Mechanical Systems Existing Conditions Report

Technical Report 3

Freetown Elementary School

Glen Burnie, MD

Matthew R. Buda

The Pennsylvania State University

Architectural Engineering – Mechanical Option

Advisor: Dr. Treado

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Executive Summary

This report summarizes the design objectives, mechanical equipment, performance and LEED classification. Design plays a big role in determining the equipment and performance of the building. Sustainability and LEED performance is a high priority in today's world and Freetown Elementary School did not have those objectives. It is important to analyze when moving forward with the proposal.

The architect made design objectives based on the occupancy of the building. Since the building is used for an elementary school, certain considerations were followed. It was important to have restrooms attached to each classroom to keep the kids close to adult supervision. Another important objective was to allow the cafeteria to transform into a multiple use room for school and public gatherings.

Mechanical equipment and performance was analyzed based on design conditions followed by the ASHRAE standards. The controls within the building monitoring the air quality and thermal comfort make it possible to switch over from heating to cooling or vice versa since the mechanical system is based off of a two pipe system.

The sustainable aspects of Freetown Elementary School include two energy recovery units which allows for energy savings. This operates reusing the warm temperature from the exhaust air to heat up the incoming cold air. This contributes to a lower load for the heating coils. An energy management system is included in the controls to have a better control on the systems which is further described in this report.

When discussing sustainability, a further analysis of this is located in the United States Green Building Council. Although Freetown Elementary School was not designed to have a LEED Certification, it will be important in determining what will be discussed in the proposal for the next stage of this project.

Design Objectives

Architecture

Freetown Elementary school was designed into three different sections of the building with three main corridors throughout the building. Two of these sections are the east and west classroom wings. The eastern wing is primarily kindergarten level classrooms on the first floor. These two wings have a second floor with similar layout for classrooms. A division of these wings allows for a courtyard to allow natural light into every classroom. This division also allows for a computer room and media center. The third section is where the gymnasium, cafeteria, extended day care, and mechanical storage are located. In case of a need for a large gathering, the cafeteria was designed with a stage to transform into an auditorium. If extra seating is still required, the partition between the gymnasium and the cafeteria can slide into storage to open up the space.

Administrative personnel are located at the entrance of the school, functioning as a place to administer visitors and control flow in and out. Also located near the entrance are the nurse's office, the principal's office, and the assistant principal's office. For easy access for music performances, the music room and storage is located behind the stage in the cafeteria in close proximity. Also in relation to the cafeteria, there are restrooms located outside in the corridor. Every classroom is equipped with its own restroom to prevent kids wandering the halls and allow for more supervision.

Freetown Elementary School's façade is mainly made up for 12" CMU's on the interior, 1 ½" rigid cavity insulation, and a running bond face brick on the exterior. On the exterior, there are brick features such as a projected brick medallion and a projected soldier course along the building, as well as stack bonds and rowlocks for different aesthetics for the building.

Structural

The building has a lateral braced frame with cast- in-place concrete columns of varying size. The first floor slab on grade is 5 inches thick with welded wire fabric over 6 mil vapor barrier and 4 inch washed gravel. The slab is thickened to 6 inches at the mechanical room to hold the load of the mechanical equipment. The second floor slab is 3 inches normal weight concrete with 28 gage galvanized form deck. Steel joists span the classrooms and the corridors.

Sustainability

Two Energy Recovery Units serve the east and west classroom wings. These units allow for energy savings through reusing the warm temperature exhaust air to heat up the incoming cold air. The mechanical system is saving energy on the heating coil loads by using of this waste heat from the building.

An energy management system was also in mind when designing. Boiler rotation is monthly and is adjusted by the owner. Independent schedules of operation for each zone listed in the auto-occupied-unoccupied sequence are for energy management. A master schedule for control of all zones (except RAHU-5) in the event of a snow day is also accounted for.

