Basis for Cost Estimates

Comprehensive Facility Management Planning

Creating High Performance Learning Environments

Plan Well…Fund Wisely

MACCRAY
Home of the Wolverines

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Energy Management and Direct Digital Controls

Existing Conditions

The heating, ventilating and air conditioning (HVAC) systems in the MACCRAY West Elementary School utilize a combination of direct digital control (DDC) and pneumatic controls. A Teletrol DDC system is responsible for controlling the scheduling, control, and monitoring of the majority of the air handling systems. A stand alone Metasys controller controls the gym air handling unit, and pneumatic controls are utilized for the remainder of the ventilation systems, terminal unit operation, and day/night set points.

Based on the site survey, observations of equipment operation and trend data, many of the system controls were identified to have sequence and calibration issues. These issues result in inefficient operation and uncomfortable building conditions. The following information documents the current state of the HVAC control systems at West Elementary School.

Energy Management System:

- The pneumatic control system is saturated with oil from the compressor and needs to be cleaned or replaced.
- The pneumatic control system is limited in its control strategies and has no alarming capability.
- The pneumatic system is difficult to re-configure and program and offer limited monitoring of the mechanical equipment and space temperatures.
- The pneumatic control system and associated mechanical equipment cannot be monitored or controlled remotely by the staff.
- Much of the system is currently being operated manually by the maintenance staff; turning the heating system on and off seasonally, and the unit ventilators on when the day staff begins and off in the evening.
- The maintenance staff manually control the heating and ventilation systems the best they can to maintain a comfortable environment. The present condition results in inefficient and inconsistent equipment operation, ineffective system performance and difficulty troubleshooting problems with the HVAC systems.

Air Handling Units and Cooling Equipment:

- The pneumatic controls that operate the ventilation systems are in need of calibration and replacement.
- The air handling units are operated longer than necessary due to limitations of the control system.

Steam Boilers and Pumps:

- The primary and back-up boilers are manually started and switched by the staff.

Exhaust Fans:

- Many of the exhaust fans in the facility are controlled manually, causing some units to run for extended periods of time.

Recommendations

Recommission the existing DDC controls and update the energy management system (EMS) for appropriate building systems to provide improved reliability, efficiency and performance. The following are examples of the proposed control strategies, sequences of operation and software program upgrades that would be incorporated for improving control of applicable HVAC equipment in the facility.

Energy Management System:

- Replace the existing pneumatic controls in the building by expanding the Teletrol DDC control system currently in operation in the school.
- Recommission the existing central energy management system (EMS) and direct digital controls (DDC) to provide scheduling and monitoring of heating, ventilating and air conditioning (HVAC) equipment.
- Utilize a web-based system to allow the EMS to be monitored and adjusted remotely from other district facilities.
- Provide a new front end including a new operator workstation, software, programming and graphics so new setpoints used for control of HVAC equipment will be displayed at the operator workstation and made adjustable.
- Replace existing DDC controls and hardware with new DDC controls.
- Provide new sequences of operation to provide more stable and precise control and improved system performance.

Steam Boilers:

- Provide new digital controls to provide enable/disable control of the steam boilers based on outside air temperature and building occupancy. The outside air temperature setpoint used to enable/disable the boilers will be reduced by an adjustable setback factor to compliment setting back space temperatures during scheduled unoccupied periods.
- Provide DDC control sequences for lead/lag and staging operation of the boilers.
- Provide DDC control sequences for monitoring and alarming of boiler flame failure.

Air Handling Units:

- Recommission DDC start/stop control of air handling system supply fans based on EMS time of day programming corresponding to scheduled space occupancy.
- Implement DDC sequence of operation for optimal start programming control of air handling systems to automatically start the systems based on outside air temperature and previous operating trend data. Sequence shall prevent outdoor air dampers from opening during the morning warm-up cycle until scheduled space occupancy.
- Provide DDC sequence of operation to allow cycling of air handling systems to maintain unoccupied space temperature setpoints.

Roof Top Units:

- Recommission DDC start/stop control of roof top unit supply fans based on EMS time of day programming corresponding to scheduled space occupancy.
- Implement DDC sequence of operation for optimal start programming control of roof top units to automatically start the systems based on outside air temperature and previous operating trend data. Sequence shall prevent outdoor air dampers from opening during the morning warm-up cycle until scheduled space occupancy.
- Recommission DDC day/night control of the roof top unit supply fans to provide automatic space temperature setback when the building is unoccupied.

Classroom Unit Ventilators:

- Provide new DDC start/stop control of unit ventilator supply fans based on EMS time of day programming corresponding to scheduled space occupancy.
- Implement DDC sequence of operation for optimal start programming control of unit ventilators to automatically start the systems based on outside air temperature and previous operating trend data.
- Implement DDC day/night control of unit ventilator supply fans to provide automatic space temperature setback when the building is unoccupied.

Direct Expansion (DX) Cooling:

- Recommission digital controls to provide enable/disable control of the DX cooling units based on outside air temperature and building occupancy.
- Provide DDC control sequences for monitoring and alarming of the DX cooling units.

Building Exhaust Fans:

- Provide new DDC start/stop control of larger exhaust fans based on EMS time of day programming corresponding to scheduled space occupancy.
- Provide DDC control sequences for status and monitoring of the larger exhaust fans.
- Replace existing manual switches with occupancy sensors in the restrooms to reduce fan runtime when the building is unoccupied.

Other Misc. Controls

- Provide DDC status monitoring of condensate water return temperature.
- Provide DDC status monitoring of the domestic hot water serving the building.
- Provide DDC sequence of operation for air handling unit mixed air damper control. Mixed air damper operation will be sequenced with heating and cooling control. The mixed air temperature setpoint will be reset based on space or return air temperature.
- Implement DDC sequence of operation for economizer control to modulate the mixed air dampers based on an outside air dry bulb temperature setpoint.
- Provide DDC sequence of operation for reset control of unit discharge air temperature setpoint based on space or return air temperature.
- Provide new DDC start/stop control of additional exhaust fans based on EMS time of day programming corresponding to scheduled space occupancy.
- Provide DDC control sequences for status and monitoring of additional exhaust fans.

Other Needed Control System Improvements

Existing Conditions

Much of the air handling equipment and space temperature controls in the building utilize older pneumatic controls. The classroom unit ventilators and other units are controlled pneumatically using a thermostat that operates the heating controls when needed to provide heating to the spaces served. Although many of the units have day/night capability, they are currently manually switched and operate inconsistently in the proper mode. These controls do not allow the space temperature to be automatically set back during unoccupied hours. These older controls are in need of calibration, adjustment or replacement to provide proper and efficient equipment operation.

Recommendations

This facility improvement will provide an allowance to recommission the existing pneumatic and electric controls including recalibration, adjustment or replacement to improve HVAC equipment functionality and operating efficiency.

Vending Machine Controls

Existing Conditions

The vending machines throughout the facilities are energized at all times. The majority of the vending machines have internal refrigeration systems for keeping beverages cool in addition to any lights that are continually energized.

Recommendations

Install controls to shut down the beverage vending machines when surrounding areas are unoccupied. The vending machines will be re-powered whenever the proximate area is occupied. In addition, the control will power up the vending machines at intervals independent of occupancy to ensure the vended product stays cool. This system has been approved by all the major soft drink companies as well as all the vending machine manufacturers.

Motor Efficiency Improvements

Existing Conditions

The majority of the mechanical systems in the building utilize older standard efficiency electric motors. The majority of electrical energy delivered to an electric motor is converted to mechanical energy and delivered to the load. Electric motors are typically 80.0 to 97% efficient with most of the efficiency losses due to heat generated by the motors.

Recommendations

Replace the larger standard efficiency electric motors with premium efficiency energy saving electric motors. Energy efficient electric motors are generally 1.0 to 6.5% more efficient than standard efficiency motors. Energy efficient electric motors achieve efficiency gains by using copper conductor windings, increasing the cross sectional area of the windings, increasing the length and quantity of iron used in the motor core, using smaller cooling fans due to smaller losses and improving the motor

manufacturing process. The increases in efficiency will result in lower operating costs and longer motor life from the reduction in losses due to heat generation.

