MECHANICAL OPTION

Hunter's Point South Intermediate School & High School

Long Island City, NY

Technical Report One

ASHRAE Standard 62.1-2007 and Standard 90.1-2007 Analysis

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Executive Summary

The purpose of thesis technical report one is to describe an ASHRAE Standard 62.1-2007 and 90.1-2007 evaluation on the Hunter's Point South Intermediate School & High School. The building is a new schoolhouse for grades 5 through 12 which is located in Long Island City, New York. Hunter's Point South School was commissioned by the NYC School Construction Authority and designed to the guidelines of the NYC Green Schools Guide. Construction of the schoolhouse began recently on January 10th, 2011 and is expected to be complete on October 7th, 2013.

ASHRAE Standard 62.1-2007 lists requirements that must be met for proper indoor air quality for buildings. This includes emphasis on preventing mold growth, hazardous chemical infiltration, proper exhaust, and minimum requirements for ventilation. After reviewing Sections 5 and 6 in the ASHRAE Standard 62.1-2007, it was determined that Hunter's Point South School complies with all the set requirements. Only one grey area exists which is the near proximity of a smoke vent to an air handling unit intake. Proper information could not be found about the control system logic, so it is undetermined if this will pose a possible threat in the event of a fire.

ASHRAE Standard 90.1-2007 deals with energy efficiency of buildings, except for low-rise and residential structures. Energy consumption by buildings in the U.S. is a growing concern. With this in mind, a push has been made to design more energy conscious structures. The building enclosure, lighting, power, and equipment used in Hunter's Point South School have been given special consideration to be more energy efficient. Through investigation, it was found that the majority of the requirements were met for Sections 5 through 10. The building enclosure for the schoolhouse far surpassed the necessary values, except for the roof assembly. The fan power limitations in Section 6 were met by all fans except supply fans in the AHU's. All power distribution and lighting requirements were met. The LPD was far below the maximum value given by the standard. The biggest concern was that none of the pumps' electric motors met efficiency. The centrifugal fans' motors did meet efficiency. Overall, the systems in Hunter's Point South School did very well in comparison with the requirements set in Standard 90.1.

Hunter's Point South Intermediate School & High School faired very well in comparison with ASHRAE Standard 62.1- and 90.1-2007. The school was design intended to reach LEED Silver status. This is quite evident in the energy efficient plan and system selection chosen by the designers. Below a greater in depth analysis as well as detailed breakdowns of the compliance with the two ASHRAE Standards is shown for this report.

Building Overview

Hunter's Point South Intermediate School & High School is a public school for grades 5 through 12 serving the PS 287 Queens School district. Hunters Point is a five story school that will house over 1,000 students. It consists of 26 classrooms, 8 special education classrooms, library, gym, assembly space, cafeteria with open terrace seating, kitchen, and support spaces. The building is a part of the Hunter's Point South Project, a redevelopment of the 30 acre Queens area to become a more sustainable, middle income urban community along the waterfront park. This redevelopment in Queens also includes residential housing, apartments, retail space, community/cultural facilities, parking, and a new 11 acre waterfront park.

Mechanical System Overview

Conditioned air is served to Hunter's Point South Intermediate School & High School via the six rooftop air handling units. Units 1, 2, and 3 are variable air volume (VAV) systems that service the classrooms, offices, corridors, and non-public spaces. Units 4, 5, and 6 are constant air volume (CAV) systems that serve the gymnasium, cafeteria/kitchen, and auditorium, respectively. All air handling units have variable frequency drives, wrap around heat pipes for dehumidification, and economizer controls. Preheat coils in the AHU's use a 35% propylene glycol – water mixture while the cooling coil utilizes a 30% propylene glycol – water mixture. This heat-transfer fluid has low toxicity and volatility. It poses little harm to humans in case of a leak.

Four natural gas fired, condensing boilers are used for Hunter's Point South School's heating needs. These boilers are located in the mechanical penthouse's boiler room. Each boiler can produce 1860 MBH worth of 35% propylene glycol – water mixture which is used for the AHU's, perimeter fin tube radiators, unit heaters, and cabinet heaters. All heating hot water and secondary pumps are located in the boiler room along with the hot and chilled water expansion tanks. Two 276 ton air cooled chillers with scroll compressors are also located on the roof. A 30% propylene glycol – water mixture is cooled by the R-410a refrigerant which is used for the AHU's cooling coils.

Cabinet and unit heaters are used to heat the building's entrances, locker rooms/showers, and stairwells. Split heat pumps are utilized in the telecom rooms on each floor, food storage, and elevator machine room. The outdoor section of each heat pump is located on the roof. Fin tubed radiators are used along the perimeter walls to heat the space in conjunction with AHU's. Upblast and mushroom fans are located on the roof where they exhaust air from the science lab's fume hoods and kitchen.

ASHRAE Standard 62.1-2007 Analysis

Section 5 – Systems and Equipment

5.1 Natural Ventilation

Perimeter rooms have manually operable windows but the building spaces are mechanically ventilated. Natural ventilation is not used.

5.2 Ventilation Air Distribution

Hunter's Point South Intermediate School & High School was designed to comply with Q 1.1R Minimum IAQ Performance/Increased Ventilation from the NYCSA's Green School Guide. It meets minimum ventilation standards set forth in Section 6 of ASHRAE Standard 62.1-2007.

5.3 Exhaust Duct Location

Fume hoods/acid cabinets located in the science classrooms and kitchen hoods each have their own separate ducting for exhaust. The main bathrooms and some locker rooms share common exhaust ducting. All exhaust ducts are negatively pressured to the surrounding spaces to prevent leaks.

5.4 Ventilation System Controls

All six air handling units have two intake dampers for outside air. One is dedicated for minimum outside air while the other is modulated to help reduce energy costs. Variable air volume boxes have minimum turn down for dampers so airflow into the spaces complies with minimum outside air from Section 6 of ASHRAE Standard. 62.1-2007.

5.5 Airstream Surfaces

Duct work is made from sheet metal; aluminum, galvanized steel, and stainless steel with metal fasteners. Therefore duct work complies with the mold growth and erosion resistance outlined in this section. Fiberglass lining for ducts is in compliance with ASTM C1338 (to prevent mold) and UL 181 (to resist erosion). Flexible ducts are made from spiral-wound steel or corrugated aluminum and comply with UL 181.

5.6 Outdoor Air Intakes

All outdoor air intakes for AHU's are over 30 feet away from lab fume hood exhaust vents. AHU's have intake and exhaust outlets on opposite sides, each of which have stormproof louvers or hoods to prevent entrainment of rainwater and an aluminum bird screen. Access doors to AHU's are easily accessible and have as much as an eight foot clearance around them.

The only questionable aspect to the compliance for Hunter's Point South School to this section is a shaft smoke vent which is located eight feet from AHU-2's intake. If AHU-2 is designed to turn off in the event of a fire, then the school is in compliance. However, no information could be found on the controls logistics that would incur during a fire for AHU-2's intake.

