TECHNICAL ASSIGNMENT #1

ASHRAE Standard 62.1: Ventilation Compliance Evaluation

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October 5, 2005

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Executive Summary

This report looks into the compliance of the Baylor College of Medicine Research Tower with ASHRAE Standard 62.1 via its Ventilation Rate Calculation Procedure. ASHRAE Standard 62.1 is widely used for designing a building with proper ventilation rates to avoid health and comfort problems. The Baylor College of Medicine Research Tower is an 8 story, 200,000 ft^2 building. The building consists of 2 levels of animal facilities (levels 1 & 2), 5 levels of research labs (levels 4-8) and 1 level, dedicated to the building's mechanical systems, contains 10 of the building's 12 air handling units.

As mentioned above the Baylor College of Medicine Research Tower contains 12 air handling units, of which 8 were analyzed for the purpose of this report. The 4 air handlers that were not accounted for could be bypassed during analysis because 2 were used for stairwell pressurization and the other 2 were used for the mechanical floor on level 3. All 4 systems were 100% outdoor air and since there is no occupancy they are assumed to meet any ventilation requirements that may apply via standard 62.

The Research Tower's air handlers have a unique configuration. Despite 8 air handling units being analyzed this only equates to 3 different air systems in the building. The air handlers tagged AHU-A.1a, AHU-A.1b, AHU-A.1c and AHU-A.1d, that serve the animal facilities, are stacked in a 2 x 2 configuration and all dump into a discharge plenum that then runs to the appropriate zones. The air handlers tagged AHU-L.1a and AHU-L.1b are stacked on top of each other run into a shared discharge plenum and likewise for the air handlers tagged AHU-L.2a and AHU-L.2b. The 8 air handling units that were analyzed by the Ventilation Rate Calculation Procedure in standard 62 all met the required outdoor air. The air handlers serving the animal facilities on levels 1 & 2 and the laboratory spaces on levels 4-8 are 100% outdoor air systems which simplifies the Ventilation Rate Calculation procedure greatly. The multiple zone recirculating systems version of the procedure was used for AHU-L.1a and AHU-L.1b because this air handler returns a portion of the air that it supplies (the air in office and lobby spaces).

All spaces within the building are supplied air via ceiling diffusers using industry accepted air temperatures. The ventilation effectiveness of all systems analyzed was taken to be 1.0. Table 6-2 dictates this because there is ceiling supply of cool air. However, this E_v was only used in calculation of one of the air systems as 100% outdoor air systems do not require use of this value.

Assumptions

- Air Handling Units for pressurization of the stairwell and the level 3 mechanical space do not need to be accounted for because all 4 units are 100% outdoor air and there is no occupancy or activity in these spaces.
- Since there are no Animal Handling rooms for laboratories listed in the ventilation requirements in standard 62.1, these rooms were treated as "Retail – Pet Shops (Animal Areas)".
- Sterile Corridors are treated like a typical corridor as far as people occupancy however in the square foot ventilation requirement a .18 cfm/ft^2 was used instead of .06 cfm/ft^2 to match the rest of the lab spaces.
- Diversity of 1.0 is assumed due to design narrative put forth by the owner. This value is also the most conservative value for required outdoor air.
- All spaces in the laboratory research areas on levels 4-8 labeled Lab Support, Fume Hood, Equipment room, Microscopy, etc were treated as "Education – Science Laboratories".
- Vestibules, pass throughs, and other areas associate with corridor spaces were treated as corridors, except where the word "sterile" was used in which case the assumption listed above was used.
- Procedures rooms were treated as "Educational – Science Laboratories".
- All design occupancies used for the spaces are from the design narrative supplied by the HVAC designers.

General Description of Air-Side Mechanical Systems

There are 12 air handlers in total that supply the tower. Of the 12 air handlers 10 are located in the level 3 mechanical space and the other 2 are located on the roof. On the roof there is a 15,000 CFM and 10,000 CFM air handler which serves to pressurize the north and south stairwells, respectively. Four 25,000 CFM air handlers service the vivarium spaces, office and lab spaces on levels 1 and 2. There are two 10,000 CFM air handlers that serve the level 3 mechanical space. The final four air handlers are 50,000 CFM and serve the main lab and office spaces on floors 4-8. Fan coil units are used in the emergency electrical rooms, elevator equipment room and in the eastern corridors on levels 4-8.

Levels 1 & 2 contain all of the animal research facilities and vivarium space. Level 2 is constant volume 100% outdoor air, as it contains no office space and all vivarium and research spaces are constant volume and exhausted through fume hoods and exhaust fans located on the roof (via exhaust risers). Level 1 contains the lobby of the research tower. This lobby space and the attached corridor are variable volume spaces and are the only spaces on level 1 in which the air is returned instead of exhausted. All the vivarium spaces and animal research spaces on level 1 are constant volume and exhausted similar to level 2. The animal facility cagewash on level 1 is variable volume and is exhausted through exhaust diffusers as well as exhaust hoods. There is office space on level 1 which is variable volume however the air in this space is also exhausted and not returned. There are many vestibules which separate the “dirty” and “sterile” sides of level 1 which is divided by the cagewash. The “dirty” side is the office side and also where dirty cages are brought into the cagewash to be cleaned and the sterile side is the opposite side of the building where the sterile cages are removed from the cage wash.

Level 3 has only a few spaces to consider. In the northeastern corner of the building there is some storage space, corridor, glass wash and equipment service area that needs to be considers for heating and cooling. These spaces are all constant volume and exhausted. The rest of the space on level 3 is the mechanical area containing a majority of the air handlers. There are louvers along the north side of the building that allow for outdoor air to come in and feed the air handlers.

On levels 4-8 the research laboratories are variable volume, as are the office spaces on the opposite side of the floors. However not all spaces on levels 4-8 are variable volume there are a some laboratory support spaces that are constant volume, typically the presence of a fume hood will indicate constant volume. The air within the laboratory and laboratory support spaces is exhausted through exhaust fans located on the roof via exhaust risers or through fume hoods that also exhaust through the roof. The laboratory and office spaces on levels 4-8 are separated by a pressurized corridor/interaction space. Air in the office side and separating corridor/interaction space is returned.

Defining of Air Systems for Analysis

There are 3 air systems in the Research Tower in which this report focuses on. This section will describe the 3 systems how they operate and what spaces they support. As stated above, the spaces that will be looked at in this report consist of animal facilities, laboratory spaces and their support spaces as well as some office spaces on the upper levels. The 8 total air handling units supply approximately 300,000 CFM to these space of which 250,150 CFM is outdoor air. For the sake of this report the 3 air systems will be referred to as System 1, System 2 and System 3, with the details of each system forthcoming.