The electric motor to be included in this improvement is the supply fan motor for the Cafeteria air handling unit – AHU-1.

Variable Speed Drives – Cafeteria Air Handling Unit

Existing Conditions

Most areas within the school are served by constant volume air handling units. These air handling unit supply fans run at full speed whenever they are operated, regardless of occupancy conditions in the spaces served. Each fan capacity was designed for maximum space occupancy and design temperature conditions that do not occur for the majority of the time that the systems operate. The Cafeteria air handling unit runs at full speed all day, however the space is not always fully occupied.

Recommendations

Install variable speed drive and controls on the Cafeteria air handling unit (AHU-1) supply fan.

The supply fan will have airflow modulated by direct digital controls based on CO_2 (Carbon dioxide), an indication of space occupancy, as well as temperature requirements in the space. The VSDs will increase airflow as necessary to maintain space temperature setpoints.

Energy consumption on motors is exponentially proportional to the motor speed; therefore, savings associated with reducing motor speeds are also exponential. Heating and cooling energy savings will be realized by reducing the amount of outside air delivered by the air handling units.

Lighting Retrofit

Existing Conditions

Lighting sources throughout the building include a variety of fixture and lamp combinations. The majority of the hallway, office and classroom lighting consist of fluorescent fixtures with newer T-8 fluorescent lamps and electronic ballasts. There is some incandescent lighting in the building as well as inefficient lamps in mechanical and storage areas.

Recommendations

This lighting retrofit option is aimed at retrofitting the majority of the existing lighting fixtures with the latest energy efficient lighting technologies while providing optimum lighting levels for the activities carried out in the various spaces. Specific areas addressed at West Elementary include:

- Replace incandescent lamps with new compact fluorescent lamps.
- Fixtures with T-12 fluorescent lamps: Retrofit or replace fixtures with new super T-8 fluorescent lamps and electronic ballasts. Most of the existing 2’ x 4’ recessed fixtures are in good shape and will be retrofitted. Many of the existing 1’ x 4’ recessed fixtures are in poor shape and could be replaced.
- Areas with inefficient fluorescent fixtures: Retrofit with new super T-8 fluorescent lamps and new low power electronic ballasts.

Lighting Fixture Replacement

Existing Conditions

Some of the lighting fixtures in the building have not been retrofitted or upgraded since the original installation over 30 years ago. These existing lighting fixtures are now aged, have cracked and yellowing lenses and could be upgraded in appearance and performance.

Recommendations

This lighting retrofit option is aimed at replacing many of the existing lighting fixtures with the latest energy efficient lighting technologies while providing optimum lighting levels for the activities carried out in the various spaces. The specific areas to be addressed include:

- Fixtures in the school that are older styles or in poor condition should be replaced to provide increased light levels:
- Replace these older fixtures with new energy efficient fixtures during the lighting retrofit.

Boiler / Heating System Upgrades

Existing Conditions

Two steam boilers, Boiler-3 and Boiler-2 are located in the boiler room and provide for the heating needs of the facility. Boiler-3 is a Kewanee boiler installed in 1965 that burns #2 fuel oil, and Boiler-2 is a Kewanee boiler that also burns #2 fuel oil. Boiler-3 serves as the primary boiler for the building, and Boiler-2 serves as its backup. The heating system consists of a steam distribution system that is piped directly to the air handlers with heating coils, unit ventilators, and cabinet unit heaters throughout the facility.

There are two boiler feed water return pumps that maintain a set level in the condensate tank and return the condensate back to the boilers. Feed Pump-1 delivers condensate back to Boiler-3, and Pump-2 delivers condensate to Boiler-2.

A combustion air damper is located in the north wall of the boiler room.

- The main school boiler is over 50 years of age and is approaching the end of its useful service life. In addition, because the boilers are sized to be redundant, and can each heat the entire school; at times during the spring and fall, the boilers are grossly over-sized for the heating load and can be quite inefficient.
- The boiler efficiency test readings were slightly outside of normal ranges of carbon dioxide and carbon monoxide. The boilers would benefit from a tune up to bring the emissions back into normal ranges.
- The efficiency test also indicated that the stack temperatures are at an elevated level for this type of boiler, which could indicate a scaling situation on the water side or soot on the fire side of the boiler. Scaling and soot acts as an insulator preventing proper heat transfer which raises the stack temperature.
- The steam boilers currently operate on heating oil and propane, which are expensive heating sources. Conversion to a natural gas hot water system would greatly improve the overall efficiency of the heating system.

Recommendations

To improve the efficiency and reliability of the heating system, replace the existing steam boilers and steam heating equipment in the school with two new hot water boilers and hot water heating system as described below:

- Replace the existing steam boilers Boiler-3 and Boiler-2 with two high efficiency hot water boilers. Hot water systems offer improved control of the supply air temperature in the central air handling units and the space temperature in each zone. These hydronic boilers are also more efficient than steam boilers at both full and partial load conditions.
- Factors to be included/considered in the final design include needed system capacity (for increased O.A. intake, equipment type, efficiency, redundancy, turn-down, condensate, steam trap size/location (to prevent system capacity/knocking issues), combustion air, controls, and codes (to name a few). Also consider (to name a few):
  - ◊ *Additional capacity for future ventilation work*
  - ◊ *Boiler redundancy (i.e. multiple boilers)*
  - ◊ *Domestic water heating*
  - ◊ *New breaching and venting*
  - ◊ *New boiler room piping (i.e. not connecting to existing steam headers)*
  - ◊ *New slabs*
  - ◊ *New combustion air system*
  - ◊ *Direct Digital Controls*
  - ◊ *Taxes and bonds (the contractors have to pay taxes on equipment unless it is purchased directly by the District)*
  - ◊ *Upgraded gas lines to meet new codes*
  - ◊ *Upgraded electrical systems to meet new codes*
  - ◊ *Demolition*

Boiler 3:

- Remove and decommission all steam piping and controls.
- Decommission, demolish and remove Boiler-3 from boiler room.
- Procure new boiler with burner & controls.
- Prepare pad /site for new boiler.
- Install new boiler.
- Route natural gas supply piping as needed, connect to new boiler. Install LP backup.
- Install new hot water piping and controls.
- Commission burner and controls.

Boiler 2:

- Remove and decommission all steam piping and controls.
- Demo and remove Boiler-2
- Procure new Boiler.
- Prepare pad /site for new boiler.
- Install new boiler.

- Route gas supply piping as needed, connect to new boiler.
- Install new hot water piping and controls.
- Commission burner and controls.

Steam to Hot Water Heating Conversion (External to Boilers)

Recommendations

This recommendation involves converting the facility steam system to hot water heating as described below:

- Existing steam radiation, convectors, unit heaters, air handling unit and unit ventilator coils will be changed out to hot water coils. Install new entry heaters as required. Deactivate perimeter heating in rooms that is not required any more.
- Existing steam and condensate piping will be replaced with new hot water supply and return distribution piping.
- A new hot water distribution pumping system will be installed which will be sized to handle the building load including future ventilation project needs. The pumping system will have two equally sized pumps with variable speed drives to allow reduction in flow during low load conditions. The system will contain glycol for freeze protection.
- Existing condensate pumping and makeup water systems will be removed.

Gymnasium De-Stratification Fans

Existing Conditions

The gymnasium is served by a single air handling unit located in the Gym mezzanine. Air is distributed to the gym through diffusers located in the mezzanine wall. Air circulation in the gym is poor and could be improved. Paddle fans are installed in the Gymnasium, however they are inefficient compared to newer designs. Temperature readings taken at various elevations indicate a significant temperature gradient from the floor surface upward to the ceilings. This condition results in stratification of the air, cold floor conditions and significant heat loss through the ceiling.

Recommendations

Install de-stratification fans in the Gymnasium to circulate air throughout the space. The fans will be installed at the ceiling level in locations designed to avoid interference with the existing lighting, ducting and roof structure. DDC controls will be included and commissioned to operate the fans to maintain space temperature setpoint in both the occupied and unoccupied conditions.