5.7 Local Capture of Contaminants

All noncombustion equipment (ex. fume hoods, kitchen equipment, etc.) have separate ducting to the roof with their own dedicated fans. The diesel oil storage tank located on first floor exhausts vapors through a vent brick in the wall.

5.8 Combustion Air

The emergency generator and boilers have direct venting to the atmosphere for their flue gas through the roof and wall louvers of the mechanical roof penthouse. Adequate air is provided to the four gas fired condensing boilers for combustion.

5.9 Particulate Matter Removal

All six AHU's have a set of two filters located upstream of the cooling coil that comply with UL 900-1994. The first filter is a 2" thick, pleated type pre-filter that has a minimum efficiency of MERV 7. The second filter is a 12" thick cartridge filter that has a minimum efficiency of MERV 13.

5.10 Dehumidification Systems

Dehumidification is accomplished by the wrap-around dehumidifier heat pipes in each AHU. Relative humidity is limited below 65 percent by these heat pipes. The minimum outdoor air intake is greater than the minimum exhaust for each air handler, so a positive pressure in the building may be contained during dehumidification processes.

5.11 Drain Pans

The drain pans in the six AHU's extend 1" upstream and 3" downstream of the cooling coils. The pans consist of one-piece seamless stainless steel that is pitched towards the drain outlet. Drain pans for the wrap around dehumidification heat pipes have the same specifications as the ones outlined above for the AHU's cooling coils. All drain pans comply with this section.

5.12 Finned-Tube Coils and Heat Exchangers

Split heat pumps have drain pans with integrated condensate pumps to distribute condensate to the nearest sanitary drain with air gap. The finned tube radiators have 48 fins per foot. The

number of coils varies per radiator, being either 1 or 2 coils. There is no mention of the 18" intervening access space, however the pressure drop is less than 0.75 in wg so the equipment outlined in this section complies.

5.13 Humidifiers and Water-Spray Systems

No humidifiers or water-spray systems are used in Hunter's Point South School. This section does not apply.

5.14 Access for Inspection, Cleaning, and Maintenance

Hunter's Point South School complies with this section. All six AHU's have multiple access doors measuring 24" wide (some 30") by 72" in height. The doors are situated so all required equipment may be serviced, including the wrap-around heat pipes. There is an eight foot clearance around access doors to allow workers plenty of space for inspection and maintenance.

5.15 Building Envelope and Interior Surfaces

The exterior walls of Hunter's Point South contain an air/vapor barrier and crystalline waterproofing which is applied to the CMU blocks. The face brick façade has weeping holes at its base to drain accumulated water. The roof and foundation both use a rubberized asphalt sheet membrane to prevent water infiltration. Ductwork and piping that has the potential to fall below the local dew point will have adequate preventative insulation.

5.16 Buildings with Attached Parking Garages

There is no attached parking garage to Hunter's Point South Intermediate School & High School. This section does not apply.

5.17 Air Classification and Recirculation

The majority of air in Hunter's Point South School is Class 1 air. Class 1 air is returned through the ceiling plenum and recirculated back to the rooftop AHU's where it can be reused or exhausted. Class 1 air is also used to supply the restrooms in the building. Class 2 air from the restrooms and locker rooms is ducted separately and exhausted on the roof. Grease hoods and laboratory hoods exhaust the Class 4 air through their own separate ducts and vents on the roof.

5.18 Requirements for Buildings Containing ETS Areas and ETS-Free Areas

No ETS Areas exist in Hunter's Point South School. This section is irrelevant.

Section 6 – Procedures

The six air handling units used in Hunter's Point South Intermediate School & High School were tested to verify their compliance with ASHRAE Standard 62.1-2007 Section 6 Ventilation Rate Procedure. The individual AHU's service multiple floors which have a variety of spaces. Due to this it was beneficial to break up the zones into single rooms (or grouped rooms when multiple similar occupancy type rooms existed) when analyzing the minimum required ventilation needed. Below are the equations and tables used from ASHRAE Std. 62.1-2007 to complete the Section 6 analysis, along with their variable definitions.

Ventilation Rate Procedure

Breathing Zone Outdoor Airflow (V_{bz}):

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

Where:

V_{bz} = breathing zone outdoor airflow – the design outdoor airflow required in the breathing zone of the occupiable space or spaces in a zone

R_p = outdoor airflow rate required per person (cfm/person), determined from Table 6-1

P_z = zone population – the number of occupants in the space, this can be estimated based on the occupant density in Table 6-1

R_a = outdoor airflow rate required per unit area (cfm/ft^2), determined from Table 6-1

A_z = zone floor area (ft^2)

Zone Air Distribution Effectiveness (E_z):

$$E_z = \# \qquad \text{(From Table 6-2)}$$

Where:

E_z = 1 for ceiling supply of cool air.

All AHU's serve conditioned air to zones through ceiling diffusers. It was assumed that all interior spaces would only need cooling and exterior rooms' heating needs would be supplied by the fin tubed radiators. Therefore an E_z value of 1 was used for all rooms.

Zone Outdoor Airflow (V_{oz}):

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

Where:

V_{oz} = zone outdoor airflow, the outdoor airflow that must be provided to the zone by the supply air distribution system

Zone Primary Outdoor Air Fraction (Z_p):

$$Z_p = V_{oz}/V_{pz} \qquad \text{(Eq. 6-5)}$$

Where:

V_{pz} = zone primary airflow, the primary airflow to the zone from the air handler including outdoor air and recirculated return air

System Ventilation Efficiency (E_v):

Use Table 6-3 to determine E_v, however if max Z_p is greater than 0.55 than Appendix A must be used to compute E_v.

Zone Ventilation Efficiency (E_{vz}) for Single Supply Systems:

$$E_{vz} = 1 + X_s - Z_d \qquad \text{(Eq. A-1)}$$

Where:

X_s = average outdoor air fraction at the primary air handler
$X_s = V_{ou}/V_{ps}$

V_{ou} = uncorrected outdoor air intake

V_{ps} = system primary airflow, the total primary airflow supplied to all zones served by the system from the air handling unit at which the outdoor air intake is located

Z_d = discharge outdoor air fraction

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

V_{dz} = zone discharge airflow, the expected supply airflow to the zone that includes primary airflow and locally recirculated airflow

Uncorrected Outdoor Air Intake (V_{ou}):

$$V_{ou} = D \cdot \sum_{all\ zones}(R_p \cdot P_z) + \sum_{all\ zones}(R_a \cdot A_z) \qquad \text{(Eq. 6-6)}$$

Where:

D = occupant diversity

Occupant Diversity (D):

$$D = P_s/\sum_{all\ zones} P_z \qquad \text{(Eq. 6-7)}$$

Where:

P_s = system population, the total population in the area served by the system

Outdoor Air Intake (V_{ot}):

$$V_{ot} = V_{ou}/E_v \qquad \text{(Eq. 6-8)}$$

Appendix A contains the excel spreadsheets of each air handler's results for minimum outdoor air intake using the above calculations for ventilation. For AHU's 4, 5, and 6, the minimum ventilation supplied to each room is contrasted against the design condition. The NYC Green Schools Guide requires all new schools, such as Hunter's Point South Intermediate School & High School, to be designed to use above 30% minimum ventilation air calculated in ASHRAE Standard 62.1. This is outlined in Q1.1R Minimum IAQ Performance/Increased Ventilation in the NYC Green Schools Guide. This is also a requirement for a LEED point that Hunter's Point South School is pursuing. Compliance with this increase has also been added to the analysis and can be seen Table 1 below.