System 1 serves the animal facilities on levels 1 & 2. This system consists of air handlers; AHU-A.1a, AHU-A.1b, AHU-A.1c and AHU-A1.d. The animal facilities on the first floor are made up of animal housing rooms in which animals to conduct experiments on are held. Connected to the animal housing rooms are procedure rooms where the experiments or preparation for experiments can be carried out. A majority of the space on level 1 is taken up by a cage wash facility for cleansing of all the cages in which animals are stored. Level 2 consists almost exclusively of the aforementioned animal housing rooms and adjacent procedure rooms. System 1's 4 air handlers are stacked in a 2x2 configuration and "dump" all their supply air into a discharge plenum where air from all 4 air handlers is mixed. Air is then supplied from there to the appropriate spaces on levels 1 & 2. The system is 100% outdoor air, this is due to needing the air as clean as possible so as to not influence experiments or spread contaminants/sickness.

System 2 serves the laboratory spaces on levels 4-8. This system consists of air handlers; AHU-L.2a and AHU-L.2b. The laboratory spaces on these levels are for research purposes at the college. The adjacent spaces are laboratory support and are made up of spaces such as fume hood rooms, equipment rooms, microscopy and general lab support rooms. The air handlers are stacked on top of each other and supply into a discharge plenum similar to system 1. This system is also 100% outdoor air for the same reasons as system 1.

System 3 is the only system analyzed (and only system in the building) that uses recirculated air. This system serves the rest of the laboratory spaces on levels 4-8 not covered by system 2, the office spaces on levels 4-8 and the main lobby and attached corridor on level 1. This system is made up of air handling units AHU-L.1a and AHU-L.1b. These units are also stacked one on top of the other and use the discharge plenum like the other 2 systems. Air in the laboratory spaces on these floors is exhausted through the roof of the building. The office side of levels 4-8 and few level 1 spaces are the spaces that are returned. The system is approximately 50% outdoor air

Standard 62.1 Analysis

For this report there were 2 versions of the Ventilation Rate Calculation procedure used. The first was for two 100% Outdoor Air systems and the second was for the multiple-zone recirculating system. The 100% Outdoor Air systems calculations simplifies the process greatly and cuts out a few steps that are in the multiple-zone version of the procedure.

The calculations were call carried out in Microsoft Excel and are presented in table form. The zones were labeled by designers in the drawing set. Minor modifications to their zones so that the space could be better understood. The space characteristics chart gives the use of each zone, the room(s) that make up that zone, the tag of the supply box that services that zone, the min and max CFM, design occupancy and area. The space characteristics chart can be seen in the Appendix.

System 1: AHU-A.1a, AHU-A.1b, AHU-A.1c & AHU-A.1d

These four air handling units, as mentioned above, are stacked in a 2x2 configuration and all supply into a discharge plenum from which a supply duct runs to the animal facilities on levels 1 & 2. These units are all 100% outdoor air systems. The Ventilation Rate Calculation procedure was carried out like this;

Step 1: Calculate design occupancy and area (P_z, A_z)for each zone. Design occupancy was gathered from the design narrative put together by the owner and HVAC designer. Area was measured off of the drawing set provided. The results of these calculations can be seen on the table in the system calculations section of the Appendix.

Step 2: Look up appropriate ventilation rates (R_p, R_a) for each zone. Appropriate ventilation rates were chosen from Table 6-1 in Standard 62.1 based on the use of each zone. In cases where a direct match could not be found, a ventilation rate was chosen based on the assumptions listed above.

Step 3: Calculate Breathing Zone Outdoor Airflow (V_{bz}) for each zone. Using the values found in the above steps, they were plugged into Breathing Zone Outdoor Airflow equation listed below, and calculated for each zone.

$$V_{bz} = R_pP_z + R_aA_z$$

Step 4: Determine Zone Air Distribution Effectiveness (E_z). As stated in the executive summary since all air supplied through the ceiling, from Table 6-2 Zone Air Distribution Effectiveness can be determined to be equal to 1.0.

Step 5: Calculate the Zone Outdoor Airflow (V_{oz}) for each zone. The Zone Outdoor Airflow can be determined from the Breathing Zone Outdoor Airflow and the Zone Air Distribution Effectiveness. Since all E_z = 1.0 then $V_{bz} = V_{oz}$, according to the following equation.

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

Step 6: For 100% Outdoor Air Systems to determine the outdoor air intake flow (V_{ot}) the final step is to sum the V_{oz} for each individual zone.

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

Summing the Zone Outdoor Airflow values for each space gives the total outdoor air required for the system per Standard 62.1. For system 1 the total outdoor air required is 8,621 CFM. Since the system is a 100,000 CFM 100% outdoor air system, it meets the ventilation requirements with ease. A detailed spreadsheet with calculations for this system can be found in the Appendix under system calculations.

System 2: AHU-L.2a & AHU-L.2b

These two air handling units are stacked one on top of another with the same discharge plenum scheme as mentioned above. The system was defined above as a 100% outdoor air system that serves laboratory spaces on levels 4-8. As such, this system follows the same procedure step by step as above. The final result of outdoor air required for the system is 9,970 CFM. The system is a 100% outdoor air system supplying 100,000 CFM of air the ventilation requirements of Standard 62.1 is met. A detailed spreadsheet with calculations for this system can be found in the Appendix under system calculations.

System 3: AHU-L.1a & AHU-L.1b

System 3 consists of two air handling units, again, stacked one on top of the other with a shared discharge plenum attached to the both of them. This system is the only system in the building that uses return air in any way. This building serves some laboratory spaces levels 4-8 as well levels 4-8's office side and the lobby/corridor space on level 1. The following is step by step through the multiple zone version of the Ventilation Rate Procedure.

Step 1: Calculate design occupancy and area (P_z, A_z)for each zone. Design occupancy was gathered from the design narrative put together by the owner and HVAC designer. Area was measured off of the drawing set provided. The results of these calculations can be seen on the table in the systems calculation section of the Appendix.

Step 2: Look up appropriate ventilation rates (R_p, R_a) for each zone. Appropriate ventilation rates were chosen from Table 6-1 in Standard 62.1 based on the use of each zone. In cases where a direct match could not be found, a ventilation rate was chosen based on the assumptions listed above.

Step 3: Calculate Breathing Zone Outdoor Airflow (V_{bz}) for each zone. Using the values found in the above steps, they were plugged into Breathing Zone Outdoor Airflow equation listed below, and calculated for each zone.

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

Step 4: Determine Zone Air Distribution Effectiveness (E_z). As stated in the executive summary since all air supplied through the ceiling, from Table 6-2 Zone Air Distribution Effectiveness can be determined to be equal to 1.0.