Mechanical

The main mechanical room is located in the southwest corner of the building along the perimeter. Two natural gas boilers and an air cooled chiller outside control the loads in the building. Freetown Elementary School is based off a 2 pipe system and has controls set up for changeover from heating to cooling and vice versa. Six rooftop air handling units serve the music rooms, gymnasium, cafeteria, administration offices and the media center. Two energy recovery units serve each of the classroom wings. In addition to the air handling units are six ductless split system units serving smaller rooms such as electrical closets. An air source heat pump is responsible for the extended day program located in the north end of the building near the entrance.

Design Factors

Site

Freetown Elementary School location is on the same site of the old school. As you can see from the aerial photos below provided by Aerial Photographers, LLC, The old school was located where the new athletic fields are today. This was done because construction of the new school was being done the same time as the old school was still in session.

Figure 1 – Site of Old School

Figure 2 – Site of New School

Cost

Freetown Elementary School is funded by the tax dollars or donations of Anne Arundel County. This public school was controlled by the Maryland State Department of Education.

Outdoor and Indoor Design Conditions

Determined in the previous technical report, the design conditions for Freetown Elementary School were assumed to be the same as Baltimore, MD. In Table-1 below, the outdoor values were obtained from the 2005 ASHRAE Handbook of Fundamentals. The indoor values were obtained from the mechanical design documents. All of these values were used in calculating the model computed in Trace in Technical Report #2.

Design Temperatures	
ASHRAE 0.4% Cooling Dry Bulb	93.6 °F
ASHRAE 0.4% Cooling Wet Bulb	75.0 °F
ASHRAE 99.6% Heating Dry Bulb	12.3 °F
Indoor Cooling Dry Bulb	78.0 °F
Indoor Heating Dry Bulb	70.0 °F

Table 1 – Design Outdoor and Indoor Air Conditions

Design Ventilation Requirements

By using ASHRAE Standard 62.1, the design ventilation requirements were compared to calculated ventilation rates by the standard. A detailed discussion of the calculations can be found in Technical Report #1. Table-2 shows the results of the analysis, compares the designed to the calculated rates, and whether it complies or not with the minimum ASHRAE standard.

The only air handler that does not meet the required minimum outdoor air rate is AHU-3. In analyzing AHU-3 (serving the cafeteria), the assumption was made that there were around 300 students in the cafeteria at once in three different lunch periods. With this assumption, the calculated outdoor compared to the designed minimum outdoor air was higher, resulting in a non-compliance with the standard. This discrepancy is not an issue as it is very close to the minimum and 300 students is the maximum number that would be at lunch during one period.

System	Calculated Outdoor Air (CFM)	Design Supply Air (CFM)	Design Minimum Outdoor Air (CFM)	ASHRAE 62.1 Compliance
AHU-1	430	1530	600	Yes
AHU-2	232	1530	375	Yes
AHU-3	**2072**	**6000**	**2000**	**No**
AHU-4A	535	7500	2500	Yes
AHU-5	278	3200	700	Yes
AHU-6	824	4680	1080	Yes
ERU-1	4665	8100	8100	Yes
ERU-2	5625	9800	9800	Yes

Table 2 - Calculated vs. Designed Ventilation Rates

Summary of Major Equipment

Freetown Elementary School was designed with a two pipe changeover system and listed in Table – 3 is the major equipment with its values. Two natural gas fired boilers were placed in the mechanical room for monthly rotation. An air cooled chiller is located outside of the building in the southwest corner near the mechanical room. The domestic water heater is located in the mechanical room and acts as a storage tank.

