	208
B	S380D	CHEMISTRY/LAB	LABORATORY	4500	483	12	10	0.18	25	208	208
A	S380E	CHEMISTRY/LAB	LABORATORY	4500	483	12	10	0.18	25	208	208
A	S388	CHEMISTRY/LAB	LABORATORY	4500	483	12	10	0.18	25	208	208
A	L380	LABORATORY	LABORATORY	2780	960	24	10	0.18	25	413	413
A	S380B	LARGE COLD ROOM	LABORATORY	50	147	4	0	0.18	25	26	26
A	S380C	MEDIUM SUPPORT ROOM	LABORATORY	800	130	3	10	0.18	25	56	56
A	P380	OFFICE	OFFICE SPACE	540	704	4	5	0.06	5	60	60
A	P381	OFFICE	OFFICE SPACE	400	330	2	5	0.06	5	28	28
A	P382	OFFICE	OFFICE SPACE	400	330	2	5	0.06	5	28	28
A	P383	OFFICE	OFFICE SPACE	700	386	2	5	0.06	5	34	34

OUTDOOR AIR REQUIREMENTS

Zone	Room	Space Name	Use	Supply Air [CFM]	Space Area Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [#1000sf]	Breathing Zone Outdoor Airflow Vz [cfm]	Zone Outdoor Airflow Vz [cfm]
A	P384	CONFERENCE	CONFERENCE	630	572	10	5	0.06	18	86	86
A	P386	OFFICE	OFFICE SPACE	400	386	2	5	0.06	5	34	34
A	P387	OFFICE	OFFICE SPACE	400	330	2	5	0.06	5	28	28
A	P388	OFFICE	OFFICE SPACE	700	330	2	5	0.06	5	28	28

ZONE PRIMARY OA FRACTION

SUMMARY OF ZONE PRIMARY OUTDOOR AIR FRACTION FOR EACH SPACE

ZONE	ROOM	SPACE AREA Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [##/1000 sf]	Breathing Zone Outdoor Airflow Vbz [cfm]	Zone Outdoor Airflow Voz [cfm]	Zone Primary Airflow Vpz [cfm]	Zone Primary Outdoor Air Fraction Zp	Zone Maximum Zp
A	C150	3484	0.0	0	0.06	0	209	209	625	0.33	0.95
B	C171	602	0.0	0	0.06	0	36	36	125	0.29	
B	C172	448	0.0	0	0.06	0	27	27	4400	0.01	
B	C182	912	0.0	0	0.06	0	55	55	250	0.22	
A	C185D	247	0.0	0	0.25	0	62	62	70	0.88	
A	C193	873	0.0	0	0.06	0	52	52	190	0.28	
A	C194	864	0.0	0	0.06	0	52	52	500	0.10	
A	C199	869	0.0	0	0.06	0	52	52	150	0.35	
A	D195K	109	0.5	5	0.06	5	9	9	65	0.14	
A	D195	735	0.0	0	0.12	0	88	88	450	0.20	
C	F168	234	4.7	10	0.18	20	89	89	300	0.30	
C	F169	1387	6.9	5	0.06	5	118	118	700	0.17	
C	F170B	115.5	0.6	5	0.06	5	10	10	165	0.06	

ZONE PRIMARY OA FRACTION

ZONE	ROOM	SPACE AREA Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [# /1000 sf]	Breathing Zone Outdoor Airflow Vbz [cfm]	Zone Outdoor Airflow Voz [cfm]	Zone Primary Airflow Vpz [cfm]	Zone Primary Outdoor Air Fraction Zp
C	F173/ F173C	552	0.0	0	0.12	0	66	66	200	0.33
B	F174	2956	0.0	0	0.12	0	355	355	605	0.59
B	F175	378	0.0	0	0.12	0	45	45	125	0.36
C	F177	277	8.3	7.5	0.06	30	79	79	300	0.26
B	F181	143	0.0	0	0.25	0	36	36	300	0.12
B	F181A	60	0.0	0	0.25	0	15	15	350	0.04
B	F182	143	0.0	0	0.25	0	36	36	300	0.12
B	F182A	60	0.0	0	0.25	0	15	15	350	0.04
A	GS194D	286	0.0	0	0.25	0	72	72	300	0.24
B	H168/ H169	751	6.0	15	0.06	20	135	135	225	0.60
B	H170/ C172	1792	44.8	7.5	0.12	25	551	551	1022.5	0.54
B	H170C	361	7.2	15	0	20	108	108	500	0.22
B	H171	110	0.6	5	0.06	5	9	9	55	0.17