Step 5: Calculate the Zone Outdoor Airflow (V_{oz}) for each zone. The Zone Outdoor Airflow can be determined from the Breathing Zone Outdoor Airflow and the Zone Air

Distribution Effectiveness. Since all E_z = 1.0 then $V_{bz} = V_{oz}$, according to the following equation.

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

Step 6: Calculate the Primary Outdoor Air Fraction (Z_p) for each space. This value compares the calculated Zone Outdoor Airflow (V_{oz}) with the Zone Primary Airflow (V_{pz}). The Zone Primary Airflow is the design airflow to the space or if it is a VAV zone the minimum design airflow.

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

Step 7: Find the maximum Z_p for system to determine what the fraction of outdoor air for the entire system should be. See the system calculations section of the Appendix for max Z_p of System 3.

Step 8: Calculate Uncorrected Outdoor Air Intake (V_{ou}) for the entire system. This takes into account the diversity of the occupancy load. Meaning not every space is going to be at design occupancy at all times. However since, D = 1 (as assumed above), V_{ou} is simply the sum of all V_{bz} values for System 3. Vou would be found typically through the following equation.

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

Step 9: Find the System Ventilation Efficiency (E_v) from Table 6-3. Using the max Z_p calculated in Step 7. For System 3 the max Z_p was .35 giving us an E_v = 0.8.

Step 10: Calculate the Outdoor Air Intake (V_{ot}) for System 3.

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

This gives V_{ot} = 13,618 CFM. The total supply air of System 3 is 100,000 CFM. There is 49,850 CFM of air returned to the system from the various office and corridor spaces. This means there is 50,150 CFM of outdoor air which is well above the required 13,618 CFM. A detailed spreadsheet of all the calculations for System 3 can be found in the Appendix.

Final Wrap Up

The following chart sums the outdoor air requirements versus what is actually supplied by the system.

AHU Tag	Service	Level(s)	62.1 O.A.	Actual O.A.
AHU-A.1a	Animal Facilities	1,2	8,651	100,000
AHU-A.1b	Animal Facilities	1,2		
AHU-A.1c	Animal Facilities	1,2		
AHU-A.1d	Animal Facilities	1,2		
AHU-L.1a	Lab/Office/Lobby	1,4-8	13,106	50,150
AHU-L.1b	Lab/Office/Lobby	1,4-8		
AHU-L.2a	Laboratory	4-8	9,970	100,000
AHU-L.2b	Laboratory	4-8		

As gathered from above the entire building is ventilated very well. This is due to the use of 100% outdoor air systems in almost every application on the air side of the mechanical systems. While this allows for excellent ventilation and prevention of contaminants spreading throughout it is a great waste of energy. The building consumed a great amount of energy taking all of the outdoor air and cooling it to the desired supply temperature. Using a combination of return and filters could allow for energy savings due to preconditioning of the air. However the energy wasting nature of the design is outside the scope of this report. The building meets standard 62.1 according to the Ventilation Rate Procedure.

Ventilation Rate Procedure Vs. Indoor Air Quality Procedure

Standard 62.1 of ASHRAE describe two distinct procedures for calculating ventilation rates and controlling contamination. The Ventilation Rate Procedure is a more general form of contamination control in which it goes based off of the general use of the building. The Indoor Air Quality Procedure is aimed more at controlling specific contaminants in a space or prevent air contaminants from coming outside.

The Ventilation Rate procedure was described in depth above for both the multiple-zone case and the 100% outdoor air case. Based on the designed use of each space a ventilation rate was chosen for occupancy and area. The ventilation rate procedure aims at moving a specific amount of air that contains a general amount of some general contaminants.

The Indoor Air Quality procedure is a more aggressive and proactive approach to controlling indoor air contamination. The IAQ Procedure identifies sources of contamination within a space and what contaminates they produce. It also takes into account the amount of contamination in the outdoor air at a certain location and identifies the levels for specific contaminants. Using the source of contamination within the space and the information about the outdoor air quality of the location the IAQ procedure will give the ventilation and filters required to prevent this contaminants level from getting out of control within the space.

For instance, the Research Tower has animal housing rooms. The Ventilation Rate procedure identified this space as an animal area, assumed to be the same as a “Retail – Pet Shop” for the sake of this report. Then based on this animal area use gave a ventilation rate for how much air to remove. If the IAQ procedure was used for an animal housing room it would identify the animal as a source of contamination. Then it would identify what contaminants are in the outdoor air of Houston, TX. Then from this the designer would choose which contaminant to control and the IAQ procedure would give the amount of ventilation needed to control the contaminant to a certain level.

Appendix A – Space Characteristics & System Calculations

Space Characteristics

Zone	Level	Space	Room #'s	Box	Use	CFM Max	CFM Min	Design Occupancy (ft^2/person)	Area (ft^2)	Occupancy
1	1	Lobby + Elevator Lobby	R100,R100B	S2	Lobby	2350	1175	250	575	2
2	1	Corridor	R1C1	S40	Corridor	1500	750	250	540	2
3	1	Corridor	R1C1,R1C2	S4	Corridor	1050	525	250	525	2
4	1	Animal Housing Room (AHR)	R126F	S15	Animal Housing	1675	1675	Actual #	750	12
5	1	Animal Housing Room (AHR)	R126H	S12	Animal Housing	1675	1675	Actual #	750	12
6	1	Animal Housing Room (AHR)	R126J	S8	Animal Housing	1675	1675	Actual #	750	12
7	1	Feed Storage	R134	S3	Storage	300	300	200	160	1
8	1	Sterile Corridor + Janitor Closet*	R1C5, R136	S47,S39	Corridor (Sterile)	1375	1375	250	1030	4
9	1	Small AHR	R126B	S21	Animal Housing	1230	1230	Actual #	125	4
10	1	Small AHR	R136C	S22	Animal Housing	1230	1230	Actual #	125	4
11	1	Small AHR	R126D	S23	Animal Housing	1180	1180	Actual #	115	4
12	1	Small AHR	R126A	S20	Animal Housing	1180	1180	Actual #	115	4
13	1	Small AHR	R126K	S9	Animal Housing	1190	1190	Actual #	100	4
14	1	Small AHR	R126G	S13	Animal Housing	1180	1180	Actual #	135	4
15	1	Procedure Room	R126FA	S14	Procedure	1180	1180	Actual #	160	2
16	1	Procedure Room	R126JA	S11	Procedure	1100	1100	Actual #	130	2
17	1	Procedure Room	R126HA	S10	Procedure	1100	1100	Actual #	130	2
18	1	Vestibule	R126	S17	Corridor	125	125	250	110	0
19	1	Storage	R124	S18	Storage	100	100	200	115	1
20	1	Corridor + Janitor Closet*	R1C4,R126E	S24,S1	Corridor	725	725	250	800	3
21	1	Gown	R128	S26	Prep room	175	175	100	165	2
22	1	Sterile Corridor	R1C5	S27	Corridor	800	800	250	275	1
23	1	Storage	R130	S28	Storage	100	100	200	100	1
24	1	Elevator Machine Room	R138C	S56	Equipment	800	400	N/A	120	0
25	1	Domestic Pump	R138B	S58	Equipment	425	225	N/A	145	0
26	1	Fire Pump	R138A	S59	Equipment	150	75	N/A	115	0
27	1	Vestibule + Corridor	R138,R1C6	S60	Corridor	200	200	250	150	1
28	1	Sterile Pass Through	R140	S61	Corridor	750	750	250	160	1
29	1	Pass Through	R119B	S5	Corridor	575	575	250	145	1
30	1	Staging	R137	S54	Corridor	600	600	250	190	1
31	1	Decon Storage	R119A	S52	Corridor	800	800	250	500	2
32	1	Fire Command	R117	S57	Office	400	200	100	195	2
33	1	Mechanical	R113	S51	Equipment	750	375	N/A	150	0
34	1	Electrical	R112	S6	Equipment	600	300	N/A	125	0
35	1	IDF	R110	S7	Tel/Data	425	225	N/A	80	0
36	1	Office	R108	S50	Office	175	100	100	75	1

