Mechanical Systems Existing Conditions Evaluation

Mechanical Technical Report #3

Bronx School for Law, Government, & Justice

Bronx, NY

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TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

The following report was to evaluate and analyze the existing mechanical system in Bronx High School for Law, Government & Justice. Influences on the objective and design requirements were first discussed. Contributing factors such as, cost and site factors were also described in this analysis. The cost of energy was obtained for a more accurate energy cost analysis. Then the actual design ventilation, heating and cooling loads were obtained and compared to the estimations found from technical report 2. Then with the estimated energy consumption and estimated annual cost was obtained using the energy rates obtained from the previous section.

Another aspect of the analysis was to evaluate the existing mechanical systems by constructing schematic drawings of the existing mechanical system. These schematic drawings are attached in an appendix to this report. Along with these schematic drawings a description of the system was also discussed.

In evaluating the system an in depth look into all major pieces of mechanical equipment was also completed. They are represented in various tables, also provided, in this analysis.

The system overall does not have components that would aid in energy efficiency. The system is a basic system that meets all design requirements set forth by the owner and local energy codes. The owner had specific design standards and ultimately, the design was a complete reflectance. A more in depth analysis must be completed of an alternative system which would allow a basis for comparison on whether the system is efficient or inefficient.

2.0 DESIGN OBJECTIVES & REQUIREMENTS

The Bronx School for Law, Government & Justice is owned and operated by the New York School Construction Authority. The School Construction Authority (SCA) was established by the New York State Legislature in December 1988 to build new public schools and manage the design, construction and renovation of capital projects in New York City's more than 1,200 public school buildings. The SCA, charged with the task of overseeing the construction of all K-12 public schools in New York City developed their own "design standard" to be implemented in all SCA projects.

The SCA design standard requires that all HVAC units are packaged air handlers with heating coils or packaged rooftop units. Chilled water is typically produced from onsite chillers or if applicable a neighboring chiller plant. Their current design standard requires that schools have gas fired boilers for heating.

The Bronx School for Law, Government & Justice provides a general high school education, with an opportunity for students to participate in studies of the criminal justice system. The school caters to students seeking careers in the legal profession; therefore it includes spaces that complement their learning. The school will contain forensic labs, tri-facial labs, a distance learning court rooms, crime labs, an art studio, library, multipurpose room and kitchen /dining areas. The capacity of the school is for approximately 1,000 students, and has a total of 25 classrooms in addition to the specialty rooms listed above.

Another factor influencing the design was New York City Energy Codes. The NYC code requires that certain spaces be served by separated air handling units such as corridors. This is to help limit where re-circulated air is be returned and thus, help limit contaminants from being circulated throughout the entire building.

The combination of the variety of types of spaces, the requirements set forth by the SCA and the NYC energy code were the main design requirements and objectives.

3.0 ENERGY SOURCES AND RATES

The primary energy source for Bronx School for Law is electricity. A detailed monthly rate for the month of July 2005 was obtained from the New York State Energy Research and Development Authority. However, the following rates were obtained under the assumption that the school consumes a "Large Amount", over 90000 KWH. Unfortunately, actual utility bills were not obtained and therefore, the following estimation was obtained.

CONSILIDATED EDISON COMPANY OF NEW YORK MONTHLY COMMERCIAL BILL JULY, 2005	
Basic Service Charge	0.00000
Delivery Charge (KWH)	0.01420
Monthly Adjustment (KWH)	(-)0.00260
Delivery Charge (KW)	0.03706
Monthly Adjustment (KW)	(-)0.00214
System Benefit Charge (KWH)	0.00160
Monthly Adjustment Charge (KWH)	0.00256
Taxes (New York City)	0.00129
Total Electric DELIVERY charge per KWH	0.05196
Electric Supply (KWH)	0.10960
Electric Supply (KW)	0.02711
Market Supply Charge (KWH)	(-)0.00198
Taxes (New York City)	0.00348
Total Electric SUPPLY Charge per KWH	0.13821
Total Electric Charge per KWH	0.19018

The Bronx School for Law contains (3) fuel oil tanks for the two boilers, generator and emergency generator. The largest tank is for the two boilers sized at 10000 gallons. Again, the actual amount and cost of fuel oil for the school was not obtained and an estimate was acquired from the Energy Information Administration. The following table shows average rates, dollar/gallon, for No. 2 Heating Oil for New York City in 2005. It can be observed that the average up to July was just over two dollars a gallon.