ZONE PRIMARY OA FRACTION

ZONE	ROOM	SPACE AREA Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [# /1000 sf]	Breathing Zone Outdoor Airflow Vbz [cfm]	Zone Outdoor Airflow Voz [cfm]	Zone Primary Airflow Vpz [cfm]	Zone Primary Outdoor Air Fraction Zp
B	H172A	252	7.6	7.5	0.06	30	72	72	150	0.48
B	H173	260	0.0	0	0.06	0	16	16	55	0.28
B	H174	440	8.8	15	0	20	132	132	1000	0.13
B	H175	336	0.0	0	0.06	0	20	20	190	0.11
B	H177	324	0.0	0	0.12	0	39	39	150	0.26
B	H178	540	10.8	15	0	20	162	162	470	0.34
B	H181	897	0.0	0	0.12	0	108	108	500	0.22
B	H183	728	3.6	5	0.06	5	62	62	625	0.10
B	H183C	182	0.9	5	0.06	5	15	15	90	0.17
B	H183D	182	0.9	5	0.06	5	15	15	90	0.17
B	H183E	144	4.3	7.5	0.06	30	41	41	120	0.34
B	H187	902	22.6	10	0.12	25	334	334	400	0.83
A	H192	624	3.1	5	0.06	5	53	53	450	0.12

ZONE PRIMARY OA FRACTION

ZONE	ROOM	SPACE AREA Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [# /1000 sf]	Breathing Zone Outdoor Airflow Vbz [cfm]	Zone Outdoor Airflow Voz [cfm]	Zone Primary Airflow Vpz [cfm]	Zone Primary Outdoor Air Fraction Zp
A	H192A	165	0.8	5	0.06	5	14	14	87.5	0.16
B	H192B	165	0.8	5	0.06	5	14	14	87.5	0.16
A	H192K	182	0.9	5	0.06	5	15	15	90	0.17
A	H192L	182	0.9	5	0.06	5	15	15	90	0.17
A	H192P	252	7.6	7.5	0.06	30	72	72	140	0.51
A	S190D195M	743.5	3.7	5	0.06	5	63	63	125	0.51
A	S191	420	10.5	10	0.18	25	181	181	225	0.80
A	S192	420	10.5	10	0.18	25	181	181	350	0.52
A	S193	496	12.4	10	0.18	25	213	213	225	0.95
B	V101	1120	0.0	0	0.12	0	134	134	3200	0.04
A	V102	2204	55.1	10	0.18	25	948	948	4500	0.21
B	V104	340	8.5	10	0.18	25	146	146	750	0.19
B	V105	340	8.5	10	0.18	25	146	146	400	0.37

ZONE PRIMARY OA FRACTION

ZONE	ROOM	SPACE AREA Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [# /1000 sf]	Breathing Zone Outdoor Airflow Vbz [cfm]	Zone Outdoor Airflow Voz [cfm]	Zone Primary Airflow Vpz [cfm]	Zone Primary Outdoor Air Fraction Zp
A	V106	348	0.0	0	0.12	0	42	42	750	0.06
A	V107	204	5.1	10	0.18	25	88	88	500	0.18
A	V109	108	2.2	10	0.18	20	41	41	250	0.16
A	V111	187	4.7	10	0.18	25	80	80	800	0.10
A	V112	168	4.2	10	0.18	25	72	72	450	0.16
A	V113	117	2.3	7.5	0.06	20	25	25	200	0.12
A	V115	66	0.0	0	0.06	0	4	4	150	0.03
A	V116	221	0.0	0	0.25	0	55	55	400	0.14
B	V120	274	6.9	10	0.18	25	118	118	1000	0.12
B	V121	278	7.0	10	0.18	25	120	120	1600	0.07
A/B	V188	1064	0.0	0	0.06	0	64	64	550	0.12
A	V192	324	8.1	10	0.18	25	139	139	750	0.19
A	V196	600	0.0	0	0.12	0	72	72	750	0.10

