Mechanical Technical Assignment One
ASHRAE Standard 62.1-2007 Compliance Evaluation

The Hospital for Special Surgery River Building
New York, New York

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1 Executive Summary

ANSI/ASHRAE Standard 62.1 – 2007, ventilation for acceptable indoor air quality sets forth measures "to provide indoor air quality that is acceptable to human occupants and that minimizes adverse health effects. Specifically, Section 6 describes how to calculate the minimum amount of outdoor air that is needed in each zone of the building. Standard 62.1 Section 5 on the other hand, sets forth measures to comply mechanical systems and equipment for acceptable air quality. The purpose of this report is to analyze and conclude whether or not the Hospital for Special Surgery River Building (HSS River Building) in New York, New York complies with ASHRAE standard 62.1-2007 Section 6 and as much of section 5 with the information available.

The HSS River Building is a 90,000 [ft^2]12 story building on the upper east side of Manhattan built on top of the FDR highway. It has office spaces functioning as exam, evaluation, and X-Ray rooms along with a rehabilitation gym and therapy space on the second floor. The building has (1) 100% Outdoor Air - Air Handling Unit (McQuay Vision Air Handler) feeding multiple zones. Each zone consists of a concealed ceiling water source heat pump conditioning and mixing the outdoor air and room air.

The results conclude that the HSS River Building complies with ASHRAE Standard 62.1-2007 Section 6 requirements. Calculations show a minimum outdoor air of 10,500 [cfm] is needed when in actuality the unit is designed for 13,000 [cfm] . This difference in value was because the design conditions for the building used more [cfm/person] of outdoor air than ASHRAE standard 62.1.

The results also conclude that the HSS River Building complies with ASHRAE Standard 62.1-2007 Section 5 as well. From the building mechanical specifications, the River Building complies to prevent mold growth, condensation on interior surfaces, and particulate filtration. From the mechanical drawings, the River Building complies to prevent re-entry of contaminated air, equipment clearance, and ventilation equipment access.

2 Mechanical System Overview

Description of the overall mechanical system

The HSS River Building has (1) McQuay Vision Air-Handler supplying 100% outdoor air serving multiple zones per floor in the building. The unit provides the outdoor air requirement for the entire (11) occupied floors. In each zone, the air is mixed with the outdoor air and conditioned by a terminal water-to-air heat pump. The building exhausts all restroom and locker areas along with highway exhaust from the FDR on the first floor.

(3) water-to-water heat pumps provide simultaneous cooling and heating to individual zones on each floor. The fluid used in the heat pump loop system is a mixture of water and 35% glycol. The loop consists of (1) 375 ton cooling tower and (2) 3,000MBH heat exchangers to provide additional cooling or heating when the temperature range of the (3) heat pumps are not sufficient to cool or heat the building. The cooling tower is a closed loop system that does not allow the water and glycol mixture to be released into the atmosphere. A chemical treatment system is also in place to purify and clean any impurities and debris from the fluid system.

Con Edison, the utility provider for the HSS River Building provides high pressure steam for the building. The steam is used by the air handling unit, cooling tower, and heat exchangers in the mechanical system. The high pressure steam is first stepped down by (2) Pressure Reducing Valves (PRV) and then distributed to the air handling unit to provide preheat during the winter and dehumidification for the summer. The low pressure steam is used in the cooling tower to provide heat to the basin sink so that the water does not freeze in the winter. And lastly, the low pressure steam is used in the heat exchangers to provide additional heat for the heat pump loop system.

3 Assumptions

Assumptions made while applying ASHRAE 62.1-2007

ASHRAE Standard 62.1-2007 assumes that outdoor air supplied is distanced away from any exhaust from the building to ensure that outdoor air supply is acceptable.

- Architectural furniture plans for each room provided the correct design occupancy value ($\mathbf{P_z}$)
- Architectural floor plans provided the zone floor area ($\mathbf{A_z}$).
- Zone air distribution effectiveness ($\mathbf{E_z}$) is **1.0** since the system contains "ceiling supply of cool air".
- The zone primary air floor ($\mathbf{V_{pz}}$) is the amount of air being supplied through diffusers to each zone.
- Occupancy diversity (**D**) is **1.0** to be conservative as the system population is not known.
- Due to the fact that floors 3 through 9 have the same layout and function, floor 3 will be calculated and multiplied to avoid redundancy.
- Exam, evaluation, and X-Ray rooms are assumed as office spaces because the room will be used for proctoring medical examinations.
- Changing rooms were assumed as office spaces because the rooms are provided for patients to change into garments necessary for medical diagnoses and not from an intense exercise.
- Locker rooms were assumed as healthcare aerobic gym spaces.
- Mechanical rooms, restrooms, janitor closets, and soiled rooms are exempt from the calculations since no outdoor air was supplied to those rooms.