ENERGY INFORMATION ADMINISTRATION (DOLLARS/GALLON) TAX EXCLUDED	
JULY	2.131
JUNE	2.085
MAY	2
APRIL	2.019
MARCH	2.004
FEBRUARY	1.905
JANUARY	1.878

http://www.eia.doe.gov/emeu/states/oilprices/oilprices_ny.html

4.0 COST & SITE FACTORS

As stated before the driving force for the design of the entire building is the design standards of the SCA. However, the SCA's design standards are heavily influenced by cost factors. The cost of constructing and renovating over 15 fifteen schools per year has a significant impact on the cost of New York City. Therefore, first cost becomes an issue in the design of the building systems of a school. Constructing a new school on average cost 5 to 10 million dollars for the mechanical systems alone, which translates to around 100 to 200 million dollars a year for mechanical systems. If the SCA was only charged with constructing one or two schools a year then first cost would be less of an issue but, when you increase the number of schools the cost factor multiplies.

However, having the same design standard does have some advantages to first cost. For instance, having the same units in each school takes advantage of the idea of "buying in bulk". If the SCA builds 15 schools in a year and puts 10 of the same air handlers in each of them that alone is 150 of the same air handlers therefore, the SCA can take advantage of buying these air handlers at a lower first cost.

Site Factors for mechanical systems are typically an issue when it comes to constructing any building because of the limited footprints in New York City. This holds true for Bronx School for Law, like most buildings in NYC, have limited space horizontally and must build vertically. Therefore, it is almost common practice to have cooling towers or rooftop units.

5.0 OUTDOOR & INDOOR DESIGN CONDITIONS

The following design conditions were used be the original mechanical design team, Joseph R. Loring. They account for the worst case scenario for both winter and summer conditions.

HEATING/COOLING DESIGN PARAMETERS

A. Heating

1. Outdoor air requirements for ventilation: A minimum of 15 cfm per occupant (number of occupants based on NYC Building code, Table 6-2).
2. Inside ambient design temperature:72°F DB.
3. Outside ambient design temperature: 5°F DB (based on wind at 15 mph).

B. Cooling

1. Outdoor air requirements for ventilation: A minimum of 15 cfm per occupant (number of occupants based on Board of Education Program Space Requirements).
2. Inside ambient design temperature:78°F DB, 50% RH.
3. Outside ambient design temperature: 89°F DB, 73°F WB.

C. Thermal Properties of Building

1.	Overall transmission coefficient for walls:	$U_W =$	0.08
2.	Overall transmission coefficient for roof:	$U_R =$	0.05
3.	Overall transmission coefficient for windows:	$U_W =$	0.63
4.	Overall transmission coefficient for walls below grade walls and floors:	$U_B =$	0.08
5.	Glass factor		0.45

6.0 DESIGN VENTILATION REQUIREMENTS

The Bronx School for Law, Government & Justice contains (10) air handling units serving all major spaces. The building's top level is a mechanical penthouse and houses all but (1) of the air handling units. All air handling units are gas fired units capable of supplying heat throughout the building. There are two steam boilers located in the cellar of the building which provide steam to fin tube radiators located in most perimeter spaces and to each of the packaged air handlers. The steam fin tube radiators are used as the primary heat source and the heating from the air handling units is used as a secondary source. The following table from technical report #1 represents all air handling units, area served, total supply air, outside air and percent outdoor air.

TABLE 5.1 [FROM TECH REPORT #1]

Air Handling Units (AHU)	Location	Type	Total CFM	Min. Outdoor Air CFM	OA %
AHU 1 [Classrooms & misc.]	Penthouse	VAV	48000	26000	54.17
AHU 2 [Classrooms & misc.]	Penthouse	VAV	19000	9000	47.37
AHU 3 [Gymnasium]	Penthouse	CAV	18500	7500	40.54
AHU 4 [Library]	Penthouse	CAV	3400	1020	30.00
AHU 5 [Lobby & Corridor]	Penthouse	CAV	12000	6900	57.50
AHU 6 [Kitchen]	Penthouse	CAV	5200/2600	5200/2600	100/100
AHU 7 [Administration]	Cellar	VAV	12000	3800	31.67
AHU 8 [Dining]	Penthouse	CAV	6000	3360	56.00
AHU 9 [Plant Operations]	Penthouse	CAV	7200	2200	30.56
AHU-10 [Orchestra]		CAV	3100	1050	33.87
TOTAL			**133440**	**66030**	**49.13**

In tech report 1, an analysis of ASHRAE Standard 62.1 was performed to determine whether Bronx High School of Law complied with the minimum outdoor air required. After completing the analysis it was determined that the school indeed meet all requirements of ASHRAE Standard 62.1. The following tables are also from tech. report 1 which illustrate each individual air handling unit and compares the ASHRAE Standard 62.1 analysis with the actual design.