Occupant density (from Table 6-1) was not used to determine the number of people per space because exact occupant numbers were given in the design. Some assumptions were made based on the occupancy type for rooms where no similar match could be found. These assumptions for occupancy type can be seen in the excel spreadsheets.

For VAV systems, V_{pz} is equal to the minimum turn down for the VAV box. Hs Special Education Room 517 (AHU-2) has a very low turndown for its VAV box. It is so low that the minimum outside air needed will not be met when it is turned down fully, even if supply air is 100% outside air. The Z_p and E_{vz} values calculated for it were disregarded because they created an unrealistic strain on the system's necessary ventilation. The VAV box can supply up to 660 cfm to Room 517. This cfm is more than sufficient for the minimum ventilation. This means that the damper on the VAV box will rarely ever be turned down low for this room, perhaps it will just be turned down during the night when there is no occupancy so as to save on energy costs.

Table 1 below contains the minimum outdoor air intakes and calculated V_{ot} for each AHU. Each AHU surpassed the corresponding calculated V_{ot}. However, AHU's 1 through 3 do not supply the above 30% minimum ventilation required for the LEED's point. This is fairly alarming considering the high priority given to meeting the standards set by the NYC Green Schools Guide and LEED's criteria. AHU's 1 through 3 are all VAV systems with VAV boxes. The minimum outside air intakes were all calculated with the VAV boxes turned down to their minimum supply position. AHU's 1 through 3 do have the ability to supply up to 100% outside air. The ability to supply up to 100% outside air with the combination of a good controls system should allow AHU-1, AHU-2, and AHU-3 to meet the above 30% minimum ventilation.

	Type	Min OA Intake	Vot	Compliant?	30% Above Vot	Above 30% Compliant?
AHU-1	VAV	14945	12218	Yes	15883	No
AHU-2	VAV	19445	18971	Yes	24662	No
AHU-3	VAV	13210	10954	Yes	14240	No
AHU-4	CAV	13360	7085	Yes	9211	Yes
AHU-5	CAV	11840	6259	Yes	8488	Yes
AHU-6	CAV	6325	2657	Yes	3454	Yes

Table 1 – Air Handling Units' Section 6 Compliance

Summary of Analysis for ASHRAE Standard 62.1-2007

Hunter's Point South Intermediate School & High School complied with all the requirements in Section 5. There was only one area that caused concern which was the smoke vent located in close proximity to AHU-2's intake. The requirements for minimum ventilation were greatly surpassed in Section 6 for all AHU's. Three of the AHU's even met the above 30% minimum ventilation for a LEED's credit; the other ones may too depending upon the control system logistics. Hunter's Point South was designed to attain LEED Silver and to the guidelines set up by the NYC Green School Guide. These two governing bodies have helped push the envelope for the efficiency and HVAC design in Hunter's Point South School.

ASHRAE Standard 90.1-2007 Analysis

Section 5 – Building Envelope

5.1.4 Climate Zone

From Figure B-1 and Table B-1 in ASHRAE Standard 90.1-2007 it was determined that Hunter's Point South Intermediate School & High School is located in climate zone 4A. This climate zone is named Mixed-Humid and has roughly 5,400 heating degree days or fewer.

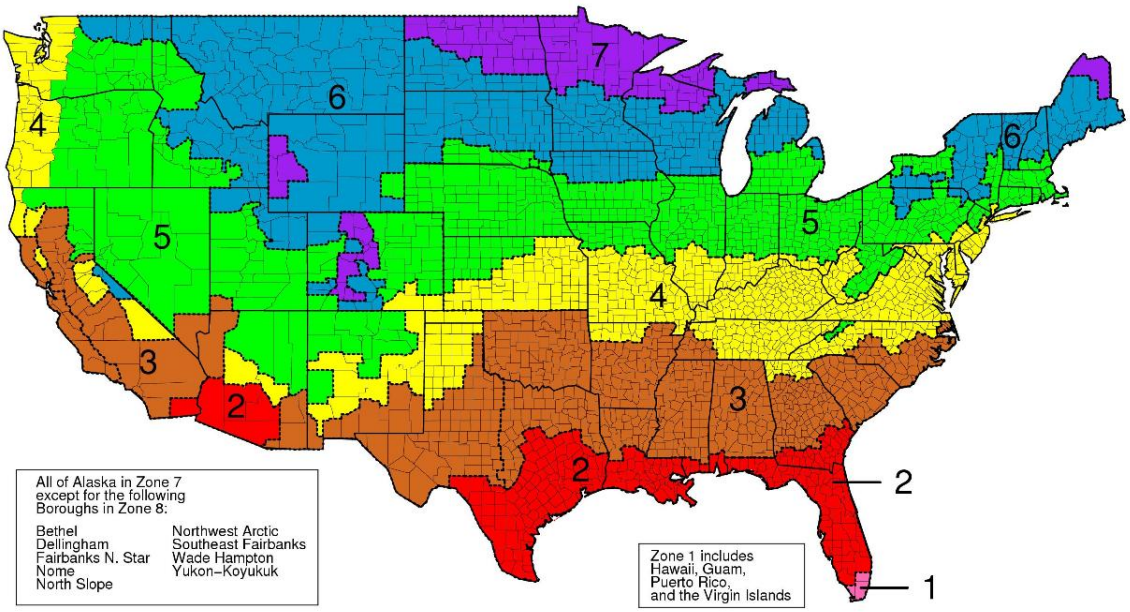

Figure 1 – Climate Regions in the United States

5.4 Mandatory Provisions

Hunter's Point South has two enclosed vestibules located directly across from each other on the north and south side. All the doors open inwards toward the vestibule and have self-closing devices. The closest doors are located roughly eight feet apart so the doors need not be opened at the same time.

5.5 Prescriptive Building Envelope Option

Hunter's Point South School has nonresidential conditioned spaces. Below in Table-2, the compliance for Hunter's Point South School's opaque elements is shown and tested against the corresponding U-values, C-values, and F-values. Fenestration is also shown in Table-2. Note that Hunter's Point South has no basement and thus no walls below grade. No skylights exist in Hunter's Point South either. The Insulated Translucent Sandwich Panel System (ITSPS) and typical windows have both been represented under fenestration. The total building glazing area is calculated and compared in Table-3.