4 Procedure

Steps taken to comply with ASHRAE 62.1-2007, Section 6

The procedure used for determining outdoor air intake flow (V_{ot}) of the air handling unit followed section 6 of ASHRAE 62.1-2007. Steps are described below and refer to assumptions on page 4 when necessary.

Step 1 Find floor areas (A_z), zone population (P_z) and design air supply for each room (V_{pz}).

Step 2 Calculate the Breathing Zone Outdoor Airflow (V_{bz}).

$$V_{bz} = R_p \cdot P_z + R_a \cdot A_z \quad \text{(Eq. 6-1)}$$

Where:

R_p: Outdoor airflow rate required per person as determined from Table 6-1.

R_a: Outdoor airflow rate required per unit area (square feet) as determined from Table 6-1.

Step 3 Determine the Zone Air Distribution Effectiveness (E_z).

Table 6-2 Zone Distribution Effectiveness	
Air Distribution Configuration	Ez
Ceiling supply cool air	1.0

From Table 6-2, a value of 1.0 for (E_z) is defined as a system with a ceiling supply of cool air.

Step 4 Calculate the Zone Outdoor Airflow (**Voz**).

$$V_{oz} = V_{bz} / E_z \quad \text{(Eq. 6-2)}$$

Step 5 Calculate the zone primary outdoor air fraction (Z_p).

$$Z_p = V_{oz} / V_{pz} \quad \text{(Eq. 6-4)}$$

Step 6 Determine the System Ventilation Efficiency (E_v).

Table 6-3 System Ventilation Efficiency	
Max (Zp)	Ev
≤0.25	0.9

From Table 6-3, a value of 0.9 for ($\mathbf{E_v}$) is defined as a maximum ($\mathbf{Z_p}$) value of <0.25.

Step 7 Determine Occupant diversity (**D**).

For being conservative, an occupant diversity value of 1.0 was used since the system population was unknown.

Step 8 Calculate the Uncorrected outdoor air intake ($\mathbf{V_{ou}}$)

$$\mathbf{V_{ou} = D\sum_{all\ zones}(R_p \bullet P_z) + \sum_{all\ zones}(R_a \bullet A_{pz})} \quad \textbf{(Eq. 6-6)}$$

Step 9 Calculate outdoor air intake ($\mathbf{V_{ot}}$).

$$\mathbf{V_{ot} = V_{ou}/E_v} \quad \textbf{(Eq. 6-8)}$$

5 Calculations

Supporting sample calculation to demonstrate compliance to ASHRAE 62.1-2007 procedures.

To demonstrate that the HSS River building complies with ASHRAE 62.1-2007, a single zone will be used to show how the numbers were calculated. Please refer to the assumptions on page 4 and the ventilation calculation chart in appendix a for values.

Step 1 Find floor areas ($\mathbf{A_z}$), zone population ($\mathbf{P_z}$), and zone primary air flow ($\mathbf{V_{pz}}$)

Rehabilitation Equipment Gym:
$\mathbf{A_z}$: 3574 [ft^2]**, $\mathbf{P_z}$: 40** [people]**, $\mathbf{V_{pz}}$: 5800** [cfm]

Step 2 Calculate the Breathing Zone Outdoor Airflow ($\mathbf{V_{bz}}$)

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

Function: Health Club/ Aerobics
R_p: 20 [cfm/person]
R_a: 0.06 [cfm/ft^2]

$$\mathbf{V_{bz} = (20) \bullet (40) + (0.06) \bullet (3574) = 1{,}014}\ \text{[cfm]}$$

Step 3 Determine the Zone Air Distribution Effectiveness ($\mathbf{E_z}$)

E_z = 1.0

Step 4 Calculate the Zone Outdoor Airflow ($\mathbf{V_{oz}}$)

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

V_{oz} = 1,014/1.0 = 1,014 [cfm]

Step 5 Calculate the zone primary outdoor air fraction ($\mathbf{Z_p}$)

Z_p = Voz/Vpz

Z_p = 1,014/5800 = .17

Step 6 Determine the System Ventilation Efficiency ($\mathbf{E_v}$)

From Table 6-3, a value of 0.9 for Ev is defined as for a maximum Zp value of <0.25.