AHU-1

Max $Z_p = 0.34$
$E_v = 0.8$
$V_{ot} = (V_{ou})/(E_v) = 13193$ cfm
Designed OA = 26000 cfm

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied

AHU-2

Max $Z_p = 0.38$
$E_v = 0.7$
$V_{ot} = (V_{ou})/(E_v) = 6630$ cfm
Designed OA = 9000 cfm

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied

AHU-3

Max Z_p = [Not Needed per ASHRAE 62.1 section 6.2.3]
E_v = [Not Needed per ASHRAE 62.1 section 6.2.3]
$V_{ot} = (V_{ou}) = (V_{oz}) = 4245$ cfm
Designed OA = 7500 cfm

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied

AHU- 4

Max $Z_p = 0.24$
$E_v = 0.9$
$V_{ot} = (V_{ou})/(E_v) = 735$ cfm
Designed OA = 1020 cfm

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied

AHU- 5

Max Z_p = 0.11
E_v = 1.0
$V_{ot} = (V_{ou})/(E_v)$ = 1135 cfm
Designed OA = 6900 cfm

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied

AHU-6

Max Z_p = [Not Needed per ASHRAE 62.1 section 6.2.4]
E_v = [Not Needed per ASHRAE 62.1 section 6.2.4]
$V_{ot} = (V_{ou}) = (V_{oz})$ = 702 cfm
Designed OA = 5200 cfm or 2600 cfm @ half speed

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied for both operating speeds

AHU- 7

Max Z_p = 0.26
E_v = 0.8
$V_{ot} = (V_{ou})/(E_v)$ = 964 cfm
Designed OA = 3800 cfm

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied

AHU-8

Max Z_p = [Not Needed per ASHRAE 62.1 section 6.2.3]
E_v = [Not Needed per ASHRAE 62.1 section 6.2.3]
$V_{ot} = (V_{ou}) = (V_{oz})$ = 2536 cfm
Designed OA = 3360 cfm

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied

AHU- 9

Max Z_p = 0.24
E_v = 0.9
$V_{ot} = (V_{ou})/(E_v)$ = 898 cfm
Designed OA = 2200 cfm

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied

AHU-10

Max Z_p = [Not Needed per ASHRAE 62.1 section 6.2.3]
E_v = [Not Needed per ASHRAE 62.1 section 6.2.3]
$V_{ot} = (V_{ou}) = (V_{oz})$ = 745 cfm
Designed OA = 1050 cfm

Designed OA > Required ASHRAE 62.1-2004
RESULT: Minimum fresh outdoor air is satisfied

7.0 DESIGN HEATING & COOLING LOADS

Tech Report #2 involved estimating the heating and cooling loads for Bronx High School for Law. Estimating loads is typically performed using energy analysis software. In this case Carrier's HAP energy program was used for this estimation. In general when comparing the HVAC loads generated from HAP they were significantly lower than the actual design loads. As explained in Tech. Report 2 there are many reasons for this discrepancy for instance, in the HAP analysis restrooms, stairs, electrical closets and mechanical spaces was not included. These spaces are not cooled but do have an impact on the overall building load. There are several labs which contain fume hoods and other equipment that need to be exhausted. In order to prevent the building from having "negative" pressure enough supply air has to be provided, which leads to an increase load on the air handler. Also, another possible factor was this analysis was completed after construction documents were completed and all information came directly from these documents. The original designer did not have these documents and had to account for spaces changing throughout the design phase. Yet another factor, the original designers may have implemented safety factors that were not implemented in this report. The results of the HAP analysis is provided from tech. report 2.

Air Handling Units (AHU)	Area ft^2	Total Load MBH		Supply CFM		Supply CFM/ft^2		Ventilation CFM		Ventilation CFM/ft^2	
		HAP	Designed	HAP	Designed	HAP	Designed	HAP	Designed	HAP	Designed
AHU 1 [Classrooms]	26059	1462.9	2440	33694	48000	1.29	1.84	12600	26000	0.48	1.00
AHU 2 [Classrooms]	12897	615.6	903.5	13882	19000	1.08	1.47	4890	9000	0.38	0.70
AHU 3 [Gymnasium]	8944	978.6	848.3	18256	18500	2.04	2.07	7500	7500	0.84	0.84
AHU 4 [Library]	3073	111.3	152.1	2137	3400	0.70	1.11	1110	1020	0.36	0.33
AHU 5 [Lobby & Corridor]	11520	222.1	728.1	5105	12000	0.44	1.04	1335	6900	0.12	0.60
AHU 6 [Kitchen]	3486	109.1	287.5	3805	5200/2600	1.09	1.49/.75	150	5200/2600	0.04	1.49/.75
AHU 7 [Administration]	6690	212.2	471.6	5508	12000	0.82	1.79	1020	3800	0.15	0.57
AHU 8 [Dining]	3739	198.4	323.3	3825	6000	1.02	1.60	3825	3360	1.02	0.90
AHU 9 [Plant Operations]	6223	115.8	284.9	2597	7200	0.42	1.16	840	2200	0.13	0.35
AHU-10 [Orchestra]	1711	95.3	134.1	2308	3100	1.35	1.81	990	1050	0.58	0.61