Building Envelope Requirements for Zone 4A					
		Assembly Maximum	Insulation Min. R-Value	Hunter's Point	Standard 90.1-2007 Compliance?
Exterior Opaque Elements:					
Roofs - Insulation Entirely above Deck		U-0.048	R-20.0 c.i.	U-0.05	No
Walls, Above Grade Mass		U-0.104	R-9.5c.i.	U-0.056	Yes
Slab-On-Grade Floors - Unheated		F-0.73	NR	F-0.49	Yes
Fenestration:					
Vertical Glazing - Metal Framing					
	Typical Window	U-0.50	SHGC-0.4	U-0.30, SHGC-0.38	Yes
	ITSPS	U-0.50	SHGC-0.4	U-0.28, SHGC-0.23	Yes

Table 2 – Building Envelope Requirements

	Glazing Area (sf)	Façade Area (sf)	Percent Glazing	Standard 90.1-2007 Compliance?
Hunter's Point South School	16,978	70,080	24.2%	Yes

Table 3 – Vertical Fenestration Area

All exterior features of Hunter's Point South School complied with the maximum assembly values except for the roof, which barely missed compliance. The glazings used in the typical low e-coating windows and insulated translucent sandwich panel system (ITSPS) greatly surpassed the threshold needed. Since Hunter's Point School must follow the NYC Green Schools Guide, it is held too much higher constraints for energy efficiency than the ASHRAE Standard 90.1-2007 contains. The total glazing area of the façade is well under 40% of the building's exterior area. Though some facades are composed of mainly glazing, the all brick façades on the southeast corners balanced this out.

Section 6 – Heating, Ventilating, and Air-Conditioning

6.2 Compliance Path

Hunter's Point South Intermediate School & High School cannot use the Simplified Approach for HVAC Systems because it does not meet the requirements. The school is 153,769 square feet and five stories tall. This is much greater than the 25,000 square feet and two stories restraint needed for Section 6.3. The Mandatory Provisions method shall be used for Hunter's Point South School.

6.4 Mandatory Provisions

Minimum equipment efficiencies are met for the HVAC equipment in Hunter's Point South School. Below in Table 4 are a few examples of the equipment characteristics. The systems used in Hunter's Point South School must abide by the NYC Green School Guide, which is based off of ASHRAE requirements but contain more stringent goals. The values used in Table 3 were pulled from Table 6.8.1A through 6.8.1G in ASHRAE Standard 90.1-2007.

	Required Minimum Efficiency	Hunter's Point South School	ASHRAE 90.1-2007 Compliant?
Air Cooled Water Chiller (with condenser and electrically operated)	COP 2.8	COP 3.25	Yes
Gas-Fired Boiler (hot water)	75%	85.3-93%	Yes
Split Heat Pump (air cooled, cooling mode)	SEER 10.0	EER 13.8	Yes

Table 4 – System Efficiencies

Thermostats in each zone control the heating and cooling needs for the space. For rooms serviced by both VAV boxes and radiators or convectors, the two shall work integrally to control the room conditions. Spaces are maintained at a temperature of 72°F when occupied, with a cooling set point of 78°F and a heating set point of 65°F. Carbon dioxide sensors are used for demand controlled ventilation in the auditorium and gymnasium. All AHU's are equipped with air-side economizers to further save on energy costs. A night time setback temperature of 55°F (heating) or 86°F (cooling) is used so energy is not wasted conditioning the spaces at night.

Table 5 below shows the insulation needed for the different pipes. All ductwork requires 2" rigid fiberglass or flexible fiberglass insulation except for exposed ductwork (with 55°F duct temperature in cooling mode) in finished spaces that they serve and exhaust.

Pipe Insultion Thickness				
	Material	≤1.5"	2"-4"	>4"
Cold Water	Fiberglass	1.0	1.5	1.5
Hot Water	Fiberglass	1.0	2.0	2.0
Refrigerant (-32 to 0°F)	Fiberglass	1.5	2.0	2.0
Refrigerant (0 to 39°F)	Fiberglass	1.0	1.5	1.5

Table 5 – Pipe Insulation Thickness

All duct sealant and their adhesives comply with the South Coast Air Quality Management District (SCAQMD) Rule #1168 and the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA). This complies with ASHRAE Standard 90.1-2007.

6.5 Prescriptive Path

Dampers in the all the AHU's provide 0-100% modulation of outside air, exhaust air, and return air for economizer operation. The air-side economizers are run by dry bulb and relative humidity control of outside and return air dampers. The high-limit shutoff controls meet the requirements in Table 6.5.1.1.3B for the economizers.

The compliance with Table 6.5.3.1.1A Fan Power Limitations in ASHARAE Standard 90.1-2007 is shown below in Table 6. All fans in the AHU's have variable frequency drives. The majority of other fans in the building are centrifugal fans. Due to the controls in the building and spaces, every fan has the ability for variable volume control except FPB-1 and FPB-4, which service the Science Preparation Rooms. These two fans are constant air volume (CAV) due to the nature of the Science Preparation Rooms. These two rooms are used for instructors' to prepare chemicals for student use. They have very low occupancy needs but when in use the chemicals must be flushed out through the fume hoods. From values calculated, all fans comply except for the supply fans in each AHU.

Fan Power					
Unit	# of Fans	HP	CFM (each)	VAV (CFM x 0.0015)	Compliant with ASHRAE Standard 90.1-2007?
AHU-1	2	30	15000	22 1/2	No
	2	15	13500	20 1/4	Yes
AHU-2	2	30	15850	23 7/9	No
	2	15	13550	20 1/3	Yes
AHU-3	2	25	13500	20 1/4	No
	2	10	12150	18 2/9	Yes
AHU-4	1	20	10430	15 2/3	No
	1	7 1/2	9280	14	Yes
AHU-5	1	40	18700	28	No
	1	10	12300	18 4/9	Yes
AHU-6	1	20	9600	14 2/5	No
	1	10	9200	13 4/5	Yes
KE-1	1	1 1/2	3000	4 1/2	Yes
KE-2	1	5	7050	10 4/7	Yes
KE-3	1	1/4	320	1/2	Yes
EF-1	1	1.5	1300	2	Yes
EF-2	1	1.5	1300	2	Yes
EF-3	1	1/3	700	1	Yes
EF-4	1	1 1/2	1300	2	Yes
EF-5	1	3	5910	8 6/7	Yes