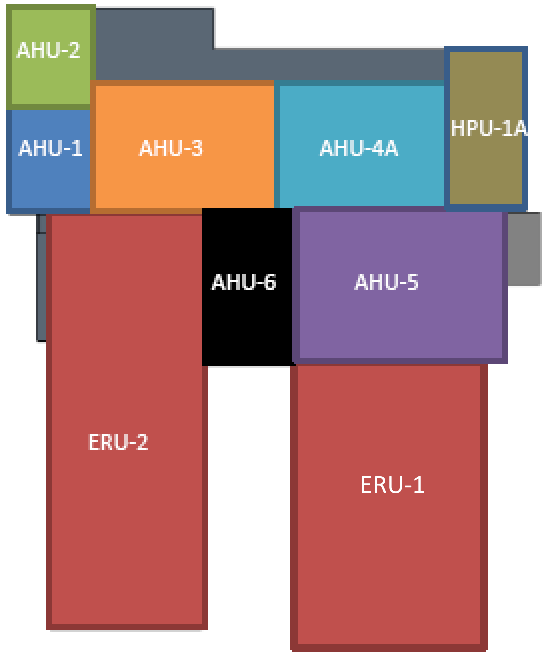

Figure 1 - Zone Diagram for AHU's

RAHU-1, RAHU-2, RAHU-3, and RAHU-4A are constant volume serving spaces such as the music rooms and the cafeteria/gymnasium. RAHU-5 serves the administration section of the school and is a variable volume unit with reheat capabilities. RAHU-6 serves the Media Center and is a constant volume unit with a return air fan.

Two energy recovery units serve the classroom wings. ERU-2 serves the west wing and ERU-1 serves the east wing. These units have DX cooling and contain an air cooled condensing unit.

Summary of Major Equipment				
Equipment	Input MBH	Output MBH	Capacity	HP
Boiler 1	3836	3040	~	90.8
Boiler 2	3836	3040	~	90.8
Air Cooled Chiller	2040	~	400 GPM	~
Domestic Water Heater	399	~	125 Gallon	~

Table 3 - Major Equipment

Other Equipment Schedules

The air source heat pump is located in the Extended Day Program area. Ductless split systems serve areas such as janitor's office, gym office, telecom, food storage, food prep office and elevator machine room. Two variable frequency drive pumps serve the chilled/heating cycle for pumps P-1 and P-2.

For further information on other equipment refer to Appendix A.

Mechanical System First Cost

Not available at this time.