8.0 ANNUAL ENERGY USE

After the design load estimations were completed HAP also calculated the energy costs based off the estimated loads. The rates were the same rates found in the energy source section. And the following table is also from tech report 2 illustrating the estimated energy cost. An actual report on energy cost for Bronx High School for Law was not able to be obtained. Since the load estimations from earlier were lower than the actual design it is predicted that the annual energy cost is lower than the actual.

Table 8.1 Annual Costs

Component	Bronx School for Law($)
Air System Fans	143,655
Cooling	6,147
Heating	9,340
Pumps	0
Cooling Tower Fans	0
HVAC Sub-Total	**159,142**
Lights	280,872
Electric Equipment	291,499
Misc. Electric	0
Misc. Fuel Use	0
Non-HVAC Sub-Total	**572,371**
Grand Total	**731,513**

Table 8.2 Annual Cost per Unit Floor Area

Component	Bronx School for Law ($/ft²)
HVAC Components	
Electric	1.853
HVAC Sub-Total	**1.853**
Non-HVAC Components	
Electric	6.786
Non-HVAC Sub-Total	**6.786**
Grand Total	**8.673**

Gross Floor Area (ft²) 84342.0
Conditioned Floor Area (ft²) 84342.0

9.0 DESCRIPTION OF SYSTEM OPERATION

Bronx High School of Law utilizes both VAV and constant volume systems. The School contains (2) 250 ton chillers that provides chilled water for all 10 air handling units. Each air handling unit, as stated earlier, are pre-packaged air handlers with heating coils. The heating coils are to provide supplemental heating, while the fin tube radiators are the primary heat source. The school has (2) gas-fired boilers that produces steam for both air handlers and fin tube radiators located throughout the building. The system is controlled by a central control panel located in the mechanical penthouse. The central

AIR HANDLERS:

Air Handling Units 1 and 2 are the two largest units in the building including all classrooms, science labs, computer labs and adjoining office spaces. The majority of the spaces AHU -1, 2 serve are located on the 2nd, 3rd and 4th floors. There are four classrooms located on the first floor which is also served by AHU-1. A large portion of the sensible load in these spaces comes from people therefore; it had to be assured that enough fresh outdoor air had to be delivered to these spaces. This was important in the design to limit the amount of contaminants recirculating throughout the building.

AHU-3 serves the gymnasium located on the 5th floor. The gymnasium is a double height space occupying the 5th and 6th floors. AHU-3 only serves the gymnasium and therefore; the outdoor air requirement was calculated from section 6.2.3 from ASHRAE 62.1. ASHRAE allows for a correction factor for occupancy diversity however, in this analysis it was assumed to be conservative to design at peak loads for all times. This assumption was made because of the large activity and assembly that would occur in the space and enough fresh outdoor air was needed to satisfy the occupants.

AHU-4 serves only the library and related spaces located on the 2nd floor. A separate unit for the library was installed for better temperature and humidity control. This was important because the library has to be relatively dry to prevent moisture to accumulate onto the books. Installing a separate air handler allowed for an isolated control.

AHU-5 serves the entrance lobby and the main corridors between floors one through 5. The New York City Energy Code requires that all corridors be served by a separate unit. This is ideal because of the traffic throughout the building is done through the corridor, contaminants circulate more readily. A separate unit is ideal to prevent these contaminants from recirculating throughout the building.

AHU-6 serves the kitchen located in the cellar of the building. AHU-6 is a 100% outdoor air unit capable of operating under (2) speeds. The installation of a variable speed fan was incorporated due to the idea that the kitchen would only operate for a short amount of time on peak demand throughout the day. It was designed to conserve energy by not having to operate the air handler at part load through the majority of the time. The large volume of air exhausted from the kitchen hoods required that this air handler be a 100% outdoor air system because there would not have been enough recirculated air.

AHU-7 serves primarily the first floor with the exception of the classrooms, main lobby and main corridor. Predominately the first floor contains administration's offices and other like spaces therefore; these spaces were served by one air handler. AHU-7 is the only air handling unit not in the mechanical penthouse on the top level, but rather located in the cellar level.