Zone	Level	Space	Room #'s	Box	Use	CFM Max	CFM Min	Design Occupancy (ft^2/person)	Area (ft^2)	Occupancy
37	1	Office	R106	S49	Office	175	100	100	75	1
38	1	Storage	R116	S48	Storage	200	200	200	175	1
39	1	Office	R104B	S42	Office	175	100	100	85	1
40	1	Meeting	R104A	S43	Conference	175	100	25	85	3
41	1	Corridor		S41	Corridor	100	100	250	90	0
42	1	Women's Locker Room	R102B	S35	Locker Room	650	650	100	340	3
43	1	Men's Locker Room	R102A	S36	Locker Room	650	650	100	340	3
44	1	Corridor	R102	S29	Corridor	400	400	250	125	1
45	1	Break / Training	R102C	S30	Break Room	1450	725	25	535	21
46	1	Dirty Corridor + Janitor Closet*	R1C3,R114	S31,S44	Corridor	1400	1400	250	1510	6
47	1	Sterile Cage + Bottle Processing	R133,R133A	S46	Equip Cleaning	2850	1425	200	1125	6
48	1	Dirty Cage + Dirty Bottle	R123,R121	S45	Equip Cleaning	3625	1825	200	1400	7
49	1	Clean Cage	R123	S33	Equip Cleaning	3750	1875	200	1450	7
50	1	Robotic Transition (Clean to Dirty)	R123	S32	Equip Cleaning	1200	1200	200	384	2
51	2	Janitor Closet + Vestibule (2) + Dirty Corridor	R200,R2C1,R 201,R202	S3	Corridor	1150	1150	250	1150	5
52	2	Procedure Room	R204A	S22	Procedure	400	400	Actual #	135	4
53	2	Procedure Room	R204B	S21	Procedure	1100	1100	Actual #	135	4
54	2	Animal Housing Room (AHR)	R204	S23	Animal Housing	1675	1675	Actual #	655	14
55	2	Procedure Room	R208A	S26	Procedure	400	400	Actual #	115	4
56	2	Procedure Room	R208B	S24	Procedure	1100	1100	Actual #	115	4
57	2	Animal Housing Room (AHR)	R208	S25	Animal Housing	1675	1675	Actual #	655	14
58	2	Procedure Room	R210B	S29	Procedure	400	400	Actual #	130	4
59	2	Procedure Room	R210A	S30	Procedure	1100	1100	Actual #	130	4
60	2	Animal Housing Room (AHR)	R210	S27	Animal Housing	1675	1675	Actual #	655	14
61	2	Vestibule + Sterile Corridor + Janitor Closet	R211,R2C5,R 213	S28	Corridor	700	700	250	650	3
62	2	Procedure Room	R209B	S11	Procedure	1100	1100	Actual #	105	4
63	2	Procedure Room	R209A	S10	Procedure	350	350	Actual #	105	4
64	2	Animal Housing Room (AHR)	R209	S8	Animal Housing	1400	1400	Actual #	570	14
65	2	Animal Housing Room (AHR)	R207	S7	Animal Housing	850	850	Actual #	330	14
66	2	Procedure Room	R207A	S4	Procedure	1100	1100	Actual #		4
67	2	Corridor	R2C6	S6	Corridor	650	650	250	625	3
68	2	Animal Housing Room (AHR)	R203	S5	Animal Housing	1400	1400	Actual #	540	14
69	2	Procedure Room	R203A	S2	Procedure	1100	1100	Actual #	105	4
70	2	Procedure Room	R203B	S1	Procedure	350	350	Actual #	105	4
71	2	Procedure Room	R224A	S33	Procedure	400	400	Actual #	125	4
72	2	Procedure Room	R224B	S32	Procedure	1100	1100	Actual #	125	4