Plumbing Improvements

Existing Conditions

Many of the older bathroom toilets, urinals and sinks in West Elementary School are original and of high water consumption. In addition, several of the existing bathroom toilet and urinal flushometer valves have exceeded their useful life.

A survey has been completed of the existing plumbing fixtures to determine age, condition and potential for utility savings.

Recommendations

In the school, replace high water consumption sink faucets, toilet flush valves and urinal flush valves with lower water consuming replacements:

- Install vandal resistant flow control devices in the sinks throughout the district buildings. Adjust total flow to no less than one gallon per minute.
- Calibrate flushometers to meet the requirements of the individual fixture to optimize the flush sequence and eliminate unnecessary consumption.
- Retrofit the flushometer valves by replacing all "wear" parts, those components that often require maintenance. The new components are designed and tested to resist rigors of substantial use, as well as the effects of chloramines and sediments in water.

Sprinkler System Improvements

Existing Conditions

The boiler room is the only area of the school that is currently protected by a sprinkler system.

Recommendations

The sprinkler system should be extended to provide coverage and protection school-wide. If ventilation and heating system improvements are implemented, the sprinklers could be added with at a lower cost.

Building Envelope / Air Leakage

Existing Conditions

It was noted during the engineering review that some areas of the building envelopes are aged and in need of refurbishment or repair. Many exterior doors have missing or ineffective weather-stripping, which allows cold air to infiltrate into the facilities. Some windows are also in need of caulking which would further enhance the interior environment.

Recommendations

A survey has been conducted to determine all needed building envelope improvements. Foam insulation will be installed to seal building openings and weather stripping will be installed as needed on external doors for each school. Sealing of the building interior and the upgraded door systems will result in reduced building heat losses and increased occupant comfort.

General Overview of Air Handling Systems Scope of Work

Centralized mechanical systems are the preferred method of conditioning today's classroom spaces. These systems not only provide for lower operating costs (utilities and maintenance), but mechanical noise is eliminated from the classroom and the improved temperature gradients provide greater comfort.

Overview of Operation

A central air-handling unit provides airflow through the ductwork system at a constant temperature, which is reset based on space heating, cooling and dehumidification needs. Variable Air Volume (VAV) terminal boxes provide individual temperature control for each zone. As a space requires heating the VAV box damper closes and allows the central air handling unit fan speed is reduced. If further heating is required the hot water heating control valve opens to maintain the space temperature set point. As a space requires cooling the reverse occurs opening the VAV box damper and closing the hot water control valve.

Scope of Work Inclusions

Soft Costs

- ◊ *Architectural Fees*
- ◊ *Engineering Fees*
- ◊ *Construction Management*
- ◊ *Commissioning*
- ◊ *Permits*
- ◊ *Bonds*
- ◊ *Contingencies*

Demolition

- ◊ *Abatement - Asbestos*
- ◊ *Demolition - Air Side and Wet Side Systems Including Boilers and Steam Distribution*
- ◊ *Demolition - Boilers, Steam Distribution System, Condensate*
- ◊ *Demolition - Chimneys, Flues, Combustion Air*

Air Distribution

- ◊ *Air Handling Units - Variable Air Volume with chilled water coils*
- ◊ *Diffusers*
- ◊ *Ductwork - Supply Air and Return Air*
- ◊ *Grilles*
- ◊ *VAV Boxes w/Reheats*

Cooling System

- ◊ *Chiller(s)*
- ◊ *Cold Water Element*
- ◊ *Cold Water Flow Piping, Cold Water Return Piping*
- ◊ *Hydronic Specialties - Expansion Tanks, Air Separators, Chemical Feeders*
- ◊ *Pipe Insulation - Labeling*
- ◊ *Test, Adjust, and Balance - Air Side*
- ◊ *Test, Adjust, and Balance - Wet Side*

Electrical System

- ◊ *Primary / Secondary Transformer*
- ◊ *Main Switch Board 1*
- ◊ *Distribution Section*
- ◊ *Feeder Section*

- ◊ *Motor Control Center*
- ◊ *Step Down Transformer*
- ◊ *Electrical Feeders*
- ◊ *Electrical Panels*
- ◊ *New Lighting Systems*
- ◊ *Variable Frequency Drives*
- ◊ *Fire Alarm*

General Construction

- ◊ *Structural*
- ◊ *Ceiling Demolition*
- ◊ *New Acoustical Ceiling Tile & Grid (ACT)*
- ◊ *Floor Demolition / Finishes*
- ◊ *Shaft / Soffit Construction*
- ◊ *Fire Sealants - Wall Penetrations*
- ◊ *Drywall and Painting*

Miscellaneous

- ◊ *Fire Protection - Relocation of Mains, Extend Heads*
- ◊ *Direct Digital Temperature Controls*

Site Work / Civil

- ◊ *Site / Civil - Demolition, Concrete Pads, Paving, Fencing*
- ◊ *Liquefied Propane - Backup Fuel for Boilers*
- ◊ *Utilities - Natural Gas Piping*

Replace Cafeteria AHU-1 with VAV System with De-Humidification

Existing Conditions

- ➢ Air handling unit AHU-1 is a constant volume unit that serves the cafeteria. This unit consists of a constant volume supply fan, mixed air dampers, and a steam heating coil.
- ➢ Relief is provided by relief dampers located in the cafeteria.
- ➢ The filters, interior plenum and coils are dirty and in need of cleaning.
- ➢ The unit is over 15 years of age and approaching the end of its useful life.
- ➢ AHU-1 is not designed to provide airflow to the areas served per current indoor air standards.
- ➢ The heating coil of AHU-1 is undersized to provide adequate outside ventilating air per current standards.
- ➢ Indoor air quality measurements taken in the Cafeteria show elevated levels of carbon dioxide (CO_2).

Recommendations

Install a new air handling system to provide heat and ventilation to the Cafeteria area per current standards. This ventilation improvement alternative includes replacing air handler AHU-1 with a new air handling systems designed to provide heating and ventilation control. Temperature control for the spaces will be by variable air volume (VAV) terminal boxes with hot water reheat coils. Provide new

supply and return air ductwork for the new system. The new system will be designed to comply with current codes, standards and statutes with regard to return/relief air, ventilation rates and air filtration. Provide direct digital controls (DDC) with demand controlled ventilation. Implement energy management system (EMS) control sequences and strategies to operate the air handling system based on anticipated occupancy schedules and actual ventilation demand. Provide commissioning of the systems and all mechanical and electrical work associated with the installation to ensure proper function, maintainability and operator training. Install mechanical systems and direct digital controls (DDC) to provide space dehumidification.

Replace Gymnasium AHU and Upgrade Locker Room Exhaust / Ventilation

Existing Conditions

- The gymnasium air handling unit is a constant volume unit that serves the gym. This unit consists of a constant volume supply fan, mixed air with an outside air damper, and a steam heating coil.
- Relief is provided by relief dampers located in the space. Perimeter radiation also serves the three exterior walls of the gym.
- Two exhaust fans serve the adjacent Men's and Women's Locker Rooms.
- One of the relief dampers located in the gym does not modulate open to provide relief. The actuator was bad and the pneumatic line has been disconnected.
- There is one strip of perimeter radiation on the north wall that has had its steam line capped off and control valve disconnected and is no longer in use.
- The unit is over 50 years of age and has exceeded its useful service life.
- There is no dedicated source of make-up air for the Locker Rooms when the exhaust fans are operated.
- The Gymnasium air handling unit is not designed to provide outside airflow to all areas served per current indoor air standards.

Recommendations

Install a new air handling system to provide heat and ventilation to the Gymnasium per current standards. Decommission Gymnasium-AHU and replace with a new air handling unit with variable speed controls. Install new supply and return ducting to serve the Gymnasium area. Install sensors and controls to modulate supply, outside and return air based on the real-time space temperature and ventilation requirements of the space. Include carbon dioxide sensors and utilize demand controlled ventilation sequences. Program the new unit to operate in an energy efficient manner while maintaining proper ventilation in the Gymnasium per current code requirements.