ZONE PRIMARY OA FRACTION

ZONE	ROOM	SPACE AREA Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [#/1000 sf]	Breathing Zone Outdoor Airflow Vbz [cfm]	Zone Outdoor Airflow Voz [cfm]	Zone Primary Airflow Vpz [cfm]	Zone Primary Outdoor Air Fraction Zp
A/B	V300	612	0.0	0	0.06	0	37	37	100	0.37
A/B	V300C	104	2.6	10	0.18	25	45	45	150	0.30
A	C275	940	0.0	0	0.06	0	56	56	1600	0.04
A	C292A	710	0.0	0	0.06	0	43	43	125	0.34
A	C295	420	0.0	0	0.06	0	25	25	105	0.24
C	L270	1020	25.5	10	0.18	25	439	439	900	0.49
C	L271	90	0.5	5	0.06	5	8	8	275	0.03
C	L272	352	1.8	5	0.06	5	30	30	125	0.24
B	L273	90	0.0	0	0.12	0	11	11	50	0.22
C	S270A	420	10.5	10	0.18	25	181	181	400	0.45
C	S270B	75	1.9	10	0.18	25	32	32	800	0.04
C	S270C	75	1.9	10	0.18	25	32	32	800	0.04
B	L275	2720	68.0	10	0.18	25	1170	1170	2400	0.49

ZONE PRIMARY OA FRACTION

ZONE	ROOM	SPACE AREA Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [# /1000 sf]	Breathing Zone Outdoor Airflow Vbz [cfm]	Zone Outdoor Airflow Voz [cfm]	Zone Primary Airflow Vpz [cfm]	Zone Primary Outdoor Air Fraction Zp
B	S275A	90	0.9	5	0.12	10	15	15	100	0.15
B	S275B	90	0.0	10	0.18	25	16	16	50	0.32
B	S275C	160	0.0	10	0.18	25	29	29	50	0.58
B	S275D	100	2.5	10	0.18	25	43	43	100	0.43
B	S275E	100	2.5	10	0.18	25	43	43	100	0.43
B	S275F	160	4.0	10	0.18	25	69	69	800	0.09
B	S275G	160	4.0	10	0.18	25	69	69	800	0.09
B	S275H	100	2.5	10	0.18	25	43	43	100	0.43
B	S275J	100	2.5	10	0.18	25	43	43	100	0.43
B	S275K	441	11.0	10	0.18	25	190	190	400	0.47
B	S275M	120	3.0	10	0.18	25	52	52	380	0.14
B	S275N	120	3.0	10	0.18	25	52	52	380	0.14
A	L285	2720	68.0	10	0.18	25	1170	1170	2400	0.49

ZONE PRIMARY OA FRACTION

ZONE	ROOM	SPACE AREA Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [# /1000 sf]	Breathing Zone Outdoor Airflow Vbz [cfm]	Zone Outdoor Airflow Voz [cfm]	Zone Primary Airflow Vpz [cfm]	Zone Primary Outdoor Air Fraction Zp
B	L281	90	0.5	5	0.06	5	8	8	50	0.15
B	L282	90	0.0	0	0.12	0	11	11	100	0.11
B	L283	352	1.8	5	0.06	5	30	30	250	0.12
A	S285C	90	0.9	5	0.12	10	15	15	100	0.15
A	S285D	90	2.3	0	0.18	25	16	16	50	0.32
A	S285E	189	4.7	0	0.18	25	34	34	50	0.68
A	S285F	210	5.3	10	0.18	25	90	90	800	0.11
A	S285G	210	5.3	10	0.18	25	90	90	800	0.11
A	L295	1428	35.7	10	0.18	25	614	614	1200	0.51
A / B	V200	1040	0.0	0	0.06	0	62	62	1200	0.05
B	V201	180	0.0	0	0.06	0	11	11	300	0.04
B	V202	180	4.5	10	0.18	25	77	77	800	0.10
B	V203	207	5.2	10	0.18	25	89	89	650	0.14