Zone	Level	Space	Room #'s	Box	Use	CFM Max	CFM Min	Design Occupancy (ft^2/person)	Area (ft^2)	Occupancy
73	2	Animal Housing Room (AHR)	R224	S34	Animal Housing	1675	1675	Actual #	650	14
74	2	Procedure Room	R228A	S37	Procedure	400	400	Actual #	130	4
75	2	Procedure Room	R228B	S35	Procedure	1100	1100	Actual #	130	4
76	2	Animal Housing Room (AHR)	R228	S36	Animal Housing	1975	1975	Actual #	750	14
77	2	Procedure Room	R230B	S40	Procedure	400	400	Actual #	125	4
78	2	Procedure Room	R230A	S41	Procedure	1100	1100	Actual #	125	4
79	2	Animal Housing Room (AHR)	R230	S38	Animal Housing	1675	1675	Actual #	655	14
80	2	Vestibule + Sterile Corridor	R225,R2C5	S39	Corridor	650	650	250	630	3
81	2	Corridor	R2C4	S47	Corridor	650	650	250	650	3
82	2	Dirty Corridor	R2C1	S42	Corridor	650	650	250	660	3
83	2	Procedure Room	R223A	S46	Procedure	1100	1100	Actual #	125	4
84	2	Procedure Room	R223B	S43	Procedure	400	400	Actual #	125	4
85	2	Animal Housing Room (AHR)	R223	S45	Animal Housing	1675	1675	Actual #	650	14
86	2	Procedure Room	R227A	S44	Procedure	1100	1100	Actual #	105	4
87	2	Procedure Room	R227B	S48	Procedure	350	350	Actual #	105	4
88	2	Animal Housing Room (AHR)	R227	S49	Animal Housing	1675	1675	Actual #	655	14
89	2	Procedure Room	R229B	S52	Procedure	1100	1100	Actual #	125	4
90	2	Procedure Room	R229A	S51	Procedure	400	400	Actual #	125	4
91	2	Animal Housing Room (AHR)	R229	S50	Animal Housing	1675	1675	Actual #	655	14
92	2	Sterile Corridor	R2C5	S53	Corridor	650	650	250	475	2
93	2	Procedure Room	R240A	S13	Procedure	1100	1100	Actual #	190	4
94	2	Animal Housing Room (AHR)	R240	S12	Animal Housing	1100	1100	Actual #	740	14
95	2	Animal Housing Room (AHR)	R238	S14	Animal Housing	1400	1400	Actual #	546	14
96	2	Procedure Room	R238A	S17	Procedure	350	350	Actual #	105	4
97	2	Procedure Room	R238B	S15	Procedure	1100	1100	Actual #	105	4
98	2	Animal Housing Room (AHR)	R234	S16	Animal Housing	1400	1400	Actual #	555	14
99	2	Procedure Room	R234A	S19	Procedure	350	350	Actual #	105	4
100	2	Procedure Room	R234B	S20	Procedure	1100	1100	Actual #	105	4
101	2	Storage + Irradiator	R247,R245	S55	Storage	400	400	200	300	2
102	2	Feed Storage	R243	S56	Storage	350	350	200	100	1
103	2	Vestibule	R232	S18	Corridor	800	800	250	395	2
104	2	Dirty Staging	R233	S62	Corridor	350	350	250	275	1
105	2	Corridor + Toilet*	R2C2,R239	S57	Corridor	450	450	250	900	4
106	2	Gown	R237	S58	Prep room	300	300	100	145	1
107	2	IDF	R237A	S59	Tel/Data	925	0	N/A	85	0
108	2	Storage	R237B	S60	Storage	200	200	200	105	1
109	2	Elevator Lobby	R235	S64	Corridor/Lobby	450	450	250	315	1
110	2	Electrical	R237C	S63	Equipment	600	0	N/A	130	0

Zone	Level	Space	Room #'s	Box	Use	CFM		Design Occupancy (ft^2/person)	Area (ft^2)	Occupancy
						Max	Min			
111	4-8	Meeting Room		S1	Conference	700	350	25	230	9
112	4-8	Office (3)	R402-R404	S2	Office	850	425	100	385	4
113	4-8	Office (4)		S4	Office	1100	550	100	460	5
114	4-8	Office (3)	R411-R413	S8	Office	825	425	100	350	4
115	4-8	Meeting Room	R414	S9	Conference	700	350	25	230	9
116	4-8	Office (3)	R415-R417	S10	Office	975	500	100	345	3
117	4-8	Corridor/Open Office	R4C6	S7	Office	625	325	100	640	6
118	4-8	Corridor/Open Office	R4C7.R421,R4C1	S6	Office	675	350	150	750	5
119	4-8	Conference Room	R408	S5	Conference	1000	500	25	625	25
120	4-8	Men's Restroom/Women's Restroom	R418,R419	S11	Toilet	500	500	N/A	320	0
121	4-8	Interaction space/Break Area	R422,R400C	S12	Gathering area	700	700	25	785	31
122	4-8	Interaction space/Elevator Lobby	R400B,R400A	S3,S12	Gathering area	1400	1400	200	1615	8
123	4-8	Lab Workstation	R450	S23	Laboratory	1700	850	100	585	6
124	4-8	Lab Workstation	R450	S24	Laboratory	850	425	100	290	3
125	4-8	Lab Workstation	R450	S42	Laboratory	1700	850	100	585	6
126	4-8	Research Lab	R451	S22	Laboratory	1600	800	100	1005	10
127	4-8	Research Lab	R451	S29	Laboratory	800	400	100	515	5
128	4-8	Research Lab	R451	S32	Laboratory	1600	800	100	1005	10
129	4-8	Lab Support	R459	S16	Laboratory	350	175	100	140	1
130	4-8	Lab Support	R432	S13	Laboratory	350	175	100	140	1
131	4-8	Fume Hood	R458	S14	Laboratory	750	750	100	135	1
132	4-8	Fume Hood	R433	S15	Laboratory	750	750	100	135	1
133	4-8	Equipment Room	R434	S17	Storage	700	350	100	285	3
134	4-8	Microscopy	R456	S21	Laboratory	175	100	100	50	1
135	4-8	Lab Support	R436	S20	Laboratory	550	275	100	225	2
136	4-8	Lab Support	R455	S31	Laboratory	550	275	100	225	2
137	4-8	Microscopy	R437	S28	Laboratory	175	100	100	50	1
138	4-8	Equipment Room	R438	S34	Storage	700	350	100	285	3
139	4-8	Tissue Culture	R454	S35	Laboratory	350	175	100	135	1
140	4-8	Tissue Culture	R439	S36	Laboratory	350	175	100	135	1
141	4-8	Fume Hood	R453	S38	Laboratory	750	750	100	135	1
142	4-8	Fume Hood	R440	S37	Laboratory	750	750	100	135	1
143	4-8	Microscopy	R452	S40	Laboratory	175	100	100	50	1
144	4-8	Dark Room/Processing	R442,R442A	S39	Laboratory	125	125	100	165	2
145	4-8	Microscopy	R441	S41	Laboratory	175	100	100	50	1
146	4-8	Corridor	R4C3,R4C2	S49,FCU1	Corridor	1200	1200	250	635	3
147	4-8	Corridor	R4C2	FCU-1	Corridor	800	800	250	375	2

Zone	Level	Space	Room #'s	Box	Use	CFM Max	CFM Min	Design Occupancy (ft^2/person)	Area (ft^2)	Occupancy
148	4-8	Corridor	R4C2,R4C5	FCU1,S50	Corridor	1200	1200	250	575	2
149	4-8	Lab	R461	S48	Laboratory	1000	500	100	335	3
150	4-8	IDF	R464	S44	Tel/Data	925	475	N/A	105	0
151	4-8	Chemical Storage	R463	S49	Chem. Storage	250	250	200	130	1
151	4-8	Electrical	R467	S46	Equipment	725	375	N/A	140	0