AHU-8 serves the student cafeteria located in the cellar level. This unit is another single zone serving only the student dining area. Due to the large volume of occupants occupying this space it was ideal to isolate this space from the rest of the building. This limited the ability for contaminants to be recirculated throughout the building.

AHU-9 distributes air to the remaining spaces in the cellar. The remaining cellar spaces are mostly building utility systems rooms such as the boiler rooms. There are a few student occupied spaces such as student organizations. The cellar with the exception of the cafeteria and kitchen required less outdoor air due to the fact that the occupants are relatively low in the cellar.

AHU-10 is the final air handler and it serves the orchestra room. Due to the relatively high concentration of people in one space it was ideal to, as well, isolate this space from the remainder of the building. This was to allow for more control of the temperature within the space.

CHILLED WATER SYSTEM:

The chilled water system in Bronx High School for Law is simple system. There are (2) 250 ton chillers with each unit having (2) independently piped circuits. Each chiller uses R-22 refrigerant and was designed for an entering and leaving temperatures of 55˚**F and 44˚F.** Air-cooled, roof-mounted condensing units above the penthouse, rejects the heat from the chillers that provide chilled water for the air handling units. Once the chilled water is supplied to the air handlers it is returned by (3) end suction pumps that pump the return chilled water back to the chillers. An expansion tank is connected to the chilled water system on the inlet (suction) side of the distribution pumps by a branch line. The expansion tank allow for thermal expansion of the chilled water that, if not for the expansion tank, could damage the piping system and the tank provides a location for makeup water to be admitted to the system.

HEATING SYSTEM:

The primary heat source comes from (2) gas-fired boilers that produces steam for all packaged air handling units and fin tube radiators. Both boilers send steam to a main distribution steam pipe in which, the respective loads branch off this main pipe. All the steam return is pumped into a boiler feeder tank and then is re-pumped to both boilers at a rated temperature of 212˚F. A chemical feed tank is also provided and is tied into the return back to the boilers. AHU-7, because it is located in the cellar along with the boilers, has an independent supply and return. A separate condensate pump is provided for return steam which is then pumped into the feeder tank. Because the gymnasium is located on the 5th and 6th floors two separate supply and return steam loops were provided for the remaining air handlers in the penthouse. The fin tubes also have a separate loop and the return is done by a vacuum pump the pumps the return steam back to the boiler feeder.

10.0 CRITIQUE OF SYSTEM

The Bronx High School of Law, Government and Justice incorporates a combination of VAV and constant volume systems. Overall the mechanical system is a basic system that provides adequate heating and cooling for the school.

First cost was an issue for this project which played an impact on the type of system that was eventually designed. A detailed first cost analysis was obtained from the Architect's cost estimate reports for tech. report 2. The total building cost was approximately 65 million and from the report the HVAC cost was almost 6 million which is roughly 9.2% of the overall building cost. The cost per ft^2 was approximately 52.63 per ft^2.

The SCA design standard requires certain spaces to be served by separate air handlers such as the cafeteria, kitchen, library, orchestra and gymnasium. This design standard increases the first cost of the mechanical system significantly because simply more equipment equals higher first cost. However, this cost is acceptable because having air handlers for separate spaces helps control where the return air is returned. Since the entire building utilizes mixing return and outdoor air, except the kitchen, it is important from an indoor air quality standpoint. For example, if odors or worse bacterial contaminants were released into a zone it would be easier to isolate those contaminants by going to the respective air handler but, if instead all air handlers used to same mixing plenum it would be impossible to isolate to contaminant without checking the entire system.

Another advantage with having a relatively simple system is maintenance. Since primarily all schools, built by the SCA, have the same components in their mechanical system, it is not needed to have a building manager for each school. Instead schools are capable of hiring one building manager for multiple schools. This overall is a huge savings since the number of maintenance people is lower.

The largest overall cost from a mechanical standpoint is the operating cost. The system is relatively poor on implementing energy efficiency to the system. It rather has basic packaged units which provide the basics needed for heating and cooling. Actual energy cost, unfortunately, were not obtained as to compare with the estimated cost.

Another issue is the spacing requirements or lost rentable space due the mechanical equipment. Since the building is not a commercial retail space and not being rented out to other tenants the lost rentable space was not a large issue. The following table, from tech. report 2, illustrates the approximate lost rentable space for the school.

MECHANICAL ROOMS		
Rm. No.	Room Name	Area (ft^2)
C11	Mechanical	2938
C12	Mechanical	624
C13	Mechanical	1178
601	Mechanical	2625
602	Mechanical	2625
P-1	Mechanical	2550
P-2	Mechanical	2550
	Total	**15090**
Estimated Mech. Shaft, ft^2		**1800**
	Total	**16890**

The building is approximately 114,000 ft^2 which leaves "Lost Rentable" = (16890/114000)*100 = 14.8% Lost

Overall, the system was designed as efficiently as possible with the given constraints from the owner. The system provides adequate cooling and heating for all occupied spaces.