Fan Power					
Unit	# of Fans	HP	CFM (each)	VAV (CFM x 0.0015)	Compliant with ASHRAE Standard 90.1-2007?
EF-6	1	1/2	1060	1 3/5	Yes
EF-7	1	3/4	1440	2 1/6	Yes
EF-8	1	1/4	300	4/9	Yes
EF-9	1	1/6	400	3/5	Yes
EF-10	1	1/2	1310	2	Yes
EF-11	1	1/3	1000	1 1/2	Yes
EF-12	1	1/4	220	1/3	Yes
EF-13	1	1/4	650	1	Yes
EF-14	1	1/4	220	1/3	Yes
EF-15	1	1/4	220	1/3	Yes
EF-16	1	1/6	100	1/7	Yes
EF-17	1	1/6	150	2/9	Yes
EF-18	1	1/6	150	2/9	Yes
SF-1	1	1/4	850	1 2/7	Yes
FPB-2	1	1/3	560	5/6	Yes
FPB-3	1	1/3	925	1 2/5	Yes
				CAV (CFM x 0.0011)	
FPB-1	1	1/2	1200	1 1/3	Yes
FPB-4	1	1/2	1200	1 1/3	Yes

Table 6 – Fan Power

6.7 Submittals

A 100% Construction Document Submission was made to the NYC Green School Guide shortly after the start of construction to make sure the requirements of the guide were upheld in design. The New York City School Construction Authority (NYC SCA) has approved the building of Hunter's Point South School through design and system submissions. Hunter's Point South School is also design intended to be LEED Silver so an application for LEED certification will be

submitted at completion. Commissioning shall take place at the completion of construction. Records of Hunter's Point South Intermediate School & High School shall be kept by the NYC SCA.

Section 7 – Service Water Heating

7.4 Mandatory Provisions

The four condensing gas fired boilers in the boiler room are used to condition spaces' thermal needs. They need not be reviewed in this section because they do not supply potable water; they supply a 35% propylene glycol – water mixture only for heating purposes. One gas fired water heater is used to supply domestic hot water to Hunter's Point South School. The water heater was specified to comply with all efficiency guidelines set up in ASHRAE Standard 90.1-2007. The water heater tank has insulation with a minimum value of R-13.4 and a designed E_t of no less than 81%. It complies with all requirements of Section 7.

7.5 Prescriptive Path

The gas fired water heater is not used to heat spaces. This section is irrelevant for it.

Section 8 – Power

Hunter's Point South School is governed by the 2005 National Electric Code (NEC). The feeder conductors' and branch circuit voltage drops that must be met in the NEC surpass the requirements set up in ASHRAE Standard 90.1-2007. Therefore, Hunter's Point South School is compliant with this section. Construction drawings contain the necessary single–line diagrams and locations/areas served for the electrical distribution systems. On completion, the needed manuals and maintenance manuals shall be provided to the building operators.

Section 9 – Lighting

9.2 Compliance Path

The Building Area Method has been chosen for analysis for Hunter's Point South School.

9.4 Mandatory Provisions

Occupancy sensors that control lighting have been installed in all classrooms and some offices for Hunter's Point South School. They are set to turn the room lighting off 15 minutes after no occupants have been detected. These sensors combined with room switches control the lights in the areas. Hunter's Point South School uses a lighting control system clock that automatically

turns lights off/on based upon the schedule. A separate schedule is used for interior and exterior lights. The system has an eight year back-up and automatically adjusts for daylight savings.

9.5 Building Area Method Compliance Path

Exterior lights have been included in these calculations. For a school, the max lighting power density is 1.2 W/ft^2. Hunter's Point South School has a LPD of 0.844 W/ft^2 which is well below the mandated maximum. Below, Table 7 has the breakdown of the lighting fixtures and fixture wattage by floors which led to the calculated value.

Lighting Power Density								
Fixture	1st	2nd	3rd	4th	5th	Penthouse	W/fixture	Total W
A	1						100	100
C	2	2	2	2			25	200
TA	63	118	215	226	86		64	45312
TA-1		11	18		4		96	3168
TB	29				2		32	992
TB-1	15				3	9	32	864
TC	19	69	57	53	36		64	14976
TC-1	44	5	5	5	13		64	4608
TD		32					256	8192
TF	15	21	10	8			32	1728
TF-1	48	39	3	6	5		32	3232
TF-2	11	9	6	10	20		32	1792
TG	10						32	320
TL	53	12	5	34	14	21	64	8896
TL-1		24					32	768
TM				30			128	3840
TN			41	36			3	231
TR				29			100	2900
TS	50						36	1800
TT	22	17	11	3	93		64	9344
TU	5						26	130
TAA-1			6	4	9		50	950
TAA-2				4			50	200
TAB	12	15	20	20	14		64	5184
TAB-1	1	4			4		128	1152
TAC	2	1					64	192
TAC-1	1		2	2	2		32	224
TAD					17		64	1088
TAE					38		64	2432
TTB				3			100	300
TTH				8			575	4600
Exit Sign	15	7	12	10	9	1	2	108
							Total Watts =	129823
							Building Area =	153796
							W/SF =	0.844

Table 7 – Lighting Power Density

Section 10 – Other Equipment

Minimum efficiencies for electrical motors are defined in this section based upon their horsepower and revolutions per minute. Below in Table 8, the evaluation of the pumps in Hunter's Point South School is shown. None of the pumps comply with the minimum efficiencies outlined in this section. The centrifugal fan motors are designed to meet the 2007 New York State Energy Conservation Construction Code and ASHRAE 90.1. All the centrifugal fans therefore meet or exceed the requirements.

Electric Motors					
Pumps	Efficiency	HP	RPM	Minimum Efficiency	ASHRAE Standard 90.1-2007 Compliance
P-1	74.8	20	1750	91	No
P-2	74.8	20	1750	91	No
P-3	74.8	20	1750	91	No
P-4	81.4	30	1750	92.4	No
P-5	81.4	30	1750	92.4	No
P-6	81.4	30	1750	92.4	No

Table 8 – Electric Motors

Summary of Analysis for ASHRAE Standard 90.1-2007

Overall Hunter's Point South Intermediate School & High School did very well in its comparison to the requirements for ASHRAE Standard 90.1-2007. It passed all requirements except for the U-value for roof assembly; the supply fans in the AHU's did not meet the fan power limitations, and the motor efficiency for the pumps. The U- and R-values for the building enclosure all far surpass the minimum standards. The glazing especially stands out and will greatly help save energy on the thermal loads induced on the building. The supply fans in the AHU's may not comply with the fan power limitations but they do have variable frequency drives which will help save on fan energy. The majority of electric motors in the building do comply; it is only the pumps that fall short. The least efficient pump is only off by roughly 16% to meet efficiency.

It is no surprise Hunter's Point South School did so well in this evaluation. The school was designed under the strict energy conscious standards set up by the NYC Green Schools Guide. That combined with the ambitious undertaking to reach LEED Silver status has made Hunter's Point South Intermediate School & High School the energy conscious building it is designed to be.