* Space is exhausted only, air is supplied through undercuts

System Calculations

System 1: AHU-A.1a, AHU-A.1b, AHU-A.1c, AHU-A.1d				CFM		Design Occupancy	Area	P_z	R_p	R_a	V_{bz}	E_z	V_{oz}
Level	Space	Room #'s	Box	Max	Min	(ft^2/person)	(ft^2)	Occup.	(cfm/per)	(cfm/ft^2)	(cfm)		(cfm)
1	Corridor	R1C1,R1C2	S4	1050	525	250	525	2	0	0.06	32	1	32
1	Animal Housing Room (AHR)	R126F	S15	1675	1675	Actual #	750	12	7.5	0.18	225	1	225
1	Animal Housing Room (AHR)	R126H	S12	1675	1675	Actual #	750	12	7.5	0.18	225	1	225
1	Animal Housing Room (AHR)	R126J	S8	1675	1675	Actual #	750	12	7.5	0.18	225	1	225
1	Feed Storage	R134	S3	300	300	200	160	1	0	0.12	19	1	19
1	Sterile Corridor + Janitor Closet	R1C5, R136	S47,S39	1375	1375	250	1030	4	0	0.06	62	1	62
1	Small AHR	R126B	S21	1230	1230	Actual #	125	4	7.5	0.18	53	1	53
1	Small AHR	R136C	S22	1230	1230	Actual #	125	4	7.5	0.18	53	1	53
1	Small AHR	R126D	S23	1180	1180	Actual #	115	4	7.5	0.18	51	1	51
1	Small AHR	R126A	S20	1180	1180	Actual #	115	4	7.5	0.18	51	1	51
1	Small AHR	R126K	S9	1190	1190	Actual #	100	4	7.5	0.18	48	1	48
1	Small AHR	R126G	S13	1180	1180	Actual #	135	4	7.5	0.18	54	1	54
1	Procedure Room	R126FA	S14	1180	1180	Actual #	160	4	10	0.18	69	1	69
1	Procedure Room	R126JA	S11	1100	1100	Actual #	130	4	10	0.18	63	1	63
1	Procedure Room	R126HA	S10	1100	1100	Actual #	130	4	10	0.18	63	1	63
1	Vestibule	R126	S17	125	125	250	110	0	0	0.06	7	1	7
1	Storage	R124	S18	100	100	200	115	1	0	0.12	14	1	14
1	Corridor + Janitor Closet	R1C4,R126E	S24,S1	725	725	250	800	3	0	0.06	48	1	48
1	Gown	R128	S26	175	175	100	165	2	10	0.18	46	1	46
1	Sterile Corridor	R1C5	S27	800	800	250	275	1	0	0.18	50	1	50
1	Storage	R130	S28	100	100	200	100	1	0	0.12	12	1	12
1	Elevator Machine Room	R138C	S56	800	400	N/A	120	0	0	0	0	1	0
1	Domestic Pump	R138B	S58	425	225	N/A	145	0	0	0	0	1	0
1	Fire Pump	R138A	S59	150	75	N/A	115	0	0	0	0	1	0
1	Vestibule + Corridor	R138,R1C6	S60	200	200	250	150	1	0	0.06	9	1	9
1	Sterile Pass Through	R140	S61	750	750	250	160	1	0	0.18	29	1	29
1	Pass Through	R119B	S5	575	575	250	145	1	0	0.06	9	1	9
1	Staging	R137	S54	600	600	250	190	1	0	0.06	11	1	11
1	Decon Storage	R119A	S52	800	800	250	500	2	0	0.12	60	1	60
1	Fire Command	R117	S57	400	200	100	195	2	5	0.06	21	1	21
1	Mechanical	R113	S51	750	375	N/A	150	0	0	0	0	1	0
1	Electrical	R112	S6	600	300	N/A	125	0	0	0	0	1	0
1	IDF	R110	S7	425	225	N/A	80	0	0	0	0	1	0
1	Office	R108	S50	175	100	100	75	1	5	0.06	8	1	8
1	Office	R106	S49	175	100	100	75	1	5	0.06	8	1	8

System 1: AHU-A.1a, AHU-A.1b, AHU-A.1c, AHU-A.1d				CFM		Design Occupancy	Area	P_z	R_p	R_a	V_{bz}	E_z	V_{oz}
Level	Space	Room #'s	Box	Max	Min	(ft^2/person)	(ft^2)	Occup.	(cfm/per)	(cfm/ft^2)	(cfm)		(cfm)
1	Storage	R116	S48	200	200	200	175	1	0	0.12	21	1	21
1	Office	R104B	S42	175	100	100	85	1	5	0.06	9	1	9
1	Meeting	R104A	S43	175	100	25	85	3	5	0.06	22	1	22
1	Corridor		S41	100	100	250	90	0	0	0.06	5	1	5
1	Women's Locker Room	R102B	S35	650	650	100	340	3	10	0.12	75	1	75
1	Men's Locker Room	R102A	S36	650	650	100	340	3	10	0.12	75	1	75
1	Corridor	R102	S29	400	400	250	125	1	0	0.06	8	1	8
1	Break / Training	R102C	S30	1450	725	25	535	21	5	0.06	139	1	139
1	Dirty Corridor + Janitor Closet	R1C3,R114	S31,S44	1400	1400	250	1510	6	0	0.06	91	1	91
1	Sterile Cage + Bottle Processing	R133,R133A	S46	2850	1425	200	1125	6	10	0.18	259	1	259
1	Dirty Cage + Dirty Bottle	R123,R121	S45	3625	1825	200	1400	7	10	0.18	322	1	322
1	Clean Cage	R123	S33	3750	1875	200	1450	7	10	0.18	334	1	334
1	Robotic Transition (Clean to Dirty)	R123	S32	1200	1200	200	384	2	10	0.18	88	1	88
2	Janitor Closet + Vestibule (2) + Dirty Corridor	R200,R2C1,R201,R202	S3	1150	1150	250	1150	5	0	0.06	69	1	69
2	Procedure Room	R204A	S22	400	400	Actual #	135	4	10	0.18	64	1	64
2	Procedure Room	R204B	S21	1100	1100	Actual #	135	4	10	0.18	64	1	64
2	Animal Housing Room (AHR)	R204	S23	1675	1675	Actual #	655	14	7.5	0.18	223	1	223
2	Procedure Room	R208A	S26	400	400	Actual #	115	4	10	0.18	61	1	61
2	Procedure Room	R208B	S24	1100	1100	Actual #	115	4	10	0.18	61	1	61
2	Animal Housing Room (AHR)	R208	S25	1675	1675	Actual #	655	14	7.5	0.18	223	1	223
2	Procedure Room	R210B	S29	400	400	Actual #	130	4	10	0.18	63	1	63
2	Procedure Room	R210A	S30	1100	1100	Actual #	130	4	10	0.18	63	1	63
2	Animal Housing Room (AHR)	R210	S27	1675	1675	Actual #	655	14	7.5	0.18	223	1	223
2	Vestibule + Sterile Corridor + Janitor Closet	R211,R2C5,R213	S28	700	700	250	650	3	0	0.06	39	1	39
2	Procedure Room	R209B	S11	1100	1100	Actual #	105	4	10	0.18	59	1	59
2	Procedure Room	R209A	S10	350	350	Actual #	105	4	10	0.18	59	1	59
2	Animal Housing Room (AHR)	R209	S8	1400	1400	Actual #	570	14	7.5	0.18	208	1	208
2	Animal Housing Room (AHR)	R207	S7	850	850	Actual #	330	14	7.5	0.18	164	1	164
2	Procedure Room	R207A	S4	1100	1100	Actual #		4	10	0.18	40	1	40
2	Corridor	R2C6	S6	650	650	250	625	3	0	0.06	38	1	38
2	Animal Housing Room (AHR)	R203	S5	1400	1400	Actual #	540	14	7.5	0.18	202	1	202
2	Procedure Room	R203A	S2	1100	1100	Actual #	105	4	10	0.18	59	1	59
2	Procedure Room	R203B	S1	350	350	Actual #	105	4	10	0.18	59	1	59
2	Procedure Room	R224A	S33	400	400	Actual #	125	4	10	0.18	63	1	63
2	Procedure Room	R224B	S32	1100	1100	Actual #	125	4	10	0.18	63	1	63