11.0 SCHEDULES

AIR HANDLING UNIT SCHEDULE							
			AHU-1	AHU-2	AHU-3	AHU-4	AHU-5
		Area Served	Classrooms and misc.	Classrooms and Misc	Gymnasium	Library	Lobby & Corridor
		Total CFM	48000	19000	18500	3400	12000
		Min. OA	26000	9000	7500	1020	6900
FAN DATA		Total Static Pressure (in. wg)	5.5	5.5	4.1	4.2	5.4
		Ext. Static Pressure (in. wg)	2.6	2.6	1	1.5	2.5
		Outlet Vel.	2862	-	-	2192	2098
		RPM	1088	1172	1555	1737	1537
		BHP	58.9	24.9	19.6	3.6	18.2
COOLING	AIR	ENT DB (F)	82.6	81.6	80.6	81	83.5
		ENT WB (F)	68.2	67.5	67	67.5	69
		LVG DB (F)	51.8	52.1	52	52.8	53.3
		LVG WB (F)	51.5	51.8	51.8	51.8	52.9
		MAX P.D. (in. wg)	0.97	0.96	1.25	0.86	0.94
	WATER	TOTAL GPM	404	164	138	25	119
		ENT TEMP (F)	44	44	44	44	44
		LVG TEMP (F)	56	56.3	56.3	58.3	56.3
		MAX P.D. (FT)	18.2	17.6	5.8	3.9	12.1
	COIL	Face Vel. (FPM)	477	475	486	422	480
		FINS per INCH	9	9	11	10	13
		Min Rows Deep	8	8	8	8	6
		Total Capacity (BTU/HR)	2440	903.5	848.36	152.1	728.1
		Sensible Capacity (BTU/HR)	1614	612.2	576.7	101.3	479.3
PREHEAT COIL	AIR	ENT TEMP DB (F)	35.8	40.5	45	58.6	33.8
		LVG TEMP DB (F)	88.1	81.4	90	107.5	82.7
	STEAM	Steam Pressure (psig)	2	2	2	2	2
		Steam Flow (lbs/HR)	2880	869	1032	174	730
		Total Heating Capacity (MBH)	2712	840	999	169	704
		Face Vel. (FPM)	481	651	704	578	544
		FINS per INCH	8	8	8	8	8
		Min Rows Deep	1	1	1	1	1

AIR HANDLING UNIT SCHEDULE							
			AHU-6	AHU-7	AHU-8	AHU-9	AHU-10
		Area Served	Kitchen	Admin.	Dining	Plant Operations	Orchestra
		Total CFM	5200/2600	12000	6000	7200	3100
		Min. OA	5200/2600	3800	3360	220	1050
FAN DATA		Total Static Pressure (in. wg)	4.5	5.6	4.2	5.2	3.9
		Ext. Static Pressure (in. wg)	1.8	2.6	1.8	2.2	1.5
		Outlet Vel.	2549	2182	2941	3529	2981
		RPM	2235	1812	2299	2639	1810
		BHP	6.1	16.2	7.3	11.1	3.3
COOLING	AIR	ENT DB (F)	90	79	83.5	79	80
		ENT WB (F)	74	66	69	66	67
		LVG DB (F)	58.6	53.6	51.9	53.3	53.2
		LVG WB (F)	58.1	53	51.5	52.9	52.8
		MAX P.D. (in. wg)	0.78	0.81	0.7	0.93	0.7
	WATER	TOTAL GPM	47	77	53	47	22
		ENT TEMP (F)	44	44	44	44	44
		LVG TEMP (F)	56.2	58.2	56.3	56.2	56.3
		MAX P.D. (FT)	1.4	28.1	27.9	8.2	4.9
	COIL	Face Vel. (FPM)	434	489	408	489	409
		FINS per INCH	12	13	12	12	12
		Min Rows Deep	6	5	6	6	6
		Total Capacity (BTU/HR)	287.5	471.6	323.3	284.9	134.1
		Sensible Capacity (BTU/HR)	178.6	333.3	207.6	202.4	91
PREHEAT COIL	AIR	ENT TEMP DB (F)	25	50.6	29.8	50.6	47.8
		LVG TEMP DB (F)	45.7	96.7	77	93.4	97.5
	STEAM	Steam Pressure (psig)	2	2	2	2	2
		Steam Flow (lbs/HR)	266	590	316	344	172
		Total Heating Capacity (MBH)	257	570	306	333	167
		Face Vel. (FPM)	625	671	587	705	531
		FINS per INCH	8	8	8	8	8
		Min Rows Deep	1	1	1	1	1