Replace Fan Coil Unit (FCU-1)

Existing Conditions

- Fan coil unit FCU-1 is a constant volume unit that serves the restrooms near the gym. This unit consists of a constant volume supply fan, two sets of return air dampers, and a steam heating coil.
- The exhaust fan EF-1 also serves the restrooms.

- Unit FCU-1 provides minimal airflow to the restrooms, and supplies no outside air for ventilation of the area.
- Exhaust fan EF-1 was not functional at the time of survey.

Recommendations

Install a new air handling system to provide heat and ventilation to the Gymnasium restrooms per current standards. Decommission FCU-1 and replace with a new air handling unit with outside air capability. Install a new energy efficient exhaust fan with controls. Install sensors and controls to modulate supply, outside and return air based on the real-time space temperature and ventilation requirements of the space. Program the new unit to operate in an energy efficient manner while maintaining proper ventilation in the restrooms per current code requirements.

Replace Office AHU (HE-1) with VAV System with De-Humidification

Existing Conditions

- Heat exchanger air handling unit HE-1 is a constant volume, 100% outside air heat exchanger located on the roof and serves the main office area. This unit consists of an outside air damper, an outside air intake fan, a return air exhaust fan, and a conjoined packaged single stage DX cooling unit with an indoor supply fan and ceiling plenum return. Relief is provided at the unit.
- There are five steam reheat coils that provide individual room temperature control to the spaces served.
- HE-1 outside air intake and return air exhaust fans were not operating at the time of survey. This creates minimal air exchange, a limited supply of ventilation and the supply fan is only re-circulating return air.
- The condenser unit located on the roof has coils that are approximately 20% damaged.
- The unit is over 15 years of age and approaching the end of its useful life.
- The office area does not need 100% outside air for proper ventilation.

Recommendations

Install a new air handling system to provide heat, cooling and ventilation to the Office area per current standards. This ventilation improvement alternative includes replacing air handler HE-1 with a new air handling systems designed to provide heating and ventilation control. Zone control for the spaces will be by variable air volume (VAV) terminal boxes with hot water reheat coils. Provide new supply and return air ductwork for the new system. The new system will be designed to comply with current codes, standards and statutes with regard to return/relief air, ventilation rates and air filtration. Provide direct digital controls (DDC) with demand controlled ventilation. Implement energy management system (EMS) control sequences and strategies to operate the air handling system based on anticipated occupancy schedules and actual ventilation demand. Provide commissioning of the systems and all mechanical and electrical work associated with the installation to ensure proper function, maintainability and operator training.

Install mechanical systems and direct digital controls (DDC) to provide space dehumidification. Adding dehumidification to the classrooms will improve the comfort of the occupants during periods of high outdoor air humidity. It can also help contain the growth of mold and mildew within the building,

reducing the presence of certain allergens. Optimal humidity levels between 30% and 60% RH (relative humidity) reduce the potential for growth and transmission of certain organisms such as the influenza virus.

Replace Classroom Roof Top Unit RTU-1

Existing Condition

- Roof top unit RTU-1 is a constant volume unit that serves rooms 122, 124, 134, 134a, 134b, and 134c. This unit consists of a constant volume supply fan and mixed air dampers.
- Six terminal steam reheats provide individual room temperature control to the spaces served. Relief is provided by relief dampers located in rooms 134 and 122.
- RTU-1 is not designed to provide airflow to the areas served per current indoor air standards.
- Indoor air quality measurements taken in the classrooms show elevated levels of carbon dioxide (CO_2).
- Air handling unit RTU-1 is over 15 years of age and approaching the end of its useful service life.

Recommendations

Install a new air handling system to provide heat and ventilation to the areas served by roof top unit RTU-1 per current standards. This ventilation improvement alternative includes replacing RTU-1 with a new air handling systems designed to provide heating and ventilation control. Zone control for the spaces will be by variable air volume (VAV) terminal boxes with hot water reheat coils. Provide new supply and return air ductwork for the new system. The new system will be designed to comply with current codes, standards and statutes with regard to return/relief air, ventilation rates and air filtration. Provide direct digital controls (DDC) with demand controlled ventilation. Implement energy management system (EMS) control sequences and strategies to operate the air handling system based on anticipated occupancy schedules and actual ventilation demand. Provide commissioning of the systems and all mechanical and electrical work associated with the installation to ensure proper function, maintainability and operator training.

In addition to replacing the unit, this ventilation improvement alternative includes provisions for installing mechanical systems and direct digital controls (DDC) to provide space dehumidification.

Replace Classroom Roof Top Unit RTU-2

Existing Conditions

- Roof top unit RTU-2 is a constant volume unit that serves rooms 115A, 117A, 119, 125, and 127. This unit consists of a constant volume supply fan and mixed air dampers.
- Five terminal steam reheats provide individual room temperature control to the spaces served. Relief is provided by relief dampers located in room 117.
- RTU-2 is not designed to provide airflow to the areas served per current indoor air standards.
- Air handling unit RTU-2 is over 15 years of age and approaching the end of its useful service life.

Recommendations

Install a new air handling system to provide heat and ventilation to the areas served by roof top unit RTU-2 per current standards. This ventilation improvement alternative includes replacing RTU-2 with a new air handling systems designed to provide heating and ventilation control. Zone control for the spaces will be by variable air volume (VAV) terminal boxes with hot water reheat coils. Provide new supply and return air ductwork for the new system. The new system will be designed to comply with current codes, standards and statutes with regard to return/relief air, ventilation rates and air filtration. Provide direct digital controls (DDC) with demand controlled ventilation. Implement energy management system (EMS) control sequences and strategies to operate the air handling system based on anticipated occupancy schedules and actual ventilation demand. Provide commissioning of the systems and all mechanical and electrical work associated with the installation to ensure proper function, maintainability and operator training.

In addition to replacing the unit, this ventilation improvement alternative includes provisions for installing mechanical systems and direct digital controls (DDC) to provide space dehumidification.

Classroom Unit Ventilators – Replacement with VAV and Dehumidification

Existing Conditions

Eighteen unit ventilators provide individual room temperature control and ventilation to various classrooms in the facility. Eleven units serve the original 1954 building and seven units serve the 1965 addition. Each unit consists of a constant volume supply fan, mixed air dampers, and a steam heating coil. Relief path is provided through transfer air grilles in each classroom out to gravity relief dampers located in the hallway. Perimeter steam radiation also serves many of these same spaces. (Rooms 101, 105, 107, 109, 111, 114, 116, 118, and 128)

- The filters and coils are dirty and in need of cleaning.
- The Classroom Unit Ventilators are not designed to provide airflow to the areas served per current indoor air standards.
- The heating coil of the Classroom Unit Ventilators is undersized to provide adequate outside ventilating air per current standards.
- Indoor air quality measurements taken in the classrooms show elevated levels of carbon dioxide (CO_2).
- The Classroom Unit Ventilators are over 40 years of age and at the end of their useful service life.
- The indoor air quality survey indicated that the occupants of these classrooms do not receive adequate outside air levels.

Recommendations

Replace the units serving the classrooms with new central air handling systems designed to provide required heating and ventilation control. Zone control will be by variable air volume (VAV) terminal boxes with hot water reheat coils. Provide new supply and return air ductwork as applicable for the new systems. The new systems will be designed to comply with current codes, standards and statutes with regard to return/relief air, ventilation rates and air filtration. Provide direct digital controls (DDC) with demand controlled ventilation. Implement energy management system (EMS) control sequences

and strategies to operate the air handling systems based on anticipated occupancy schedules and actual ventilation demand. Provide commissioning of the systems and all mechanical and electrical work associated with the installation to ensure proper function, maintainability and operator training.

Install mechanical systems and direct digital controls (DDC) to provide space dehumidification.