System 1: AHU-A.1a, AHU-A.1b, AHU-A.1c, AHU-A.1d				CFM		Design Occupancy	Area	P_z	R_p	R_a	V_{bz}	E_z	V_{oz}
Level	Space	Room #'s	Box	Max	Min	(ft^2/person)	(ft^2)	Occup.	(cfm/per)	(cfm/ft^2)	(cfm)		(cfm)
2	Animal Housing Room (AHR)	R224	S34	1675	1675	Actual #	650	14	7.5	0.18	222	1	222
2	Procedure Room	R228A	S37	400	400	Actual #	130	4	10	0.18	63	1	63
2	Procedure Room	R228B	S35	1100	1100	Actual #	130	4	10	0.18	63	1	63
2	Animal Housing Room (AHR)	R228	S36	1975	1975	Actual #	750	14	7.5	0.18	240	1	240
2	Procedure Room	R230B	S40	400	400	Actual #	125	4	10	0.18	63	1	63
2	Procedure Room	R230A	S41	1100	1100	Actual #	125	4	10	0.18	63	1	63
2	Animal Housing Room (AHR)	R230	S38	1675	1675	Actual #	655	14	7.5	0.18	223	1	223
2	Vestibule + Sterile Corridor	R225,R2C5	S39	650	650	250	630	3	0	0.18	113	1	113
2	Corridor	R2C4	S47	650	650	250	650	3	0	0.06	39	1	39
2	Dirty Corridor	R2C1	S42	650	650	250	660	3	0	0.06	40	1	40
2	Procedure Room	R223A	S46	1100	1100	Actual #	125	4	10	0.18	63	1	63
2	Procedure Room	R223B	S43	400	400	Actual #	125	4	10	0.18	63	1	63
2	Animal Housing Room (AHR)	R223	S45	1675	1675	Actual #	650	14	7.5	0.18	222	1	222
2	Procedure Room	R227A	S44	1100	1100	Actual #	105	4	10	0.18	59	1	59
2	Procedure Room	R227B	S48	350	350	Actual #	105	4	10	0.18	59	1	59
2	Animal Housing Room (AHR)	R227	S49	1675	1675	Actual #	655	14	7.5	0.18	223	1	223
2	Procedure Room	R229B	S52	1100	1100	Actual #	125	4	10	0.18	63	1	63
2	Procedure Room	R229A	S51	400	400	Actual #	125	4	10	0.18	63	1	63
2	Animal Housing Room (AHR)	R229	S50	1675	1675	Actual #	655	14	7.5	0.18	223	1	223
2	Sterile Corridor	R2C5	S53	650	650	250	475	2	0	0.18	86	1	86
2	Procedure Room	R240A	S13	1100	1100	Actual #	190	4	10	0.18	74	1	74
2	Animal Housing Room (AHR)	R240	S12	1100	1100	Actual #	740	14	7.5	0.18	238	1	238
2	Animal Housing Room (AHR)	R238	S14	1400	1400	Actual #	546	14	7.5	0.18	203	1	203
2	Procedure Room	R238A	S17	350	350	Actual #	105	4	10	0.18	59	1	59
2	Procedure Room	R238B	S15	1100	1100	Actual #	105	4	10	0.18	59	1	59
2	Animal Housing Room (AHR)	R234	S16	1400	1400	Actual #	555	14	7.5	0.18	205	1	205
2	Procedure Room	R234A	S19	350	350	Actual #	105	4	10	0.18	59	1	59
2	Procedure Room	R234B	S20	1100	1100	Actual #	105	4	10	0.18	59	1	59
2	Storage + Irradiator	R247,R245	S55	400	400	200	300	2	0	0.12	36	1	36
2	Feed Storage	R243	S56	350	350	200	100	1	0	0.12	12	1	12
2	Vestibule	R232	S18	800	800	250	395	2	0	0.06	24	1	24
2	Dirty Staging	R233	S62	350	350	250	275	1	0	0.06	17	1	17
2	Corridor + Toilet	R2C2,R239	S57	450	450	250	900	4	0	0.06	54	1	54
2	Gown	R237	S58	300	300	100	145	1	10	0.18	41	1	41
2	IDF	R237A	S59	925	0	N/A	85	0	0	0	0	1	0
2	Storage	R237B	S60	200	200	200	105	1	0	0.06	6	1	6
2	Elevator Lobby	R235	S64	450	450	250	315	1	0	0.06	19	1	19

System 1: AHU-A.1a, AHU-A.1b, AHU-A.1c, AHU-A.1d				CFM		Design Occupancy	Area	P_z	R_p	R_a	V_{bz}	E_z	V_{oz}
Level	Space	Room #'s	Box	Max	Min	(ft^2/person)	(ft^2)	Occup.	(cfm/per)	(cfm/ft^2)	(cfm)		(cfm)
2	Electrical	R237C	S63	600	0	N/A	130	0	0	0	0	1	0
												V_{ot}=	8651