Step 8 Calculate the Uncorrected outdoor air intake ($\mathbf{V_{ou}}$)

$Vou = D\sum_{all\ zones}(R_p \bullet P_z) + \sum_{all\ zones}(R_a \bullet A_{pz})$

V_{ou} = (1)[1255+9(375)] + [518+10(532)] = 10,468 [cfm]

Since floor levels 3 through 12 have the same function and layout, floor 3 was calculated and then multiplied by 10 to account for floors 3 through 12. Floor 2 had a different function and layout and was calculated separately.

Step 9 Calculate the outdoor air intake ($\mathbf{V_{ot}}$).

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

V_{ot}= 8,122/0.9 = 9,000 [cfm]

6 Discussion of Results

In conclusion, the Hospital for Special Surgery River Building complies with ASHRAE 62.1-2007 section 6 as the amount of nominal outdoor air of 13,000 [cfm] is more than the 10,500 [cfm] required. The difference of air intake can be accounted for as Cannon Design uses a more stringent design criterion for calculating their outdoor air than ASHRAE 62.1-2008. Instead of 5 [cfm/person] for office spaces as specified in ASHRAE, Cannon Design provides 20 [cfm/person].

The HSS River building also complies with ASHRAE 62.1-2007 section 5. Important issues such as mold growth, re-entry of contaminated air, and particulate filtration were verified to comply. Compliance of outdoor air intake location was verified and demonstrated in Appendix B (page 12) as the location of the outdoor air intake meets the minimum distance from exhausts specified in Table 5-1. The mechanical system also complies with resistance to mold growth. Section 15892-Mechanical Cleaning of HVAC Systems in the specifications states that the ductwork shall be coated to be resistant to fungus and resistant to erosion. Compliance in particulate matter removal was also verified in section 15885 – Air Cleaning of the specifications stating compliance to ANSI/ASHRAE 52.2-1992 and having only filters of MERV 7 or higher. The building also complies with other portions of section 5 such as equipment clearance, and ventilation equipment access from the unit cut sheets and schedule.

7 References

ASHRAE. 2007, ANSI/ASHRAE, Standard 62.1 – 2007, Ventilation for Acceptable Indoor Air Quality. American Society of Heating Refrigeration and Air Conditioning Engineers, Inc., Atlanta, GA. 2007.

Cannon Design. 2007. Mechanical Documents. Cannon Design, New York, New York. 2007

Appendix A – Ventilation Calculations - Floor 2

Room Number	Room Name	Function	Az	Pz	Rp	Ra	Pz*Rp	Az*Ra	Voz	Vpz	Zp
200	Lobby	Lobby	400	1	5	0.06	5	24	29	500	0.06
202	Waiting Area	Reception	460	10	5	0.06	50	28	78	550	0.14
202A	Reception	Reception	180	2	5	0.06	10	11	21	200	0.10
203	Admin	Office Space	315	1	5	0.06	5	19	24	250	0.10
204	Consultation	Office Space	170	4	5	0.06	20	10	30	450	0.07
206	Interview	Office Space	264	4	5	0.06	20	16	36	750	0.05
207	Charting	Office Space	385	8	5	0.06	40	23	63	1050	0.06
208/209	Locker room	Health Club/Aerobics	870	8	20	0.06	160	52	212	900	0.24
210	Rehab Equip Gym	Health Club/Aerobics	3574	40	20	0.06	800	214	1014	5800	0.17
211	Eval	Office Space	82	2	5	0.06	10	5	15	115	0.13
212	Eval	Office Space	82	2	5	0.06	10	5	15	115	0.13
213	Eval	Office Space	82	2	5	0.06	10	5	15	115	0.13
214	Eval	Office Space	82	2	5	0.06	10	5	15	115	0.13
215	Eval	Office Space	82	2	5	0.06	10	5	15	115	0.13
216	Hydrotherapy	Health Club/Aerobics	430	2	20	0.06	40	26	66	650	0.10
221	Massage Therapy	Health Club/Aerobics	117	2	20	0.06	40	7	47	250	0.19
222	Staff Lounge	Conference	200	3	5	0.06	15	12	27	500	0.05
223	Equip Storage	Storage	88	0	0	0.12	0	11	11	100	0.11
225	Corridor	Corridor	210	1	0	0.06	0	13	13	100	0.13
228	Elec Closet	Eletrical Equip Room	80	0	0	0.06	0	5	5	175	0.03
229	Storage	Storage	100	0	0	0.12	0	12	12	100	0.12
230	Telecom Closet	Telephone Closets	39	0	0	0	0	0	0	100	0.00
231	Corridor	Corridor	200	1	0	0.06	0	12	12	100	0.12
		Totals	**8492**	**97**			**1255**	**518**	**1773**		