ZONE PRIMARY OA FRACTION

ZONE	ROOM	SPACE AREA Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [# /1000 sf]	Breathing Zone Outdoor Airflow Vbz [cfm]	Zone Outdoor Airflow Voz [cfm]	Zone Primary Airflow Vpz [cfm]	Zone Primary Outdoor Air Fraction Zp
B	V204	207	5.2	10	0.18	25	89	89	650	0.14
B	V205	207	5.2	10	0.18	25	89	89	650	0.14
B	V206	207	5.2	10	0.18	25	89	89	650	0.14
B	V207	207	5.2	10	0.18	25	89	89	650	0.14
B	V208	207	5.2	10	0.18	25	89	89	650	0.14
B	V209	216	5.4	10	0.18	25	93	93	800	0.12
B	V210	207	5.2	10	0.18	25	89	89	800	0.11
B	V212	207	5.2	10	0.18	25	89	89	650	0.14
B	V213	270	6.8	10	0.18	25	116	116	1140	0.10
B	V214	198	5.0	10	0.18	25	85	85	800	0.11
B	V215	207	5.2	10	0.18	25	89	89	650	0.14
B	V216	207	5.2	10	0.18	25	89	89	650	0.14
B	V217	207	5.2	10	0.18	25	89	89	650	0.14

ZONE PRIMARY OA FRACTION

ZONE	ROOM	SPACE AREA Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [# /1000 sf]	Breathing Zone Outdoor Airflow Vbz [cfm]	Zone Outdoor Airflow Voz [cfm]	Zone Primary Airflow Vpz [cfm]	Zone Primary Outdoor Air Fraction Zp
A	V218	306	7.7	10	0.18	25	132	132	950	0.14
A	V220	306	7.7	10	0.18	25	132	132	950	0.14
A	V221	207	5.2	10	0.18	25	89	89	650	0.14
A	V222	180	4.5	10	0.18	25	77	77	800	0.10
A	V223	252	6.3	10	0.18	25	108	108	1825	0.06
A	V224	216	0.0	0	0.25	0	54	54	205	0.26
A	V225	216	0.0	0	0.25	0	54	54	205	0.26
A	V227	424	0.0	0	0.06	0	25	25	600	0.04
C	C366B	210	0.0	0	0.25	0	53	53	200	0.26
C	C367	859	0.0	0	0.06	0	52	52	200	0.26
C	C368B	210	0.0	0	0.25	0	53	53	200	0.26
A	C375	2670	0.0	0	0.06	0	160	160	5600	0.03
B	C370	1708	0.0	0	0.06	0	102	102	2450	0.04

ZONE PRIMARY OA FRACTION

ZONE	ROOM	SPACE AREA Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [# /1000 sf]	Breathing Zone Outdoor Airflow Vbz [cfm]	Zone Outdoor Airflow Voz [cfm]	Zone Primary Airflow Vpz [cfm]	Zone Primary Outdoor Air Fraction Zp
B	L375	352	1.8	5	0.06	5	30	30	250	0.12
B	L376	90	0.5	5	0.06	5	8	8	50	0.15
B	L378	90	0.0	0	0.12	0	11	11	100	0.11
C	L370	2720	68.0	10	0.18	25	1170	1170	2400	0.49
C	S370A	441	11.0	10	0.18	25	190	190	400	0.47
C	S370B	130	3.3	10	0.18	25	56	56	400	0.14
C	S370C	130	3.3	10	0.18	25	56	56	400	0.14
C	S370D	130	3.3	10	0.18	25	56	56	800	0.07
C	S370E	130	3.3	10	0.18	25	56	56	800	0.07
C	S370G	147	3.7	0	0.18	25	26	26	50	0.53
C	S375	441	11.0	10	0.18	25	190	190	2000	0.09
B	P370	704	3.5	5	0.06	5	60	60	135	0.44
B	P371	330	1.7	5	0.06	5	28	28	100	0.28

ZONE PRIMARY OA FRACTION

ZONE	ROOM	SPACE AREA Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [# /1000 sf]	Breathing Zone Outdoor Airflow Vbz [cfm]	Zone Outdoor Airflow Voz [cfm]	Zone Primary Airflow Vpz [cfm]	Zone Primary Outdoor Air Fraction Zp
B	P372	330	1.7	5	0.06	5	28	28	100	0.28
B	P373	396	2.0	5	0.06	5	34	34	175	0.19
B	P374	572	10.3	5	0.06	18	86	86	160	0.54
B	P375	396	2.0	5	0.06	5	34	34	175	0.19
B	P376	330	1.7	5	0.06	5	28	28	100	0.28
B	P377	330	1.7	5	0.06	5	28	28	100	0.28
B	L380	2816	70.4	10	0.18	25	1211	1211	3400	0.36
A	L386	90	0.5	5	0.06	5	8	8	50	0.15
A	L387	352	1.8	5	0.06	5	30	30	250	0.12
A	L388	90	0.0	0	0.12	0	11	11	100	0.11
B	S380A	483	12.1	10	0.18	25	208	208	3000	0.07
B	S380B	483	12.1	10	0.18	25	208	208	3000	0.07
B	S380C	483	12.1	10	0.18	25	208	208	3000	0.07