System 2: AHU-L.2a, AHU-L.2b				CFM		Design Occupancy	Area	P_z	R_p	R_a	V_{bz}	E_z	V_{oz}
Level	Space	Room #'s	Box	Max	Min	(ft^2/person)	(ft^2)	Occup.	(cfm/per)	(cfm/ft^2)	(cfm)		(cfm)
4-8	Lab Support	R436	S20	550	275	100	225	2	10	0.18	63	1	63
4-8	Microscopy	R456	S21	175	100	100	50	1	10	0.18	14	1	14
4-8	Lab Workstation	R450	S24	850	425	100	290	3	10	0.18	81	1	81
4-8	Lab Workstation	R430	S27	850	425	100	290	3	10	0.18	81	1	81
4-8	Microscopy	R437	S28	175	100	100	50	1	10	0.18	14	1	14
4-8	Research Lab	R451	S29	800	400	100	515	5	10	0.18	144	1	144
4-8	Research Lab	R431	S30	800	400	100	515	5	10	0.18	144	1	144
4-8	Lab Support	R455	S31	550	275	100	225	2	10	0.18	63	1	63
4-8	Research Lab	R451	S32	1600	800	100	1005	10	10	0.18	281	1	281
4-8	Research Lab	R431	S33	1600	800	100	1005	10	10	0.18	281	1	281
4-8	Equipment Room	R438	S34	700	350	100	285	3	10	0.18	80	1	80
4-8	Tissue Culture	R454	S35	350	175	100	135	1	10	0.18	38	1	38
4-8	Tissue Culture	R439	S36	350	175	100	135	1	10	0.18	38	1	38
4-8	Fume Hood	R440	S37	750	750	100	135	1	10	0.18	38	1	38
4-8	Fume Hood	R453	S38	750	750	100	135	1	10	0.18	38	1	38
4-8	Dark Room/Processing	R442,R442A	S39	125	125	100	165	2	5	0.12	28	1	28
4-8	Microscopy	R452	S40	175	100	100	50	1	10	0.18	14	1	14
4-8	Microscopy	R441	S41	175	100	100	50	1	10	0.18	14	1	14
4-8	Lab Workstation	R450	S42	1700	850	100	585	6	10	0.18	164	1	164
4-8	Lab Workstation	R430	S43	1700	850	100	585	6	10	0.18	164	1	164
4-8	IDF	R464	S44	925	475	N/A	105	0	0	0	0	1	0
4-8	Electrical	R467	S46	725	375	N/A	140	0	0	0	0	1	0
4-8	Lab	R461	S48	1000	500	100	335	3	10	0.18	94	1	94
4-8	Chemical Storage	R463	S49	250	250	200	130	1	0	0.18	23	1	23
4-8	Corridor	R4C3,R4C2	S49,FCU1	1200	1200	250	635	3	0	0.06	38	1	38
4-8	Corridor	R4C2	FCU-1	800	800	250	375	2	0	0.06	23	1	23
4-8	Corridor	R4C2,R4C5	FCU1,S50	1200	1200	250	575	2	0	0.06	35	1	35
											Per Floor V_{ot}=		1995
											Σ of 5 Floors V_{ot}=		9973

* Levels 4 through 8 are repeating floors, so the results for one floor's total outdoor air requirement can be multiplied by 5 to find for entire system.

System 3: AHU-L.1a, AHU-L.1b				CFM		Design Occupancy	Area	P_z	R_p	R_a	V_{bz}	E_z	V_{oz}	Z_p	D*	V_{ou}
Level	Space	Room #'s	Box	Max	Min	(ft^2/person)	(ft^2)	Occup.	(cfm/per)	(cfm/ft^2)	(cfm)		(cfm)			**(cfm)**
1	Lobby + Elevator Lobby	R100,R100B	S2	2350	1175	250	575	2	0	0.06	35	1	35	0.029	1	35
1	Corridor	R1C1	S40	1500	750	250	540	2	0	0.06	32	1	32	0.043	1	32
4-8	Meeting Room		S1	700	350	25	230	9	5	0.06	60	1	60	0.171	1	60
4-8	Office (3)	R402-R404	S2	850	425	100	385	4	5	0.06	42	1	42	0.100	1	42
4-8	Interaction space/Elevator Lobby	R400B,R400A	S3,S12	1400	1400	200	1615	8	0	0.06	97	1	97	0.069	1	97
4-8	Office (4)		S4	1100	550	100	460	5	5	0.06	51	1	51	0.092	1	51
4-8	Conference Room	R408	S5	1000	500	25	625	25	5	0.06	163	1	163	0.325	1	163
4-8	Corridor/Open Office	R4C7.R421,R4C1	S6	675	350	150	750	5	5	0.06	70	1	70	0.200	1	70
4-8	Corridor/Open Office	R4C6	S7	625	325	100	640	6	5	0.06	70	1	70	0.217	1	70
4-8	Office (3)	R411-R413	S8	825	425	100	350	4	5	0.06	39	1	39	0.091	1	39
4-8	Meeting Room	R414	S9	700	350	25	230	9	5	0.06	60	1	60	0.171	1	60
4-8	Office (3)	R415-R417	S10	975	500	100	345	3	5	0.06	38	1	38	0.076	1	38
4-8	Men's Restroom/Women's Restroom	R418,R419	S11	500	500	N/A	320	0	0	0.06	19	1	19	0.038	1	19
4-8	Interaction space/Break Area	R422,R400C	S12	700	700	25	785	31	5	0.06	204	1	204	0.292	1	204
4-8	Lab Support	R432	S13	350	175	100	140	1	10	0.18	39	1	39	0.224	1	39
4-8	Fume Hood	R458	S14	750	750	100	135	1	10	0.18	38	1	38	0.050	1	38
4-8	Fume Hood	R433	S15	750	750	100	135	1	10	0.18	38	1	38	0.050	1	38
4-8	Lab Support	R459	S16	350	175	100	140	1	10	0.18	39	1	39	0.224	1	39
4-8	Equipment Room	R434	S17	700	350	100	285	3	10	0.18	80	1	80	0.228	1	80
4-8	Tissue Culture	R457	S18	350	175	100	135	1	10	0.18	38	1	38	0.216	1	38
4-8	Tissue Culture	R435	S19	350	175	100	135	1	10	0.18	38	1	38	0.216	1	38
4-8	Research Lab	R451	S22	1600	800	100	1005	10	10	0.18	281	1	281	0.352	1	281
4-8	Lab Workstation	R450	S23	1700	850	100	585	6	10	0.18	164	1	164	0.193	1	164
4-8	Research Lab	R431	S25	1600	800	100	1005	10	10	0.18	281	1	281	0.352	1	281
4-8	Lab Workstation	R430	S26	1700	850	100	585	6	10	0.18	164	1	164	0.193	1	164

Max Z_p =	0.352
E_v =	0.8
Per Floor V_{ou}=	2179
System V_{ou}=	10894
System V_{ot}=	13618

* Diversity is 1 due there being no variation in design occupancy according to design narratives supplied by owner