References

ANSI/ASHRAE. (2007). *Standard 62.1-2007, Ventilation for Acceptable Indoor Air Quality*. Atlanta, GA: American Society of Heating, Refrigerating, and Air-Condition Engineers, Inc.

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FXFOWLE Architects. 100% Construction Documents Volume 1 – Architectural & Structural. FXFOWLE Architects, New York, NY.

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Appendix A – Minimum Ventilation Calculation

AHU-1												
Room No.	Room Name	Occupancy Type	Area (sf)	Rp (cfm/person)	Ra (cfm/sf)	Pz	Vbz (cfm)	Ez	Voz (cfm)	Vpz (cfm)	Zp	Evz
141	CustodianStorage	Storage Rooms	401	0	0.12	0	49	0.8	62	135	0.46	1.10
101/103	Is Project Room	Classrooms (age 9 plus)	1412	5	0.12	70	520	0.8	650	1240	0.52	1.04
105	Is Art	Art Classroom	1088	10	0.018	54	560	0.8	700	960	0.73	0.83
109A	Supervisor	Office Space	270	5	0.06	2	27	0.8	34	100	0.34	1.22
	Corridor 1st Floor West	Corridors	2800	0	0.06	0	168	0.8	210	230	0.91	0.65
246	Medical Suite	Daycare sickroom	702	10	0.18	6	187	0.8	234	230	1.02	0.55
241	Custodian Shop	Break Rooms	364	5	0.06	3	37	0.8	47	125	0.38	1.19
207B	Storage	Storage Rooms	104	0	0.12	0	13	0.8	17	34	0.50	1.06
205A	Office Work Room	Office Space	331	5	0.06	3	35	1	35	59	0.59	0.97
207	Staff Development/Literacy Coacl	Conference/meeting	954	5	0.06	47	293	0.8	367	620	0.59	0.97
207A	Office	Office Space	77	5	0.06	1	10	0.8	13	45	0.29	1.27
205B	A/V Storage	Storage Rooms	89	0	0.12	0	11	1	11	12	0.92	0.65
205C	Tech Center	Computer lab	412	10	0.12	10	150	0.8	188	200	0.94	0.62
205	Library	Libraries	3883	5	0.06	48	473	0.8	592	1170	0.51	1.06
242	Physical Therapy	Health club/aerobics	477	20	0.06	4	109	1	109	105	1.04	0.52
206	Office	Office Space	203	5	0.06	2	23	0.8	29	35	0.83	0.73
209	Cw - Activities for Daily Living	Classrooms (age 9 plus)	500	10	0.12	12	180	0.8	225	235	0.96	0.61
	Corridor 2nd Floor South	Corridors	1230	0	0.06	0	74	0.8	93	125	0.74	0.82
308A	Meeting Room	Conference/meeting	133	5	0.06	6	38	1	38	160	0.24	1.33
301	Is Classroom	Classrooms (age 9 plus)	684	10	0.12	34	423	0.8	529	550	0.96	0.60
303	Is Classroom	Classrooms (age 9 plus)	684	10	0.12	34	423	0.8	529	550	0.96	0.60
305	Is Classroom	Classrooms (age 9 plus)	688	10	0.12	34	423	0.8	529	550	0.96	0.60
307	Records	Storage Rooms	208	0	0.12	0	25	1	25	100	0.25	1.31
311	Gen Office	Office Space	494	5	0.06	5	55	0.8	69	190	0.36	1.20
315	Principal	Office Space	394	5	0.06	3	39	0.8	49	100	0.49	1.07
309A	Waiting	Reception areas	144	5	0.06	6	39	1	39	67	0.58	0.98
309	Mail	Office Space	288	5	0.06	2	28	1	28	35	0.80	0.76
	Corridor 3rd Floor West	Corridors	1350	0	0.06	0	81	0.8	102	135	0.76	0.81
401	Hs Classroom	Classrooms (age 9 plus)	680	10	0.12	34	422	0.8	528	550	0.96	0.60
403/405	Hs Classroom	Classrooms (age 9 plus)	1400	10	0.12	68	848	0.8	1060	1100	0.96	0.60
407	Records	Storage Rooms	208	0	0.12	0	25	1	25	100	0.25	1.31
411	Gen Office	Office Space	494	5	0.06	5	55	0.8	69	99	0.70	0.87
415	Principal	Office Space	394	5	0.06	2	34	0.8	43	100	0.43	1.13
411A	Copy	Office Space	144	5	0.06	1	14	0.8	18	41	0.44	1.12
411A	Copy	Office Space	144	5	0.06	1	14	0.8	18	21	0.86	0.71
409	Mail	Office Space	288	5	0.06	2	28	1	28	35	0.80	0.76
409A	Waiting	Reception areas	144	5	0.06	6	39	1	39	67	0.58	0.98
	Corridor 4th Floor West	Corridors	1350	0	0.06	0	81	0.8	102	135	0.76	0.81
524	Hs Receiving	Office Space	428	5	0.06	1	31	0.8	39	83	0.47	1.09
522	Hs Receiving Vestibule	Reception areas	386	5	0.06	2	34	0.8	43	103	0.42	1.15
518/518A/518B	Hs Guidance College	Office Space	372	5	0.06	3	38	0.8	48	100	0.48	1.08
516/516A/516B	Hs Guidance Office	Office Space	489	5	0.06	5	55	0.8	69	200	0.35	1.22
	Corridor 5th Floor East	Corridors	1800	0	0.06	0	108	0.8	135	200	0.68	0.89
508	Hs Supervisory	Office Space	224	5	0.06	2	24	1	24	60	0.40	1.16
506	Mediation	Conference/meeting	99	5	0.06	4	26	1	26	40	0.65	0.91
245	Office	Office Space	164	5	0.06	2	20	0.8	25	100	0.25	1.31
308B	Guidance Room	Office Space	250	5	0.06	2	25	1	25	160	0.16	1.41
						526	6414			11391		

	AHU-1			Vou ^	Vps ^
actual	min oa intake (cfm):	14945			
actual	max supply (cfm):	30000			Xs = 0.56308
	minimum oa fraction AHU can	0.50			
	Ev=	0.52	System Ventilation Efficiency		
	Vot=	12218			
	30%above	15883			