School-Wide Exhaust Fans – Repair and Replace

Existing Conditions

The majority of the exhaust fans that serve the school are original with some over 50 years of age. The staff has noted that many fans are inadequate and have exceeded their expected service life. Measurement of exhaust airflow indicated areas that are operating below ventilation requirements. Proper ventilation in the school is contingent upon properly operating mechanical exhaust systems; however, the survey of exhaust airflow indicated areas that are operating below ventilation requirements. Many of the exhaust fans located on the roof have exceeded their expected life and are in need of replacement.

Recommendations

Inspect and refurbish all exhaust fans in the building and their controls. Clean fan housings, tighten belts and check electrical connections and motor starters and switches. Recommission controls and program for energy efficient operation of the exhaust fans. Replace older exhaust fans and underperforming units with new direct drive exhaust fans to meet ventilation standards. Direct drive fans eliminate the need for replacing belts. Include integral electric back draft dampers to operate with exhaust fan. Provide new DDC controls to control the larger exhaust fans based on a building occupancy schedule.

Energy Management and Direct Digital Controls

Existing Conditions

The heating, ventilating, and air conditioning (HVAC) systems in East Elementary School utilize a combination of pneumatic and electric controls. A Barber Coleman Network 8000 stand alone controller located in the boiler room monitors the majority of the air handling units. The maintenance staff is responsible for manually switching from the day to night operation of most major equipment in the building from a pneumatic control panel in the boiler room. The start/stop operation of the majority of the equipment is also controlled manually by staff.

Based on the site survey, observations of equipment operation and trend data, many of the system controls were identified to have sequence and calibration issues. These issues result in inefficient operation and uncomfortable building conditions. The following information documents the current state of the HVAC control systems at East Elementary School.

Energy Management System:

- The EMS control system is an obsolete technology with limited or nonexistent replacement parts.
- The EMS does not have a central workstation or front end preventing the building equipment in the system from being monitored and controlled.
- The only access to the system is from touch pad located on the control panel.
- There is no access to the control strategies in the system, and no documentation is available to the customer.
- The pneumatic control system is limited in its control strategies and has no alarming capability.
- The pneumatic system is difficult to re-configure and program and offer limited monitoring of the mechanical equipment and space temperatures.
- The pneumatic control system and associated mechanical equipment cannot be monitored or controlled remotely by the staff.
- The maintenance staff manually control the heating and ventilation systems the best they can to maintain a comfortable environment. The present condition results in inefficient and inconsistent equipment operation, ineffective system performance and difficulty troubleshooting problems with the HVAC systems.

Air Handling Units and Cooling Equipment:

- There is no way to remotely troubleshoot or have the ability to view mechanical operation of the heating and ventilation systems.
- The pneumatic controls that operate the ventilation systems are in need of calibration and replacement.
- The air handling units are operated longer than necessary due to limitations of the control system.
- The EMS system cannot currently be used to automatically switch HVAC equipment in the building from Day to Night modes.

Steam Boilers and Pumps:

- The primary and back-up boilers are manually started and switched by the staff.

Exhaust Fans:

- Many of the exhaust fans in the facility are controlled manually, causing some units to run for extended periods of time.

Recommendations

- Replace the existing pneumatic controls with a new energy management system (EMS) and direct digital control (DDC) controls that are compatible with the Teletrol EMS systems currently installed at the MACCRAY School District West Elementary School.
- Utilize a web-based system to allow the EMS to be monitored and adjusted remotely from other district facilities.
- Provide a new front end including a new operator workstation, software, programming and graphics so new setpoints used for control of HVAC equipment will be displayed at the operator workstation and made adjustable.
- Replace existing pneumatic and electric controls and hardware with new DDC controls.
- Provide new sequences of operation to provide more stable and precise control and improved system performance.

Energy Management System:

- Install direct digital control (DDC) hardware including DDC sensors such as temperature and duct static pressure sensors.
- Install current switches to be used for on/off status reporting and relays used for start/stop control.
- Install energy management system software, programming and sequences of operation. Include the tuning of control loops to provide more stable and precise control and improved system performance.
- Install energy management system graphics so new DDC setpoints used for control of HVAC equipment will be displayed at the operator workstation and make adjustments to the system.

Steam Boilers:

- Provide new digital controls to provide enable/disable control of the steam boilers based on outside air temperature and building occupancy. The outside air temperature setpoint used to enable/disable the boilers will be reduced by an adjustable setback factor to compliment setting back space temperatures during scheduled unoccupied periods.
- Provide DDC control sequences for lead/lag and staging operation of the boilers.
- Provide DDC control sequences for monitoring and alarming of boiler flame failure.

Air Handling Units:

- Provide new DDC start/stop control of air handling system supply fans based on EMS time of day programming corresponding to scheduled space occupancy.
- Implement DDC sequence of operation for optimal start programming control of air handling systems to automatically start the systems based on outside air temperature and previous

operating trend data. Sequence shall prevent outdoor air dampers from opening during the morning warm-up cycle until scheduled space occupancy.

- Provide DDC sequence of operation to allow cycling of air handling systems to maintain unoccupied space temperature setpoints.

Roof Top Units:

- Provide new DDC start/stop control of air handling system supply fans based on EMS time of day programming corresponding to scheduled space occupancy.
- Implement DDC sequence of operation for optimal start programming control of air handling systems to automatically start the systems based on outside air temperature and previous operating trend data. Sequence shall prevent outdoor air dampers from opening during the morning warm-up cycle until scheduled space occupancy.
- Provide DDC sequence of operation to allow cycling of roof top units to maintain unoccupied space temperature setpoints.

Classroom Unit Ventilators:

- Provide new DDC start/stop control of unit ventilator supply fans based on EMS time of day programming corresponding to scheduled space occupancy.
- Implement DDC sequence of operation for optimal start programming control of unit ventilators to automatically start the systems based on outside air temperature and previous operating trend data.
- Provide DDC sequence of operation to allow cycling of unit ventilators to maintain unoccupied space temperature setpoints.

Direct Expansion (DX) Cooling:

- Provide new digital controls to provide enable/disable control of the DX cooling units based on outside air temperature and building occupancy.
- Provide DDC control sequences for monitoring and alarming of the DX cooling units.

Building Exhaust Fans:

- Provide new DDC start/stop control of larger exhaust fans based on EMS time of day programming corresponding to scheduled space occupancy.
- Provide DDC control sequences for status and monitoring of the larger exhaust fans.
- Replace existing manual switches with occupancy sensors in the restrooms to reduce fan runtime when the building is unoccupied.

Other Misc. Controls

- Provide DDC status monitoring of condensate water return temperature.
- Provide DDC status monitoring of the domestic hot water serving the building.
- Implement DDC sequence of operation for economizer control to modulate the mixed air dampers based on an outside air dry bulb temperature setpoint.
- Provide DDC sequence of operation for reset control of unit discharge air temperature setpoint based on space or return air temperature.

- Provide DDC sequence of operation for air handling unit mixed air damper control. Mixed air damper operation will be sequenced with heating and cooling control. The mixed air temperature setpoint will be reset based on space or return air temperature.
- Provide new DDC start/stop control of additional exhaust fans based on EMS time of day programming corresponding to scheduled space occupancy.
- Provide DDC control sequences for status and monitoring of additional exhaust fans.

Other Needed Control System Improvements

Existing Conditions

Much of the air handling equipment and space temperature controls in the building utilize older pneumatic controls. The classroom unit ventilators and other units are controlled pneumatically using a thermostat that operates the heating controls when needed to provide heating to the spaces served. Although many of the units have day/night capability, they are currently manually switched and operate inconsistently in the proper mode. These controls do not allow the space temperature to be automatically set back during unoccupied hours. These older controls are in need of calibration, adjustment or replacement to provide proper and efficient equipment operation.

Recommendations

This facility improvement will provide an allowance to recommission the existing pneumatic and electric controls including recalibration, adjustment or replacement to improve HVAC equipment functionality and operating efficiency.

Vending Machine Controls

Existing Conditions

The vending machines throughout the facilities are energized at all times. The majority of the vending machines have internal refrigeration systems for keeping beverages cool in addition to any lights that are continually energized.