Schematic Drawings of Chilled/Heating Water System

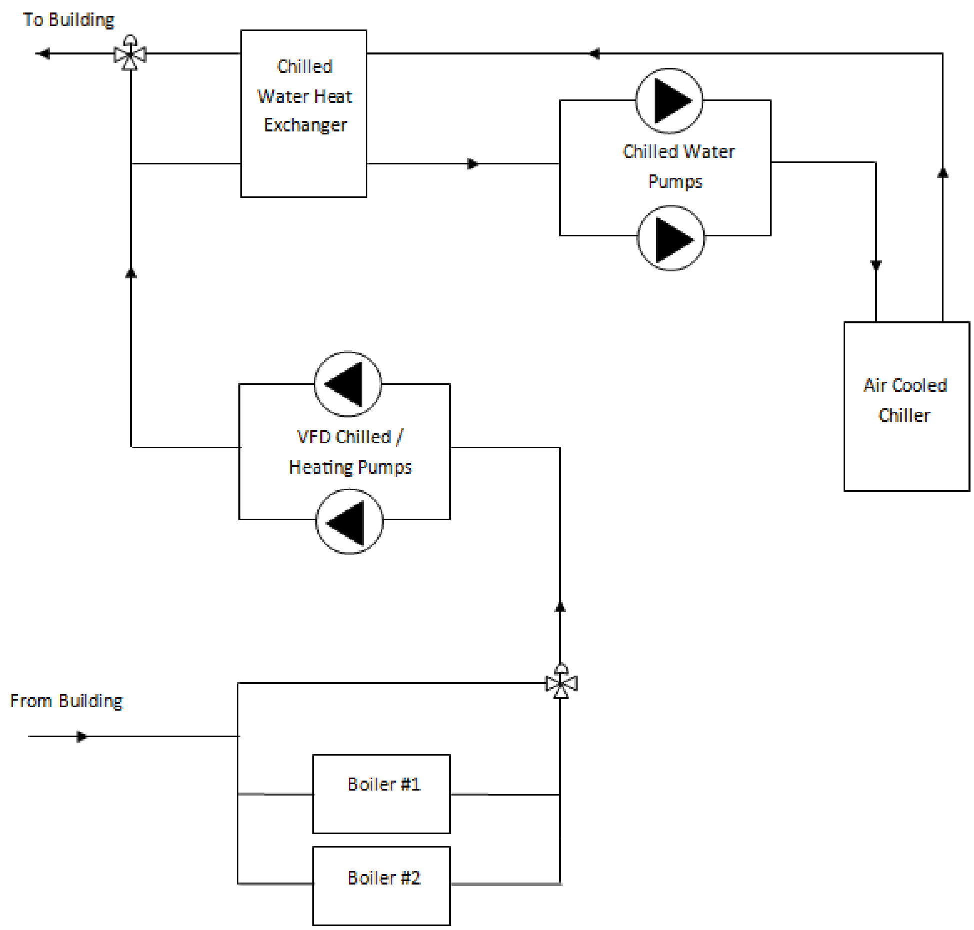

Figure 4 – Chilled/Heating Water System

System Operation Description

RAHU-1, RAHU-2, RAHU-3, RAHU-4A, RAHUA-6

These air handling units are controlled by the following cycles: Occupied Cycle, Unoccupied Cycle (heating mode), Unoccupied Cycle (cooling mode), Maintenance Cycle, and Safety and Emergency Controls.

Occupied Cycle:

In the occupied cycle, the supply air fan motor is energized and runs continuously.

Heating Mode:

When the system is in heating mode, the following occurrences can happen. If the space temperature is more than 2 degrees F below the heating set point of the room sensor, the face and bypass dampers are positioned to provide full flow across the coil. The outdoor air and pressure release damper remain closed with the return air damper remaining open.

If a rise in space temperature is within 2 degrees F of the heating set point of the room sensor, the face and bypass dampers modulate towards bypassing the coil with the outdoor air and pressure release dampers opening to a minimum position. Return air damper closes proportionally in unison.

The outdoor air damper and pressure release damper modulates toward the open position and the return air damper closes proportionally to maintain the room sensor set point. This occurs if there is a further rise in space temperature after the face and bypass dampers are completely bypassed and a 6 degree F dead band increase is reached.

A low limit sensor overrides the room sensor to prevent discharge air from falling below 55 degrees F. This low limit is locked out when system is in cooling mode.

Cooling Mode:

The air handling unit shall continue in heating mode until the chilled/heating system water temperatures falls below 85 degrees F.

The outdoor air and pressure release dampers close to their minimum position. The return air damper opens proportionally. The face and bypass dampers modulate between full airflow across the coil to full bypass around the coil. This maintains the room sensor set point.

Unoccupied Cycle:

Heating Mode:

The supply air fan motor, face and bypass dampers are placed under control of the night set point of the sensor. Under this set point, the fans will cycle and open the coil face dampers to maintain the set point. The outdoor air and pressure release dampers remain close and the return air damper remain open.

Cooling Mode:

De-energized supply fan motor and closing of the outdoor air and pressure release dampers happen during the unoccupied, cooling mode. However, the return air damper remains open.

RAHU-5

This air handling unit is controlled by the following cycles: Occupied cycle (heating and cooling modes), Zone Reheat Coils, Control of Changeover Between Heating and Cooling Mode, Unoccupied Cycle, Maintenance Cycle and Safety and Emergency Controls.

When the building system is in heating mode, the two position isolation control valves are open. This valve is then close for cooling mode.