Appendix A – Ventilation Calculations – Floors 3-12

Room Number	Room Name	Function	Az	Pz	Rp	Ra	Pz*Rp	Az*Ra	Voz	Vpz	Zp
300	Lobby	Lobby	229	1	5	0.06	5	14	19	200	0.09
301	Waiting	Reception	722	15	5	0.06	75	43	118	1225	0.10
302	Corridor	Corridor	215	1	0	0.06	0	13	13	225	0.06
303	Corridor	Corridor	374	1	0	0.06	0	22	22	250	0.09
304	Corridor	Corridor	170	1	0	0.06	0	10	10	75	0.14
305	Corridor	Corridor	209	1	0	0.06	0	13	13	125	0.10
306	Corridor	Corridor	600	1	0	0.06	0	36	36	175	0.21
307	Staff Work	Break rooms	108	1	5	0.06	5	6	11	275	0.04
308	Exam	Office Space	102	1	5	0.06	5	6	11	275	0.04
309	Exam	Office Space	102	1	5	0.06	5	6	11	275	0.04
310	Exam	Office Space	102	1	5	0.06	5	6	11	275	0.04
311	Office	Office Space	240	1	5	0.06	5	14	19	600	0.03
312	Admin	Office Space	221	3	5	0.06	15	13	28	325	0.09
313	Admin	Office Space	213	3	5	0.06	15	13	28	650	0.04
314	Office	Office Space	170	1	5	0.06	5	10	15	350	0.04
315	Office	Office Space	170	1	5	0.06	5	10	15	350	0.04
316	Admin	Office Space	213	3	5	0.06	15	13	28	650	0.04
317	Admin	Office Space	213	3	5	0.06	15	13	28	650	0.04
318	Office	Office Space	234	1	5	0.06	5	14	19	550	0.03
319	Office	Office Space	216	1	5	0.06	5	13	18	275	0.07
320	Admin	Office Space	234	3	5	0.06	15	14	29	625	0.05
321	Admin	Office Space	234	3	5	0.06	15	14	29	625	0.05
322	Office	Office Space	180	1	5	0.06	5	11	16	275	0.06
323	Admin	Office Space	216	3	5	0.06	15	13	28	625	0.04
324	Office	Office Space	156	1	5	0.06	5	9	14	300	0.05
325	Conference	Conference	264	10	5	0.06	50	16	66	500	0.13
327	Corridor	Corridor	286	1	0	0.06	0	17	17	200	0.09
330	Elec Closet	Electrical Eq. Room	80	0	0	0	0	0	0	175	0.00
331	Storage	Storage	100	0	0	0.12	0	12	12	100	0.12
332	Telcom Closet	Telephone Closets	39	0	0	0	0	0	0	100	0.00
336	Changing	Office Space	95	1	5	0.06	5	6	11	50	0.21
339	X-Ray	Office Space	451	1	5	0.06	5	27	32	250	0.13
340	Changing	Office Space	42	1	5	0.06	5	3	8	50	0.15
341	X-Ray	Office Space	451	4	5	0.06	20	27	47	250	0.19
344	Exam	Office Space	105	1	5	0.06	5	6	11	125	0.09
345	Exam	Office Space	100	1	5	0.06	5	6	11	125	0.09
346	Exam	Office Space	100	1	5	0.06	5	6	11	125	0.09
347	Exam	Office Space	100	1	5	0.06	5	6	11	125	0.09
348	Exam	Office Space	99	1	5	0.06	5	6	11	125	0.09
349	Exam	Office Space	140	1	5	0.06	5	8	13	125	0.11
350	Exam	Office Space	96	1	5	0.06	5	6	11	125	0.09
351	Exam	Office Space	96	1	5	0.06	5	6	11	125	0.09
352	Exam	Office Space	96	1	5	0.06	5	6	11	125	0.09
353	Exam	Office Space	96	1	5	0.06	5	6	11	125	0.09
354	Corridor	Corridor	200	1	0	0.06	0	12	12	100	0.12
		Totals	**8,879**				**375**	**532**	**907**		

Appendix B – ASHRAE Table 5.1

Object	Minimum Distance, ft	Actual Distance, ft
Significantly contaminated exhaust	15	15
Noxious or dangerous exhaust	30	Not Applicable
Vents, chimneys, and flues from combustion applicances and equipment	15	Not Applicable
Garage entry, automobile loading area, or drive-in queue	15	158.5
Truck loading area or dock, bus parking/idling area	25	Not Applicable
Driveway, street, or parking place	5	158.5
Thoroughfare with high traffic volume	25	158.5
Roof, landscaped grade, or other surface directly below intake	1	Not Applicable
Garbage storage/pick-up area, dumpsters	15	Not Applicable
Cooling tower intake or basin	15	30
Cooling tower exhaust	25	28