REFRIGERATION MACHINE SCHEDULE								
			Temp. 'F					
Unit Number	Service	Tons	Ent.	Leav.	Max P.D. (ft)	Ref. Type	Fouling Factor	GPM
ACC-1/EVAP 1	Chilled Water	235.5	56	44	19.3	R22	0.00025	551.5
ACC-2/EVAP-2	Chilled Water	235.5	56	44	19.3	R22	0.00025	551.5

BOILER SCHEDULE								
						Steam Data		
No.	Boiler (Hp)	Type	Operating Pressure	Design Pressure	Efficiency @ Rated Load	Gross lbs./Hr	Net lbs./Hr	Press.
B-1	175	Fire-Tube 3-Pass	8	20	80	6040	4708	12
B-2	175	Fire-Tube 3-Pass	8	20	80	6040	4708	12

BOILER SCHEDULE CONTINUED							
	Fuel-Oil Burner Data			Fuel-Gas Burner Data			
Feed Water Temp 'F	Fuel Grade	Fuel Btu/hr	Firing @ Rated Load (GPH)	Gas Type	Gas (Btu/Hr)	Firing @ Rated Load (SCFH)	Min. Gas Inlet Press.
212	No.2	140000	52	Natural	1000	7323	7
212	No.2	140000	52	Natural	1000	7323	7

EXPANSION TANK SCHEDULE							
No.	System	Type	Volume	Avg. Oper. Tank	Initial Fill Press	Max. Oper Press.	A.S.M.E. Work Press.
ET-1	Chilled Wtr	Closed	53 (gal)	50 F	16 psig	37 psig	125 psig

FUEL OIL TANK			
No.	Service	Volume (Gal.)	Inlet Press. (psig)
FOT-1	Boilers	10000	-
FOT-2	Generator	275	-
DT-1	Emerg. Gen.	60	10

PUMP SCHEDULE								
No.	Equipment/ Area Served	Type	GPM	Total Head (FT)	NPSH Req'd (FT)	Fluid Temp. (F)	Efficiency @ Oper. Pt.	BHP
CHWP-1	Chilled Wtr	End Suction	470	85	7.53	44	78.5	12.6
CHWP-2	Chilled Wtr	End Suction	470	85	7.53	44	78.5	12.6
CHWP-3	Chilled Wtr	End Suction	470	85	7.53	44	78.5	12.6
FOP-1&2	Fuel Oil (Gen)	Gear	1.4	-	-	50	-	-
FOP-3&4	Fuel Oil (Boilers)	Gear	4.7	-	-	50	-	-

DUPLEX CONDENSATE PUMP/BOILER FEED PUMP SCHEDULE					
No.	Service	No. of Pumps	GPM (Each)	Disch Press.(psig)	RPM Oper. Temp. (F)
VP-1	Steam Heating	2 Air, 2 Water	60	25	1750
BF-1	Steam Heating	2	90	30	1750
CP-1	AHU-7	2	6	15	3500

HEATING COIL SCHEDULE (STEAM)									
			Air Data				Steam Data		
No.	Equipment or System Served	CFM	Max Face Vel. (FPM)	Ent Temp DB (F)	Lvg Temp DB (F)	Heating Cap. (MBH)	P.D. (in. wg)	Coil Press. (psig)	Total lbs/hr
RHC-B-1	Cellar	390	400	70	119	21	0.08	2	21.8
RHC-B-2	Cellar	350	400	70	122	19.9	0.07	2	20.6
RHC-B-3	Cellar	1450	580	70	101	49.8	0.13	2	52.5
RHC-B-4	Cellar	800	400	70	119	42.6	0.09	2	44.1
RHC-B-5	Cellar	620	450	70	118	32.4	0.09	2	33.6
RHC-6	AHU-6	5200	1320	52	87.7	201	10	2	208
RHC-4-3	Cellar	1130	452	55	94.9	48.9	0.08	2	50.6
RHC-4-4	Cellar	1000	400	55	97.8	46.1	0.07	2	47.7