Occupied Cycle:

Energizing of the supply fan motor is the beginning stage of this operation. The motor should run continuously and the outdoor air damper is open. A central controller directed through the DDC monitors the supply air temperature and velocity. This controller also modulates the bypass damper to maintain constant supply air flow through the air handling unit.

In order to maintain zone thermostat set points, zone dampers modulate between maximum and minimum flow. The central controller monitors all zone thermostats and dampers. At this point, the system selects heating or cooling operation.

Heating Mode:

Heating is called for from the central controller. It causes a 3-way control valve to modulate to provide heat. A low limit thermostat overrides the central controller and the 3-way control valve to prevent discharge air from falling below a set point set at 55 degrees F.

Cooling Mode:

Cooling is called for from the central controller and closes the 3-way control valve to the heating coil. The cooling system energizes the stages of DX cooling as needed.

Zone Reheat Coils:

If the space temperature sensor is calling for heating and the central controller is calling for cooling, the zone duct mounted temperature sensor modulates 2-way heating control valve to adjust to 90 degrees F.

Changeover between Heating and Cooling Modes:

Monitoring of all space temperatures is done by the central controller. The maximum number of calls for space heating or cooling determines cooling or heating. Changeover occurs when the maximum number of heating requirements outnumbers the cooling requirements by at least two zones. This is also true for cooling requirements outnumbering the heating requirements. If any zone temperature falls more than two degrees below its set point the system goes into heating mode.

Unoccupied Cycle:

The supply air fan motor and 3-way control valve is placed under control of the night thermostat. The outdoor air damper is closed and the cooling system is de-energized. A key operated manual override is located in the principal's office. This places the system in occupied mode for 0-3 hours. The circulating pump for the heating coil is energized when the outdoor air temperature is below 45 degrees F and de-energized when above 50 degrees F. Pump is also energized when the 3-way valve is open to the coil and this overrides any outdoor air temperature.

ERU-1, ERU-2

These air handling units are controlled by the following cycles: Occupied Cycle, Unoccupied Cycle, and Safety and Emergency Controls.

Occupied Cycle:

This unit is energized by the occupied cycle in the direct digital control clock.

Unoccupied Cycle:

The exhaust fan is energized when activated by the ATC system. When it is not energized it operates under the packaged controls.

Design Heating and Cooling Loads

Technical Report #2 displays a detailed discussion of the assumptions that went into making the energy model for Freetown Elementary School.

Modeled vs. Designed				
	Cooling (tons)		Heating (MBH)	
	Modeled	Designed	Modeled	Designed
AHU-1	5.6	6.5	55	78
AHU-2	4.6	5.2	43	61
AHU-3	30.6	23	214	280
AHU-4A	16.9	29	151	355
AHU-5	8.1	10.3	7	120
AHU-6	14.7	14.6	69	183
ERU-1	77.7	33.1	252	613
ERU-2	83.7	42.2	235	741
HPU-1	7.3	9.6	72	119

Table 4 - Modeled vs. Designed Loads

AHU-1 and AHU-2 were modeled reasonably close to the design conditions. These two air handlers only serve one or two rooms with furniture in it so it was accurate in terms of occupants.

AHU-3 and AHU-4A were difficult to model because of the spaces they serve. These air handlers serve the cafeteria and the gymnasium. In the design documents the occupants per room were not discussed therefore an estimation was made. Originally, the ASHRAE recommended number was used for square foot per person. This called for an approximate 500 people in the cafeteria at once. This number had to be adjusted since there are approximately 768 students in the school (32 classrooms of 24 students each). Assuming three lunch periods, a value for the cafeteria was numbered at 256 students. The values are not near design conditions because the schedule is also assumed constant for all rooms. This causes the air handler to work harder when no one is occupying the cafeteria when lunch is not in session or when the gymnasium is not being used. Another issue arises when the partition located between the gymnasium and cafeteria is removed for assemblies or gatherings. This was not taken into effect when modeling these two air handlers.