AHU-2													
Room No.	Room Name	Occupancy Type	Area (sf)	Rp (cfm/person)	Ra (cfm/sf)	Pz	Vbz (cfm)	Ez	Voz (cfm)	Vpz (cfm)	Zp	Evz	
113/115	Is & Hs Parents Meeting Room	Conference/meeting	802	5	0.06	10	99	0.8	124	270	0.46	1.18	
126A, 126C, L1C	Furniture Storage, Vault W. Anteroom, Vestibu	Storage Room	474	0	0.12	0	57	0.8	72	150	0.48	1.16	
119	Custodial Office	Office Space	314	5	0.06	3	34	1	34	100	0.34	1.30	
116	School Safety Office/Locker Rooms	Office Space	479	5	0.06	3	44	0.8	55	100	0.55	1.09	
118, 120	Is Receiving/General Supply Room	Office Space	519	5	0.06	5	57	0.8	72	100	0.72	0.92	
	Corridor 1st Floor East	Corridors	1060	0	0.06	0	64	1	64	100	0.64	1.00	
213/215/219/221	Special Education Classroom	Classrooms (age 9 plus)	1888	10	0.12	100	1227	0.8	1534	1600	0.96	0.68	
217	Special Education Clasroom	Classrooms (age 9 plus)	500	10	0.12	25	310	0.8	388	400	0.97	0.67	
225	Special Education Clasroom	Classrooms (age 9 plus)	659	10	0.12	31	390	0.8	488	510	0.96	0.69	
226	Special Education Clasroom	Classrooms (age 9 plus)	505	10	0.12	25	311	0.8	389	375	1.04	0.61	
224	Special Education Clasroom	Classrooms (age 9 plus)	530	10	0.12	26	324	0.8	405	425	0.95	0.69	
222	Hs Book Storage	Storage Room	489	0	0.12	0	59	0.8	74	113	0.65	0.99	
220	Classroom Speech	Classrooms (age 9 plus)	190	10	0.12	9	113	1	113	148	0.76	0.88	
218	Classroom Speech	Classrooms (age 9 plus)	190	10	0.12	9	113	1	113	148	0.76	0.88	
216	Is Book Storage	Storage Room	489	0	0.12	0	59	0.8	74	113	0.65	0.99	
214	Is Audio/Video Security Storage Room	Storage Room	361	0	0.12	0	44	0.8	55	65	0.85	0.80	
	Corridor 2nd Floor East	Corridors	1450	0	0.06	0	87	1	87	145	0.60	1.04	
318	Is Music	Classrooms (age 9 plus)	536	10	0.12	27	335	0.8	419	405	1.03	0.61	
320	Is Resource	Classrooms (age 9 plus)	323	10	0.12	16	199	0.8	249	260	0.96	0.68	
322	Is Resource	Classrooms (age 9 plus)	311	10	0.12	15	188	0.8	235	245	0.96	0.68	
	Corridor 3rd Floor East	Corridors	830	0	0.06	0	50	1	50	100	0.50	1.14	
324	Is Classroom	Classrooms (age 9 plus)	726	10	0.12	34	428	0.8	535	555	0.96	0.68	
325	Is Special Education	Classrooms (age 9 plus)	467	10	0.12	23	287	0.8	359	375	0.96	0.69	
323	Is Science Lab	Science Laboratories	903	10	0.18	30	463	0.8	579	600	0.97	0.68	
321	Is Science Prep	Science Laboratories	374	10	0.18	1	78	0.8	98	1200	0.08	1.56	
319	Is Science Lab	Science Laboratories	900	10	0.18	30	462	0.8	578	600	0.96	0.68	
317	Is Classroom	Classrooms (age 9 plus)	726	10	0.12	36	448	0.8	560	580	0.97	0.68	
	Corridor 4th Floor East	Corridors	830	0	0.06	0	50	1	50	100	0.50	1.14	
417/419/421	Hs Classroom	Classrooms (age 9 plus)	2022	10	0.12	102	1263	0.8	1579	1650	0.96	0.69	
423/425	Hs Classroom	Classrooms (age 9 plus)	1415	10	0.12	70	870	0.8	1088	1130	0.96	0.68	
424	Hs Classroom	Classrooms (age 9 plus)	685	10	0.12	34	423	0.8	529	550	0.96	0.68	
422	Hs Resource	Classrooms (age 9 plus)	356	10	0.12	17	213	0.8	267	280	0.95	0.69	
420	Hs Music Storage	Storage Room	383	0	0.12	0	46	0.8	58	69	0.84	0.80	
418	Hs Music	Classrooms (age 9 plus)	465	10	0.12	23	286	0.8	358	367	0.98	0.67	
517	Hs Special Education	Classrooms (age 9 plus)	468	10	0.12	23	287	0.8	359	185	1.94	-0.30	not used
519	Hs Science Lab	Science Laboratories	1261	10	0.18	38	607	0.8	759	1300	0.58	1.06	
521	Science Prep	Science Laboratories	501	10	0.18	5	141	0.8	177	1200	0.15	1.49	
523	Science Lab Demo	Science Laboratories	996	10	0.18	30	480	0.8	600	625	0.96	0.68	
525	Science Lab Demo	Science Laboratories	1010	10	0.18	30	482	0.8	603	630	0.96	0.69	
						830	11478			17868			
			AHU-2				Vou ^			Vps ^			
		actual	min oa intake (cfm):		19445								
		actual	max supply (cfm):		31700					Xs =	0.64238		
			minimum oa fraction AHU can		0.61								
			Ev=		0.61	System Ventilation Efficiency							
			Vot=		18971								
			30% above		24662								

AHU-3

Room No.	Room Name	Occupancy Type	Area (sf)	Rp (cfm/person)	Ra (cfm/sf)	Pz	Vbz (cfm)	Ez	Voz (cfm)	Vpz (cfm)	Zp	Evz
361/359/357/355	Is Classroom	Classroom (age 9 plus)	2892	10	0.12	144	1788	0.8	2235	2320	0.96	0.74
353	Is Classroom	Classroom (age 9 plus)	780	10	0.12	39	484	0.8	605	630	0.96	0.74
351/349	Is Classroom	Classroom (age 9 plus)	1358	10	0.12	66	823	0.8	1029	1070	0.96	0.74
347	Is Special Education	Classroom (age 9 plus)	438	10	0.12	21	263	0.8	329	340	0.97	0.73
341	Is Staff Locker	Storage Room	280	0	0.12	0	34	0.8	43	180	0.24	1.46
	Corridor 3rd Floor South	Corridors	3125	0	0.06	0	188	0.8	235	325	0.72	0.98
461/459/457/455	Hs Classroom	Classroom (age 9 plus)	2944	10	0.12	144	1794	0.8	2243	2400	0.93	0.77
453	Hs Classroom	Classroom (age 9 plus)	780	10	0.12	39	484	0.8	605	630	0.96	0.74
451/449	Hs Classroom	Classroom (age 9 plus)	1360	10	0.12	66	824	0.8	1030	1070	0.96	0.74
447	Hs Special Education	Classroom (age 9 plus)	389	10	0.12	12	167	0.8	209	220	0.95	0.75
441	Hs Staff Locker	Storage Room	280	0	0.12	0	34	0.8	43	185	0.23	1.47
	Corridor 4th Floor South	Corridors	3125	0	0.06	0	188	0.8	235	325	0.72	0.98
	Corridor 5th Floor South	Corridors	1540	0	0.06	0	93	1	93	230	0.40	1.30
539/541	Men's & Women's Locker Rooms	Storage Room	170	0	0.12	0	21	0.8	27	110	0.25	1.45
545	Guidance Records	Office Space	165	5	0.06	1	15	0.8	19	45	0.42	1.28
547	Program Office	Office Space	235	5	0.06	2	25	0.8	32	155	0.21	1.49
549	Hs Store	Storage Room	260	0	0.12	2	32	0.8	40	100	0.40	1.30
551	Government & Club House	Office Space	474	5	0.06	6	59	0.8	74	200	0.37	1.33
552	Hs Art Room	Art Classroom	1051	10	0.18	52	710	0.8	888	925	0.96	0.74
						594	8026			11460		