FAN SCHEDULE						
No.	Area or System Served	CFM	Static Press. (in wg)	RPM	BHP	Type
RF-1	Classroom	25300	1.9	778	12.2	Vane Axial
RF-2	Classroom	10000	1.9	711	5.45	Tubular
RF-3	Gymnasium	16000	1.1	745	6.89	Tubular
RF-4	Library	3000	1.2	1198	1.12	Tubular
RF-5	Corridor/Misc.	3250	1.9	993	3.55	Tubular
RF-7	Administration	8300	1.8	895	4.27	Tubular
RF-8	Dining	3150	1.5	1297	1.41	Tubular
RF-9	Plant Operations	4900	1.4	1136	2.1	Tubular
RF-10	Orchestra	2790	1.2	1170	1.03	Tubular
HEF-1	Fume Hood Exhaust RM. 301	1550	3.2	2687	1.38	Roof
HEF-2	Fume Hood Exhaust RM. 306	1550	3.2	2687	1.38	Roof
HEF-3	Fume Hood Exhaust RM. 308	1550	3.2	2687	1.38	Roof
HEF-4	Fume Hood Exhaust RM. 310	1550	3.2	2687	1.38	Roof
HEF-5	Fume Hoods Portable	700	3.2	2494	1.05	Roof
KEF-1	Kiln Hood Exhaust RM. 409	2500	1	1025	0.62	Roof
SEF-1	Floor Smoke Exhaust	23000	0.75	455	6.25	Roof
EF-1	MER Exhaust AHU-7	850	0.5	1398	0.17	Inline
EF-2	MER Exhaust (East)	5800	0.75	1232	2.19	Inline
EF-3	MER Exhaust (West)	5800	0.75	1232	2.19	Inline
EF-4	EMR Exhaust	150	0.4	1400	0.13	Inline
EF-5	Gas mether RM Exhaust	150	0.4	1300	0.004	Inline
EF-6	Elev. Smoke Exhaust	2700	0.6	1161	0.61	Roof
SF-2	Elect. Rm. Supply	7300	0.7	574	1.61	Inline
EF-7	Elect. Rm. Exhaust	7000	0.7	574	1.61	Inline
EF-8	Medical Suite	780	0.6	1161	0.16	Inline
EF-10	Acid Storage	1000	1.1	1620	0.29	Inline
EF-11	Storage Rooms	1430	1.1	1361	0.49	Inline
EF-12	Refrig. Condensers	1250	0.5	985	0	Inline
EF-13	Acid Nuet. Rm.	300	0.6	1387	0.11	Inline
LX-1	Corridor lockers	4300	1	1263	0.34	Roof
KX-1	Kitchen Hood Exhaust	5080	3.6	1319	4.61	Roof
GX-1	Kitchen General Exhaust	1900	0.8	870	0.4	Roof
GX-2	Lab General Exhaust	10800	1.1	1725	3.67	Inline
SF-1	AHU-1	48000	5.5	1088	58.9	Roof
TX-1	Toilets/Lockers	4200	1.1	1332	1.71	Roof
TX-2	Toilets/Lockers	5200	0.9	1022	1.77	Roof
TF-B-1	Telecom. Rm.	380	0.3	1350	0.19	Inline
TF-1-1	Telecom. Rm.	380	0.3	1350	0.19	Inline
TF-2-1	Telecom. Rm.	380	0.3	1350	0.19	Inline
TF-3-1	Telecom. Rm.	380	0.3	1350	0.19	Inline
TF-4-1	Telecom. Rm.	380	0.3	1350	0.19	Inline
TF-5-1	Telecom. Rm.	380	0.3	1350	0.19	Inline
TF-5-2	Sound Rack	750	0.3	950	0.43	Inline

VAV BOXES				
	Rated CFM Range		Maximum P.D.	Maximum Inlet Pressure
Type	Min.	Max	(in. wg)	(in. wg)
VAV-A	UP TO 200		0.5	1.5
VAV-B	201	350	0.5	1.5
VAV-C	351	700	0.5	1.5
VAV-D	701	1000	0.8	1.5
VAV-E	1001	1500	0.8	1.5
VAV-F	1501	2000	0.8	1.5
BVAV-A	UP TO 200		0.01	1
BVAV-B	201	350	0.01	1
BVAV-C	351	700	0.01	1
BVAV-D	701	1000	0.25	1
BVAV-E	1001	1500	0.03	1
BVAV-F	1501	2000	0.05	1
CAV-A	UP TO 200		0.5	1.5
CAV-B	201	350	0.5	1.5
CAV-C	351	700	0.5	1.5
CAV-D	701	1000	0.5	1.5
CAV-E	1001	1500	0.8	1.5
CAV-F	1501	2000	0.8	1.5

12.0 SCHEMATIC DRAWINGS

SEE APPENDIX A.

13.0 REFERENCES

ASHRAE Standard 62.1-2004

ASHRAE Standard 90.1-2004

Board of Education Program Space Requirements

Hillier Architecture, schematic reports

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NYC Building code, Table 6-2

New York City School Construction Authority Design Guide