AHU-5 was modeled as a variable volume reheat. In the design documents, there is also a bypass damper from the return air stream to bypass the air handling unit to serve the space. This was not available in the systems for the model in Trace. Therefore the heating energy is not a reasonable estimate.

AHU-6 was modeled as a constant volume – non-mixing computer room unit because it serves the media center. In the model, there is a reheat before the room but there is no reheat after it leaves the fan in the design documents so this number is not comparable.

ERU-1 and ERU-2 were difficult to model. They were modeled as a constant volume with mixing, terminal air blender. This does not take into consideration that they are energy recovery units and the model schematic also differs from the design schematic. The model schematic has a reheat and an extra fan before the supply air and room air enter the room. The design documents do not show these two features. The design documents simply have the room air mixing with the supply air before entering the room again. In conclusion, the results calculated were not comparable to the design conditions.

Site Energy Sources

The mechanical system in Freetown Elementary School uses electricity for the primary energy source for cooling systems and natural gas for the heating systems. Actual utility bills are not available so it won't be compared to the actual energy use. Baltimore Gas and Electric Company were used for determining rates for both gas and electric. It is assumed that Freetown Elementary School is using this because it is so close to Baltimore, MD. Since the demand load for the building is 1,056.9kW, the 2,000kWh or more in any month option was used for the following rates. This is listed under commercial, industrial, and lighting rates. For gas distribution, the general category was assumed.

Electricity	Customer Charge: $17.50 per month Energy Charge: $0.10 per kilowatt hour per month
Gas	Customer Charge: $35.00 per month Distribution Charge: 19.75 cents per therm for first 10,000 therms 9.48 cents per therm over 10,000 therms

Annual Energy Use

Energy Consumption: Freetown Elementary School consumes 2,112,000 kWh of electricity and 119,000 kBtu of gas annually based on the model. Below is a breakdown of energy consumption for each category. The main energy consumption is by the air cooled chiller and the boiler (when converted to kWh, it is comparable to the air cooled chiller). Lighting is also a large portion of the energy consumption at peak load.

LEED New Construction Rating

LEED is a rating system by the U. S. Green Building Council that describes and measures by certification on how green a building is. The range is from LEED certified to LEED Platinum. This rating system analyzes the following: sustainably sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, locations and linkages, awareness and education, innovation in design, and regional priority. This report focuses on the categories relating directly to the mechanical systems, energy and atmosphere and indoor environmental quality.

Energy and Atmosphere

EA Prerequisite 1: Fundamental Commissioning of Building Energy Systems

This prerequisite is intended to verify the energy related systems within Freetown Elementary School are installed and calibrated to perform according to the owner's requirements based on the design and construction documents.

Freetown Elementary School designated an individual as the commissioning authority to review and oversee the completion of the commissioning process. The individual verified the installation and performance of the systems to be commissioned.

EA Prerequisite 2: Minimum Energy Performance

This prerequisite is to establish a minimum level of energy efficiency for Freetown Elementary School and systems. This is meant to reduce environmental and economic impacts arising from excessive energy use.

Option 1: Whole Building Energy Simulation. This requirement describes a 10 % improvement in the proposed building performance rating compared to the baseline building performance rating. The baseline was calculated according to the method in Appendix G of ASHRAE Standard 90.1-2007 using a computer simulation model.

EA Prerequisite 3: Fundamental Refrigerant Management

This prerequisite is intended to reduce ozone depletion. The requirement is to use zero chlorofluorocarbon-based (CFC) refrigerants in heating, ventilating, air conditioning and refrigeration systems.

EA Credit 1: Optimize Energy Performance

This credit is intended to increase the level of energy performance beyond the prerequisite to reduce both environmental and economic impacts with excessive energy use.

EA Credit 2: On-site Renewable Energy

Freetown Elementary School does not use any renewable on-site energy sources such as solar, wind or geothermal. Therefore, it does not obtain any points for this section.