Recommendations

Install controls to shut down the beverage vending machines when surrounding areas are unoccupied. The vending machines will be re-powered whenever the proximate area is occupied. In addition, the control will power up the vending machines at intervals independent of occupancy to ensure the vended product stays cool. This system has been approved by all the major soft drink companies as well as all the vending machine manufacturers.

Lighting Retrofit

Existing Conditions

The lighting sources throughout the building include a variety of fixture and lamp combinations. The majority of the lighting consists of fluorescent fixtures with newer T-8 fluorescent lamps and electronic ballasts. There are still some inefficient lighting sources, however including incandescent lighting in the

building, inefficient lamps in mechanical and storage areas and metal halide fixtures on the building exterior.

Recommendations

This lighting retrofit option is aimed at retrofitting the majority of the existing lighting fixtures with the latest energy efficient lighting technologies while providing optimum lighting levels for the activities carried out in the various spaces. The specific areas to be addressed at East Elementary School include:

- Replace T-12 lamps and magnetic ballasts with energy efficient T-8 fluorescent lamps and electronic ballasts.
- Replace incandescent lamps with new compact fluorescent lamps.
- Replace exterior metal halide lighting with pulse start lamps

Lighting Fixture Replacement

Existing Conditions

Some areas of the building could be upgraded in terms of lighting fixture quality and appearance.

Recommendations

Replace the existing aged lighting fixtures with new energy efficient fluorescent fixtures with T-8 fluorescent lamps and energy efficient ballasts.

Lighting Controls

Existing Conditions

Many spaces throughout the facility have variable occupancy, including conference rooms, offices and restrooms. When spaces are vacated, the lights are often left burning although the spaces are empty.

Recommendations

This lighting control improvement is aimed at installing occupancy controls in various spaces within the building to shut off lights when the rooms are unoccupied. The specific areas to be addressed at East Elementary include:

- Install occupancy sensors in areas with high savings potential.

Boiler / Heating System Upgrades

Existing Conditions

- Two steam boilers, Boiler-1 and Boiler-2 are located in the boiler room and provide for the heating needs of the facility. Boiler-1 is a Dunham Bush boiler that burns #2 fuel oil, and Boiler-2 is a Powermaster that also uses #2 fuel oil. Boiler-1 serves as the primary boiler for the building, and Boiler-2 serves as its backup. The heating system consists of a steam distribution system that is piped directly to the air handlers with heating coils, unit ventilators, perimeter radiation, and cabinet unit heaters throughout the facility.
- The primary boiler is over 50 years of age and is approaching the end of its useful service life. In addition, because the boilers are sized to be redundant, and can each heat the entire school; at

times during the spring and fall, the boilers are grossly over-sized for the heating load and can be quite inefficient.

- There are four boiler feed water return pumps that maintain a set level in the condensate tanks and return the condensate back to the boilers. Feed Pump-1 delivers condensate back to Boiler-1, Pump-2 delivers condensate to Boiler-2, and pumps -3, -4 serve the secondary condensate receivers.
- Each boiler has an associated combustion air damper located in the west wall of the boiler room.
- At the time of survey, condensate pump P-4 was not operational and in need of repair.
- High condensate return temperatures returning from the classroom wing indicate the possibility of failed steam traps in that vicinity.
- Although generally good, the boiler efficiency test readings were just outside of normal ranges of carbon dioxide levels. The boilers would benefit from a tune up to bring the emissions back into normal ranges.
- The steam boilers currently operate on heating oil and propane, which are expensive heating sources. Conversion to a natural gas hot water system would greatly improve the overall efficiency of the heating system.

Recommendations

To improve the efficiency and reliability of the heating system, replace the existing steam boilers and steam heating equipment in the school with two new hot water boilers and hot water heating system as described below:

- Replace the existing steam boilers B-1 and B-2 with two high efficiency hot water boilers. Hot water systems offer improved control of the supply air temperature in the central air handling units and the space temperature in each zone. These hydronic boilers are also more efficient than steam boilers at both full and partial load conditions.
- Factors to be included/considered in the final design include needed system capacity (for increased O.A. intake, equipment type, efficiency, redundancy, turn-down, condensate, steam trap size/location (to prevent system capacity/knocking issues), combustion air, controls, and codes (to name a few). Also consider (to name a few):
  - ◊ *Additional capacity for future ventilation work*
  - ◊ *Boiler redundancy (i.e. multiple boilers)*
  - ◊ *Domestic water heating*
  - ◊ *New breaching and venting*
  - ◊ *New boiler room piping (i.e. not connecting to existing steam headers)*
  - ◊ *New slabs*
  - ◊ *New combustion air system*
  - ◊ *Direct Digital Controls*
  - ◊ *Taxes and bonds (the contractors have to pay taxes on equipment unless it is purchased directly by the District)*
  - ◊ *Upgraded gas lines to meet new codes*
  - ◊ *Upgraded electrical systems to meet new codes*
  - ◊ *Demolition*

Boiler B-1:

- Remove and decommission all steam piping and controls.
- Decommission, demolish and remove Boiler B-1 from boiler room.
- Procure new Boiler with burner and controls.
- Prepare pad /site for new boiler.
- Install new boiler.
- Route natural gas supply piping as needed, connect to new boiler.
- Install new hot water piping and controls.
- Commission burner and controls.

Boiler B-2:

- Remove and decommission all steam piping and controls.
- Demo and remove Boiler B-2
- Procure new Boiler.
- Prepare pad /site for new boiler.
- Install new boiler.
- Route gas supply piping as needed, connect to new boiler.
- Install new hot water piping and controls.
- Commission burner & controls.

Steam to Hot Water Heating Conversion (External to Boilers)

Recommendations

This recommendation involves converting the facility steam system to hot water heating as described below:

- Existing steam radiation, convectors, unit heaters, air handling unit and unit ventilator coils will be changed out to hot water coils. Install new entry heaters as required. Deactivate perimeter heating in rooms that is not required any more.
- Existing steam and condensate piping will be replaced with new hot water supply and return distribution piping.
- A new hot water distribution pumping system will be installed which will be sized to handle the building load including future ventilation project needs. The pumping system will have two equally sized pumps with variable speed drives to allow reduction in flow during low load conditions. The system will contain glycol for freeze protection.
- Existing condensate pumping and makeup water systems will be removed.

Install De-Stratification Fans - Gymnasium

Existing Conditions

The gymnasium is served by two air handling units located in adjacent mechanical mezzanine. Air is distributed to the gym through diffusers located in the mezzanine wall. Air circulation in the gym is poor and could be improved. Temperature readings taken at various elevations indicate a significant

temperature gradient from the floor surface upward to the ceilings. This condition results in stratification of the air, cold floor conditions and significant heat loss through the ceiling.

Recommendations

Install de-stratification fans in the Gymnasium to circulate air throughout the spaces. The fans will be installed at the ceiling level in locations designed to avoid interference with the existing lighting, ducting and roof structure. DDC controls will be included and commissioned to operate the fans to maintain space temperature setpoint in both the occupied and unoccupied conditions.

Plumbing Improvements

Existing Conditions

Many of the older bathroom toilets, urinals and sinks in the building are original and of high water consumption. In addition, several of the existing bathroom toilet and urinal flushometer valves have exceeded their useful life. A survey has been completed of the existing plumbing fixtures to determine age, condition and potential for utility savings.

Recommendations

In MACCRAY East Elementary School, replace high water consumption sink faucets, toilet flush valves and urinal flush valves with lower water consuming replacements:

- Install vandal resistant flow control devices in the sinks throughout the district buildings. Adjust total flow to no less than one gallon per minute.
- Calibrate flushometers to meet the requirements of the individual fixture to optimize the flush sequence and eliminate unnecessary consumption.
- Retrofit the flushometer valves by replacing all “wear” parts, those components that often require maintenance. The new components are designed and tested to resist rigors of substantial use, as well as the effects of chloramines and sediments in water.

Sprinkler System Improvements

Existing Conditions

Only the boiler room and east area corridor of the school are protected by a sprinkler system.