ZONE PRIMARY OA FRACTION

ZONE	ROOM	SPACE AREA Az [SF]	Design Occupancy Pz [people]	People Outdoor Air Rate Rp [cfm/person]	Area Outdoor Air Rate Ra [cfm/sf]	Default Occupancy Density [# /1000 sf]	Breathing Zone Outdoor Airflow Vbz [cfm]	Zone Outdoor Airflow Voz [cfm]	Zone Primary Airflow Vpz [cfm]	Zone Primary Outdoor Air Fraction Zp
B	S380D	483	12.1	10	0.18	25	208	208	3000	0.07
A	S380E	483	12.1	10	0.18	25	208	208	3000	0.07
A	S388	483	12.1	10	0.18	25	208	208	3000	0.07
A	L390	960	24.0	10	0.18	25	413	413	1200	0.34
A	S390B	147	3.7	0	0.18	25	26	26	50	0.53
A	S390C	130	3.3	10	0.18	25	56	56	800	0.07
A	P380	704	3.5	5	0.06	5	60	60	135	0.44
A	P381	330	1.7	5	0.06	5	28	28	100	0.28
A	P382	330	1.7	5	0.06	5	28	28	100	0.28
A	P383	396	2.0	5	0.06	5	34	34	175	0.19
A	P384	572	10.3	5	0.06	18	86	86	160	0.54
A	P386	396	2.0	5	0.06	5	34	34	100	0.34
A	P387	330	1.7	5	0.06	5	28	28	100	0.28
A	P388	330	1.7	5	0.06	5	28	28	175	0.16

COMPARISON OF OUTDOOR AIR

NOMINAL VS REQUIRED

ZONE	System Ventilation Efficiency, E_v	System Zone Outdoor Airflow ΣV_{oz} [cfm]	Design Outdoor Air Intake Flow V_{ot} [cfm]	Actual Capacity of AHUs V_{actual} [cfm]
AHU 1 & 2	0.22	19,373	88,059	90,000

$$\Sigma V_{oz} < V_{ot} < V_{actual}$$

System ventilation calculation can be found on pages 8 - 10

Air handlers 1 & 2 are compliant with AHRAE 62.1-2004 ventilation requirements. The design cfm is 4.5 times greater than the nominal outdoor airflow. The two air handlers require approximately 88,000 cfm and have a capacity of 90,000 cfm. The difference can be accounted for by assumptions made during analysis. Information such as occupancy and use could not always be determined from known information and therefore had to be assumed. It is possible that the owner required different space ventilation requirements that are known.

DISCUSSION

THE VENTILATION RATEPROCEDURE VS. THE INDOOR AIR QUALITY PROCEDURE

The purpose of the Ventilation Rate Procedure is “to specify minimum ventilation rates and indoor air quality that will be acceptable to human occupants and are intended to minimize for adverse health effects. The procedure is based on general contaminant levels and requirements for cfm/person. It is a relatively fast method to calculate and does not require extensive knowledge of the space requirements. This allows the basic system to be designed before specific use and occupancy are ever determined allowing the design process to take less time. The major drawback is that the designed system may not be tailored to the specific need of all spaces. This could mean over - or under - heating or cooling, wasted energy, or contaminant levels exceeding recommended limits.

The first alternative procedure was introduced in 1981. The Indoor Air Quality Procedure is a “performance-based procedure [which allows] the use of any amount of outdoor air deemed necessary if the designer can show that the levels of indoor air contaminants are held below recommended limits.” This procedure required the engineer to know the specific function of every space in the building. A design of this precision could be necessary in critical spaces or spaces with specialized functions such as hospital rooms, scientific research facilities, museums, or other spaces where there is a threat of contamination from known sources. This information is not always known and therefore make designing based on this procedure impossible. Also, using the Indoor Air Quality Procedure eliminates flexibility in the design. The system is specific for each space therefore any alterations would require the system to be modified. In comparison, the Ventilation Rate Procedure is able to absorb some changes in space characteristics as the procedure only uses generalized requirements.

REFERENCES

2003 ASHRAE Handbook – HVAC Applications. ASHRAE, Inc. Atlanta, GA. 2003.

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