EA Credit 3: Enhanced Commissioning

This credit is intended to assure commissioning early on in the design process and to implement additional activities after systems verification is complete. Freetown Elementary School did not have additional commissioning services. Therefore, it does not obtain any points for this section.

EA Credit 4: Enhanced Refrigerant Management

This credit is intended to reduce ozone depletion and support compliance with the Montreal Protocol while decreasing global warming effects. Within this credit, since refrigerants are used in Freetown Elementary School, a maximum threshold for the combined contributions to ozone depletion and global warming is calculated.

$LCGWP + LCODP \times 10^5 \leq 100$

EA Credit 5: Measurement and Verification

This credit is intended to provide for the accountability of building energy consumption over time. A requirement to develop a measurement and verification plan to maximize energy conservation. The measurement and verification plan should at least cover one year of post-construction occupancy. A process for corrective action should be produced if the plan is not being met. Freetown Elementary School does not have this plan such as this so it does not obtain any points for this section.

EA Credit 6: Green Power

This credit is intended to develop and use grid-source, renewable energy on a net zero pollution emphasis. A requirement is described to participate in at least a two year renewable energy contract which provides at least 35% of the building's electricity. The green power purchases are based on energy consumed. Freetown Elementary School does not use any green power so it does not obtain any points for this section.

Indoor Environmental Quality

IEQ Prerequisite 1: Minimum Indoor Air Quality Performance

This prerequisite is intended to establish a minimum indoor air quality performance to comfort the occupants by enhancing the indoor air quality. The requirement is made to meet the minimum of the ASHRAE Standard 62.1-2007, which is Ventilation for Acceptable Indoor Air Quality. Also, mechanically ventilated systems are designed according to the ventilation rate procedure. Naturally ventilated spaces also meet the requirement from the standard.

IEQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control

This prerequisite is intended to prevent exposure to building occupants, indoor surfaces, and ventilation air distribution systems from tobacco smoke. Freetown Elementary School is a smoke-free building so it meets the prerequisite.

IEQ Credit 1: Outdoor Air Delivery Monitoring

This credit is intended to assure that monitoring of ventilation systems is available to help promote occupant comfort and well-being. This requirement is to ensure that the ventilation systems maintain design minimum requirements. Freetown Elementary School does not contain an alarm when airflow values or carbon dioxide levels vary by more than 10% from the design values. The building does not monitor CO_2 concentrations in mechanically ventilated spaces or naturally ventilated spaces. Therefore, the building does not obtain the points for this credit.

IEQ Credit 2: Increased Ventilation

This credit is intended to provide additional outdoor air ventilation to improve indoor air quality. The requirements specify for mechanically ventilated spaces to increase breathing zone outdoor air ventilation rates to all occupied spaces by at least 30% above the minimum rates required by the ASHRAE Standard 62.1- 2007. The design natural ventilation systems for occupied spaces should meet the recommendations by Chartered Institution of Building Services Engineers Application Manual.

IEQ Credit 3.1: Construction Indoor Air Quality Management Plan – During Construction

This credit is intended to reduce indoor air quality problems from construction. A management plan is required for the construction and preoccupancy phases. During construction control measures were met by the Sheet Metal Air Conditioning National Contractors Association. Absorptive materials were protected from moisture damage.

IEQ Credit 3.2: Construction Indoor Air Quality Management Plan – Before Occupancy

This credit is intended to reduce indoor air quality problems from construction after all finishes have been installed and the building has been completely cleaned before occupancy. A management plan was implemented for Freetown Elementary School to eliminate any indoor air quality problems. New filtration media was installed and a flush-out of the building was implemented.

IEQ Credit 6.2: Controllability of Systems – Thermal Comfort

This credit is intended to provide controls for thermal comfort that are used by individual occupants or groups in multi-occupant spaces. Freetown Elementary School does not meet this requirement as it is an elementary school therefore 50 % of the building occupants cannot adjust the controls based on individual needs.