		AHU-3		Vou ^	Vps ^	
actual	min oa intake (cfm):	13210				
actual	max supply (cfm):	27000			Xs =	0.70035
	minimum oa fraction AHU can supply	0.49				
	Ev=	0.73	System Ventilation Efficiency			
	Vot=	10954				
	30% above	14240				

AHU-4											
Room No.	Room Name	Occupancy Type	Area (sf)	Rp (cfm/person)	Ra (cfm/sf)	Pz (people)	Vbz (cfm)	Ez	Voz (cfm)	Vpz (cfm)	Zp
130/146	Competition Gymnasium	Multipurpose Assembly	8052	5	0.06	660	3784	1	3784	15040	0.25
130A	Gym Storage	Storage Rooms	366	0	0.12	0	44	1	44	180	0.24
106	Is Girls' Locker Room	Storage Rooms	345	0	0.12	0	42	1	42	350	0.12
108	Health Instructor's Office	Office Space	349	5	0.06	2	31	1	31	180	0.17
102	Is Boys' Locker Room	Storage Rooms	345	0	0.12	0	42	1	42	350	0.12
134	Hs Girls' Locker Room	Storage Rooms	470	0	0.12	0	57	1	57	420	0.14
144	Hs Boys' Locker Room	Storage Rooms	430	0	0.12	0	52	1	52	380	0.14
145	Visitor Team's Locker Room	Storage Rooms	270	0	0.12	0	33	1	33	180	0.18
230/240	Auxiliary Exercise Room	Health Club/Aerobics Room	1900	20	0.06	38	874	1	874	2000	0.44
						Vou	4959				

AHU-4		
actual	min oa intake (cfm):	13360
actual	max supply (cfm):	20860
	minimum oa fraction	0.64
	Vot=	7085
	30% above	9211

Max Zp =	0.44
Ev =	0.7

AHU-4						
Room Number	Room Name	Design Ventillation	Minimum Ventilation	% Above Standard 62.1	Compliant With Standard	Above 30% (LEED)
130/146	Competition Gymnasium	9633	3784	255	Yes	Yes
130A	Gym Storage	115	44	262	Yes	Yes
106	Is Girls' Locker Room	224	42	534	Yes	Yes
108	Health Instructor's Office	115	31	372	Yes	Yes
102	Is Boys' Locker Room	224	42	534	Yes	Yes
134	Hs Girls' Locker Room	269	57	472	Yes	Yes
144	Hs Boys' Locker Room	243	52	468	Yes	Yes
145	Visitor Team's Locker Room	115	33	349	Yes	Yes
230/240	Auxiliary Exercise Room	1281	874	147	Yes	Yes

AHU-5												
Room No.	Room Name	Occupancy Type	Area (sf)	Rp (cfm/person)	Ra (cfm/sf)	Pz	Vbz (cfm)	Ez	Voz (cfm)	Vpz (cfm)	Zp	Evz
338/356	Is Café	Cafeteria/fast food-dining	2530	7.5	0.18	172	1746	1	1746	4920	0.35	0.96
534	Kitchen Complex	Cafeteria/fast food-dining	2174	7.5	0.18	16	512	1	512	3038	0.17	1.15
534C	Office 3	Office	125	5	0.06	1	13	1	13	75	0.17	1.14
534H	Food Storage	Storage	480	0	0.12	0	58	1	58	100	0.58	0.74
505/511	Hs Café	Cafeteria/fast food-dining	3150	7.5	0.18	210	2142	1	2142	5990	0.36	0.96
513, 515	Staff Dining & Servery	Cafeteria/fast food-dining	1027	7.5	0.18	8	245	1	245	600	0.41	0.91
536, 538	Men/Women Locker Room	Storage	320	0	0.12	0	39	1	39	250	0.16	1.16
534A	Can Wash	Storage	480	0	0.12	0	58	1	58	200	0.29	1.03
						Vou	4813			15173		
				AHU-5						Vpz ^		
		actual	min oa intake (cfm):		11840							
		actual	max supply (cfm):		18700					Xs =	0.317208	
			minimum oa fraction AHU can supply		0.63							
				Ev=	0.74	System Ventilation Efficiency						
				Vot=	6529							
				30% above	8488							

AHU-5						
Room Number	Room Name	Design Ventillation	Minimum Ventilation	% Above Standard 62.1	Compliant With Standard	Above 30% (LEED)
338/356	Is Café	3116	1746	178	Yes	Yes
534	Kitchen Complex	1924	512	376	Yes	Yes
534C	Office 3	48	13	369	Yes	Yes
534H	Food Storage	64	58	110	Yes	No
505/511	Hs Café	3793	2142	177	Yes	Yes
513	Staff Dining & Servery	380	245	155	Yes	Yes
536, 538	Men/Women Locker Room	159	39	408	Yes	Yes
534A	Can Wash	127	58	219	Yes	Yes

AHU-6											
Room No.	Room Name	Occupancy Type	Area (sf)	Rp (cfm/person)	Ra (cfm/sf)	Pz	Vbz (cfm)	Ez	Voz (cfm)	Vpz (cfm)	Zp
338/356	Auditorium	Auditorium Seating Area	3844	5	0.06	366	2061	1	2061	7488	0.28
360	Dress Room	Storage Room	190	0	0.12	0	23	1	23	150	0.15
362	Dress Room	Storage Room	190	0	0.12	0	23	1	23	150	0.15
406	Projection Room	Telephone/Data Entry	117	5	0.06	2	18	1	18	140	0.13
						Vou	2125				

AHU-6		
actual	min oa intake (cfm):	6325
actual	max supply (cfm):	9600
	minimum oa fraction AHU can supply	0.66
	Vot=	2657
	30% above	3454

Max Zp =	0.28
Ev =	0.8

AHU-6						
Room Number	Room Name	Design Ventillation	Minimum Ventilation	% Above Standard 62.1	Compliant With Standard	Above 30% (LEED)
338/356	Auditorium	4934	2061	239	Yes	Yes
360	Dress Room	99	23	430	Yes	Yes
362	Dress Room	99	23	430	Yes	Yes
406	Projection Room	93	18	517	Yes	Yes