Recommendations

The sprinkler system should be extended to provide coverage and protection school-wide. If ventilation and heating system improvements are implemented, the sprinklers could be added with at a lower cost.

Building Envelope / Air Leakage

Existing Conditions

It was noted during the engineering review that some areas of the building envelopes are aged and in need of refurbishment or repair. Many exterior doors have missing or ineffective weather-stripping,

which allows cold air to infiltrate into the facilities. Some windows are also in need of caulking which would further enhance the interior environment.

Recommendations

A survey has been conducted to determine all needed building envelope improvements. Foam insulation will be installed to seal building openings and weather stripping will be installed as needed on external doors for each school. Sealing of the building interior and the upgraded door systems will result in reduced building heat losses and increased occupant comfort.

General Overview of Air Handling Systems Scope of Work

Centralized mechanical systems are the preferred method of conditioning today's classroom spaces. These systems not only provide for lower operating costs (utilities and maintenance), but mechanical noise is eliminated from the classroom and the improved temperature gradients provide greater comfort.

Overview of Operation

A central air-handling unit provides airflow through the ductwork system at a constant temperature, which is reset based on space heating, cooling and dehumidification needs. Variable Air Volume (VAV) terminal boxes provide individual temperature control for each zone. As a space requires heating the VAV box damper closes and allows the central air handling unit fan speed is reduced. If further heating is required the hot water heating control valve opens to maintain the space temperature set point. As a space requires cooling the reverse occurs opening the VAV box damper and closing the hot water control valve.

Scope of Work Inclusions

Soft Costs

- ◊ *Architectural Fees*
- ◊ *Engineering Fees*
- ◊ *Construction Management*
- ◊ *Commissioning*
- ◊ *Permits*
- ◊ *Bonds*
- ◊ *Contingencies*

Demolition

- ◊ *Abatement - Asbestos*
- ◊ *Demolition - Air Side and Wet Side Systems Including Boilers and Steam Distribution*
- ◊ *Demolition - Boilers, Steam Distribution System, Condensate*
- ◊ *Demolition - Chimneys, Flues, Combustion Air*

Air Distribution

- ◊ *Air Handling Units - Variable Air Volume with chilled water coils*
- ◊ *Diffusers*
- ◊ *Ductwork - Supply Air and Return Air*
- ◊ *Grilles*

- ◊ *VAV Boxes w/Reheats*

Cooling System

- ◊ *Chiller(s)*
- ◊ *Cold Water Element*
- ◊ *Cold Water Flow Piping, Cold Water Return Piping*
- ◊ *Hydronic Specialties - Expansion Tanks, Air Separators, Chemical Feeders*
- ◊ *Pipe Insulation - Labeling*
- ◊ *Test, Adjust, and Balance - Air Side*
- ◊ *Test, Adjust, and Balance - Wet Side*

Electrical System

- ◊ *Primary / Secondary Transformer*
- ◊ *Main Switch Board 1*
- ◊ *Distribution Section*
- ◊ *Feeder Section*
- ◊ *Motor Control Center*
- ◊ *Step Down Transformer*
- ◊ *Electrical Feeders*
- ◊ *Electrical Panels*
- ◊ *New Lighting Systems*
- ◊ *Variable Frequency Drives*
- ◊ *Fire Alarm*

General Construction

- ◊ *Structural*
- ◊ *Ceiling Demolition*
- ◊ *New Acoustical Ceiling Tile & Grid (ACT)*
- ◊ *Floor Demolition / Finishes*
- ◊ *Shaft / Soffit Construction*
- ◊ *Fire Sealants - Wall Penetrations*
- ◊ *Drywall and Painting*

Miscellaneous

- ◊ *Fire Protection - Relocation of Mains, Extend Heads*
- ◊ *Direct Digital Temperature Controls*

Site Work / Civil

- ◊ *Site / Civil - Demolition, Concrete Pads, Paving, Fencing*
- ◊ *Liquefied Propane - Backup Fuel for Boilers*
- ◊ *Utilities - Natural Gas Piping*

Replace Cafeteria AHU (S-1) with VAV System with De-Humidification

Existing Conditions

- ➢ Air handling unit S-1 is a constant volume unit located in the penthouse and serves the cafeteria. This unit consists of a constant volume supply fan, mixed air dampers, and a steam heating coil. The unit utilizes a ceiling plenum return, and the relief is provided in the space.

- The heating coil of S-1 is damaged.
- Air handling unit S-1 is over 15 years of age and approaching the end of its useful service life.

Recommendations

Install a new air handling system to provide heat and ventilation to the Cafeteria per current standards. This ventilation improvement alternative includes replacing air handler S-1 with a new air handling systems designed to provide heating and ventilation control. Temperature control for the spaces will be by variable air volume (VAV) terminal boxes with hot water reheat coils. Provide new supply and return air ductwork for the new system. The new system will be designed to comply with current codes, standards and statutes with regard to return/relief air, ventilation rates and air filtration. Provide direct digital controls (DDC) with demand controlled ventilation. Implement energy management system (EMS) control sequences and strategies to operate the air handling system based on anticipated occupancy schedules and actual ventilation demand. Provide commissioning of the systems and all mechanical and electrical work associated with the installation to ensure proper function, maintainability and operator training.

Install mechanical systems and direct digital controls (DDC) to provide space dehumidification.

Replace Science Room Air Handling Unit (S-2) with De-Humidification

Existing Conditions

- Air handling unit S-2 is a constant volume unit that serves the Science Room. This unit consists of a constant volume supply fan, mixed air dampers, and a steam heating coil. The unit utilizes a ceiling plenum return, and the relief is provided through a transfer air grille into the cafeteria.
- There is no dedicated relief path for the unit; the relief is routed into the cafeteria.
- The outside air dampers do not seal completely and there is considerable leakage even when the dampers are closed.
- The air handler is located in the ceiling space; this location is difficult to access and maintain the air handler.
- The steam heating coil is undersized and shows signs of damage
- Air handling unit S-2 is over 15 years of age and approaching the end of its useful service life.

Recommendations

Insall mechanical systems and direct digital controls (DDC) to provide space dehumidification. Adding dehumidification to the classrooms will improve the comfort of the occupants during periods of high outdoor air humidity. It can also help contain the growth of mold and mildew within the building, reducing the presence of certain allergens. Optimal humidity levels between 30% and 60% RH (relative humidity) reduce the potential for growth and transmission of certain organisms such as the influenza virus.

Replace Air Handling Unit S-3 / Add De-Humidification

Existing Conditions

- Air handling unit S-3 is a constant volume air-to-air heat exchanger, which serves Rooms 201 and 202. This unit consists of a constant volume supply fan, return air, outside air, and a steam heating coil. Relief is located at the unit. Perimeter steam radiation also serves the classrooms.
- The air handler has been installed incorrectly, with the fresh air intake routed to the exhaust outlet, and the return air routed back into the space. This results in the unit continuously circulating return air instead of supplying fresh air to the building.
- The air handler is noisy when it is running, and has a tendency to make hearing in the classrooms difficult.
- There is no outside air damper that can be closed when the unit is off.
- Air handling unit S-3 is over 15 years of age and approaching the end of its useful service life.

Recommendations

Install mechanical systems and direct digital controls (DDC) to provide space dehumidification.

Replace Gymnasium Air Handling Units

Existing Conditions

- The north gym air handling unit is a constant volume unit, which serves the north half of the gym. This unit consists of a constant volume supply fan, mixed air dampers, and a steam heating coil. Relief is provided by the east gym exhaust fan. Perimeter steam radiation also serves the exterior walls of the gym.
- The supply air from the unit is not ducted over the gymnasium floor.
- Air handling unit is over 50 years of age and at the end of its useful service life.
- The south gym air handling unit is a constant volume unit located in the south gym mezzanine and serves the south half of the gym. This unit consists of a constant volume supply fan, mixed air dampers, and a steam heating coil. Relief is provided by the west gym exhaust fan. Perimeter steam radiation also serves the exterior walls of the gym.
- The supply air from the unit is not ducted over the gymnasium floor.
- There is a small leak in the steam coil at the unit and the coil has been valved off and is in need of repair.
- Because the unit is operated manually based on the need for heating or cooling, there are often times when the space is occupied and the unit is not providing ventilation because it is left off.
- There is no minimum position set point for the outside air dampers; this can cause the space to be under ventilated even when the unit is running.
- Air handling unit is over 50 years of age and at the end of its useful service life.