IEQ Credit 7.1: Thermal Comfort – Design

This credit is intended to create a comfortable thermal environment to promote occupant productivity and well-being. This requirement is controlled by ASHRAE Standard 55-2004.

IEQ Credit 7.2: Thermal Comfort- Verification

This credit is intended to keep track of building occupant thermal comfort over time. This requirement specifies a permanent monitoring system to ensure that the building performance meets the desired comfort criteria as mentioned in IEQ Credit 7.1. This credit analyzes the occupant's comments through a survey within 6 to 18 months after occupancy.

Conclusion of LEED:

Although Freetown Elementary school was not designed with LEED intentions, the thermal comfort and cleanliness of indoor air was executed during construction and before occupancy. The building did not obtain any LEED accreditation. Addition of more LEED components will be further researched when analyzing a proposal for the building.

Lost Usable Space

Freetown Elementary School has a mechanical room that takes up 1200 square feet on the first floor located in the southwest corner of the building. This is 1.4% of the total 83,000 square feet of the building. The air handling units are positioned on the roof top so those did not take up any of the buildings square footage.

Overall System Evaluation

Construction Cost

The cost associated with the mechanical systems of the building was approximately 24% of the total construction cost.

Operating Cost

The total annual energy cost for Freetown Elementary School was modeled to be $212,000 or a cost per area of $2.79/ft^2. This value will be further analyzed to create a more accurate value.

Space Requirements

Freetown Elementary School has a mechanical room instead of a mechanical penthouse. This will be further analyzed when looking at the square footage.

Maintainability

A staff on site is responsible for maintaining the equipment as well as input from the owner, Anne Arundel County Public Schools.

Resources

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Appendix A – Equipment Schedules

Summary of AHU's									
			Supply Fan			Return Fan			
	Supply (CFM)	Outdoor Air (CFM)	Total SP (in.)	Max RPM	Min. Motor HP	Return (CFM)	Total SP (in.)	Max. RPM	Min. Motor HP
RAHU-1	1530	600	2.45	1560	1.5	~	~	~	~
RAHU-2	1530	375	2.4	1540	1.5	~	~	~	~
RAHU-3	6000	2000	2.4	800	5	~	~	~	~
RAHU-4A	7500	2500	4.15	1970	10	~	~	~	~
RAHU-5	3200	700	3.15	1510	3	~	~	~	~
RAHU-6	4680	1080	2.05	900	3	4200	1.35	750	1.5
ERU-1	8100	8100	5.03	2330	15	7900	2.07	820	5
ERU-2	9800	9800	5.03	2070	15	9450	2.31	770	7.5

Summary of Ductless Split System Units					
	Indoor Unit			Outdoor Unit	
	CFM	Cooling Capacity MBH	Heating Capacity MBH	Total Capacity MBH	SEER
DSS-1	310	9.0	8.2	9.0	13.0
DSS-2	310	9.0	8.2	9.0	13.0
DSS-3	310	9.0	8.2	9.0	13.0
DSS-4	310	9.0	8.2	9.0	13.0
DSS-5	310	12.0	10.2	12.0	13.0
DSS-6	310	12.0	10.2	12.0	13.0

Summary of Air Source Heat Pump				
	Indoor Unit			
	Supply (CFM)	Outdoor (CFM)	Total SP (in. w.c.)	Motor HP
HPU-1A	3600	800	0.9	2

Summary of Pumps				
	GPM	Head (ft)	HP	RPM
P-1	301-522	115	25	1760
P-2	301-522	115	25	1760
P-3	400	60	10	1760
P-4	400	60	10	1760
P-5	60	16	0.5	1750
P-6	60	16	0.5	1750
P-7	13	20	0.25	1750
P-8	72	27	1	1750
P-9	84	27	1	1750
P-10	10	27	0.17	3250