Recommendations

Install a new air handling system to provide heat and ventilation to the Gymnasium per current standards. Decommission N Gym-AHU and S Gym-AHU and replace with a new system with variable

speed controls. Install new supply and return ducting throughout the Gymnasium to properly serve all occupied spaces. Install sensors and controls to modulate supply, outside and return air based on the real-time space temperature and ventilation requirements of the space. Include carbon dioxide sensors and utilize demand controlled ventilation sequences. Program the new system to operate in an energy efficient manner while maintaining proper ventilation in the Gymnasium per current code requirements.

Replace Classroom Roof Top Unit RTU-1

Existing Conditions

Roof top unit RTU-1 is a constant volume unit that serves rooms 112, 114, 116, and 117. This unit consists of a constant volume supply fan and mixed air dampers. The unit utilizes a ceiling plenum return and relief is provided by relief dampers located in the space.

- The outside air dampers do not seal completely and there is considerable leakage even when the dampers are closed.
- Indoor air quality readings taken in the spaces served indicate elevated levels of carbon dioxide.
- Air handling unit RTU-1 is over 15 years of age and approaching the end of its useful service life.

Recommendations

Install a new air handling system to provide heat and ventilation to the areas served by roof top unit RTU-1 per current standards. This ventilation improvement alternative includes replacing air handler RTU-1 with a new air handling system designed to provide heating and ventilation control. Zone control for the spaces will be by variable air volume (VAV) terminal boxes with hot water reheat coils. Provide new supply and return air ductwork for the new system. The new system will be designed to comply with current codes, standards and statutes with regard to return/relief air, ventilation rates and air filtration. Provide direct digital controls (DDC) with demand controlled ventilation. Implement energy management system (EMS) control sequences and strategies to operate the air handling system based on anticipated occupancy schedules and actual ventilation demand. Provide commissioning of the systems and all mechanical and electrical work associated with the installation to ensure proper function, maintainability and operator training.

In addition to replacing the unit as described above, this ventilation improvement alternative includes provisions for installing mechanical systems and direct digital controls (DDC) to provide space dehumidification.

Replace Classroom Roof Top Unit RTU-2

Existing Condition

- Roof top unit- RTU2 is a constant volume unit that serves rooms 118, 119, 119A, 120, 121, 122, and the staff workroom. This unit consists of a constant volume supply fan and mixed air dampers. The unit utilizes a ceiling plenum return and its relief is provided by relief dampers located in the space.
- The space thermostat in the computer lab is out of calibration and bleeding air.
- The outside air dampers do not seal completely and there is considerable leakage even when the dampers are closed.

- Air handling unit RTU-2 is over 15 years of age and approaching the end of its useful service life.

Recommendations

Install a new air handling system to provide heat and ventilation to the areas served by roof top unit RTU-2 per current standards. This ventilation improvement alternative includes replacing air handler RTU-2 with a new air handling systems designed to provide heating and ventilation control. Zone control for the spaces will be by variable air volume (VAV) terminal boxes with hot water reheat coils. Provide new supply and return air ductwork for the new system. The new system will be designed to comply with current codes, standards and statutes with regard to return/relief air, ventilation rates and air filtration. Provide direct digital controls (DDC) with demand controlled ventilation. Implement energy management system (EMS) control sequences and strategies to operate the air handling system based on anticipated occupancy schedules and actual ventilation demand. Provide commissioning of the systems and all mechanical and electrical work associated with the installation to ensure proper function, maintainability and operator training.

Install mechanical systems and direct digital controls (DDC) to provide space dehumidification.

Replace Classroom Roof Top Unit RTU-3

Existing Condition

- Roof top unit RTU-3 is a constant volume unit that serves rooms 124, 125, 129, 130, 131, 132, and the north restrooms. This unit consists of a constant volume supply fan and mixed air dampers. The unit utilizes a ceiling plenum return and its relief is provided by relief dampers located in the space.
- The outside air dampers do not seal completely and there is considerable leakage even when the dampers are closed.
- Indoor air quality readings taken in the spaces served indicate elevated levels of carbon dioxide.
- Air handling unit RTU-3 is over 15 years of age and approaching the end of its useful service life.

Recommendations

Install a new air handling system to provide heat and ventilation to the areas served by roof top unit RTU-3 per current standards. This ventilation improvement alternative includes replacing air handler RTU-3 with a new air handling systems designed to provide heating and ventilation control. Zone control for the spaces will be by variable air volume (VAV) terminal boxes with hot water reheat coils. Provide new supply and return air ductwork for the new system. The new system will be designed to comply with current codes, standards and statutes with regard to return/relief air, ventilation rates and air filtration. Provide direct digital controls (DDC) with demand controlled ventilation. Implement energy management system (EMS) control sequences and strategies to operate the air handling system based on anticipated occupancy schedules and actual ventilation demand. Provide commissioning of the systems and all mechanical and electrical work associated with the installation to ensure proper function, maintainability and operator training.

Install mechanical systems and direct digital controls (DDC) to provide space dehumidification.

Classroom Unit Ventilators – Replacement with VAV and Dehumidification

Existing Conditions

- There are eight unit ventilators that serve classrooms 101-108 on the south end of the building. Each of these units consists of a constant volume supply fan, mixed air dampers, and a steam heating coil. Relief is provided by transfer air grilles from each classroom into the hallway. Each space is also served by a cabinet convector.
- The filters and coils are dirty and in need of cleaning.
- There is no minimum position set point for the outside air dampers to provide ventilation to the building.
- The Classroom Unit Ventilators are not designed to provide airflow to the areas served per current indoor air standards.
- The heating coil of the Classroom Unit Ventilators is undersized to provide adequate outside ventilating air per current standards.
- Indoor air quality measurements taken in the classrooms show elevated levels of carbon dioxide (CO_2).
- The Classroom Unit Ventilators are over 40 years of age and at the end of their useful service life.
- The indoor air quality survey indicated that the occupants of these classrooms do not receive adequate outside air levels.

Recommendations

Replace the units serving the classrooms with new central air handling systems designed to provide required heating and ventilation control. Zone control will be by variable air volume (VAV) terminal boxes with hot water reheat coils. Provide new supply and return air ductwork as applicable for the new systems. The new systems will be designed to comply with current codes, standards and statutes with regard to return/relief air, ventilation rates and air filtration. Provide direct digital controls (DDC) with demand controlled ventilation. Implement energy management system (EMS) control sequences and strategies to operate the air handling systems based on anticipated occupancy schedules and actual ventilation demand. Provide commissioning of the systems and all mechanical and electrical work associated with the installation to ensure proper function, maintainability and operator training.

Install mechanical systems and direct digital controls (DDC) to provide space dehumidification.

School-Wide Exhaust Fans – Repair and Replace

Existing Conditions

Many of the exhaust fans that serve the school are from the original construction and have exceeded their expected service life. Measurement of exhaust airflow indicated areas that are operating below ventilation requirements. Proper ventilation in the school is contingent upon properly operating mechanical exhaust systems; however, the survey of exhaust airflow indicated areas that are operating below ventilation requirements. The exhaust fans located on the roof have exceeded their expected life and are in need of replacement.

Recommendations

Inspect and refurbish all exhaust fans and their controls. Clean fan housings, tighten belts and check electrical connections and motor starters and switches. Recommission controls and program for energy efficient operation of the exhaust fans. Replace older rooftop exhaust fans and underperforming units with new direct drive exhaust fans to meet ventilation standards. Direct drive fans eliminate the need for replacing belts. Include integral electric back draft dampers to operate with exhaust fan. Provide new DDC controls to control the larger exhaust fans based on a building occupancy schedule.