CORE GROUP MEETING #19

December 4, 2017

PROJECT
Dover Area High School
CRA Project No. 3068

In Attendance: Representing:
Dave Nelson DASD – Facilities, Safety, & Technology
Ken Kaufman Moore Engineering Company - Mechanical
Dave Leese Moore Engineering Company - Mechanical
Ken McGinnis Moore Engineering Company - Electrical
Andrew Nolt Moore Engineering Company - Electrical
Tony Magaro Crabtree, Rohrbaugh & Associates
Scott Cousin Crabtree, Rohrbaugh & Associates

On the above date, a core group meeting was held at the Dover Area School District Offices to review HVAC and other MEP systems for the Dover Area High School project. Pertinent issues and items of discussion are as follows.

1. The HVAC systems analysis prepared by MEC was reviewed (see attached). DASD decided to proceed with Option 2: 4-pipe VA Heating/Cooling System with high efficiency gas boilers and air cooled chillers.

2. HVAC systems were reviewed and the following pertinent items discussed:
   a. DASD requested that the following areas have separate HVAC units for scheduling use over the summer: Cafeteria, Office suite, Auditorium, Gymnasium, Auxiliary Gymnasium, Natatorium, Music area, and LGI.
   b. DASD is acceptable to two on-grade chillers. Specific sizing was discussed and will be further determined once the envelope is confirmed and the HVAC load calculations are completed.
   c. Multiple rooftop units per wing will be provided (one per floor) to limit areas that would be down if a main unit were to fail. MEC will develop a zoning plan for review at a future meeting.
   d. CRA indicated that they would like to review the unit locations with the sight lines. This is a particular concern on the front elevation.
   e. Dust collection was discussed. CRA and DASD will be meeting in the near future to review the equipment and needs. MEC will evaluate the required systems or systems once that list is created. MEC suggested that DASD try to limit the systems and share equipment as much as possible to keep the cost down.
   f. DASD indicated that there was a piano storage room and instrument storage room that should be specified to include humidity control.
   g. Locker rooms are to include active de-humidification control.
   h. DASD requested that the control system (ALC) be extended to the electric, water, and gas meters for monitoring.
   i. IT closets are to include separate mini-split units that are tied to the emergency generator.

3. Plumbing Items discussed:
   a. All water coolers are to include bottle filling stations.
b. Bradley sinks will be electric, but all other electronic faucets and flush valves will be battery type.
c. MEC to contact ELA about the status of the flow test.
d. MEC to have water testing done for hardness as well as the general water chemistry for the pool consultant’s use.

4. Electrical Requirements
   a. The building electrical service will be 3-phase, 480/277V.
   b. DASD will provide contact information for a Met-Ed representative who has handled their account on past projects.
   c. DASD does not object to use of aluminum conductors for main electrical service conductors. Utilize copper conductors for distribution within the building.
   d. DASD has no preference between aluminum or copper windings in transformers.
   e. One electrical meter shall be provided to meter the main electrical service to the building. Separate metering of receptacle, lighting, HVAC loads is not required.
   f. DASD does not object to panelboards and small size transformers (~30-45kVA) being located in storage rooms; provided that panelboards are lockable.
   g. Lighting
      i. 277-volts is acceptable for lighting.
      ii. Lighting control options were briefly discussed. DASD prefers a simple lighting control system. DASD to decide on a wired low-voltage (Wattstopper DLM) system over wireless control (Lutron Vive) system; once more information is received. MEC will set up a presentation by a Wattstopper representative to demonstrate the system to DASD.
      iii. DASD has an existing Eaton-Cutler Hammer lighting control system in one of their facilities, and have experienced issues with system servicing and maintenance response times. Eaton-Cutler Hammer should not be included in the lighting controls specification for the high school project.
      iv. Corridor lighting controls were reviewed. Topic will need to be revisited upon selection of lighting control system technology.
   h. Emergency Power
      i. DASD prefers the use of multiple natural gas generators in lieu of using a larger diesel generator. MEC will determine required generator size and provide recommendation of natural gas (possibly parallel generator sets) or diesel generator(s), including estimated pricing.
      II. The following minimal loads shall require emergency or standby power:
         1. Emergency lighting (code minimum).
         2. MDF/IDF computer equipment.
         3. MDF/IDF air conditioning equipment.
         5. Building heat (including boilers and pumps).
         6. Administrative Office room lighting and power.
         7. 2nd Floor Access Elevator. Natatorium elevator does not require standby power.
         8. Electric sinks (Bradley fixtures) in gang toilet rooms. Water fountains do not require standby power.
      iii. DASD will confirm if the high school will be required to serve as an emergency shelter. Additional building loads will require emergency power if the building is an emergency shelter.
i. Emergency shutoffs will be provided in laboratory and shop spaces.
   i. Shutoffs in labs should disconnect power and gas supplies to the lab tables.
   ii. Shutoffs in shop spaces should disconnect power to the shop equipment and dust collectors.
   iii. Provide a contactor based shutoff system be installed in lieu of shunt-trip circuit breakers.

5. General Items discussed:
   a. DASD to provide Evacu-Trac cabinets by Garaventa at all stairways for evacuation of physically disabled occupants during emergency events.
   b. Provide plastic lockers in the natatorium, athletic, and phys ed locker rooms.

Respectfully submitted,
CRABTREE, ROHRBAUGH & ASSOCIATES

Scott Cousin
Project Manager

cc: Core Group
Design Consultants
HVAC System Options Study
for the new
Dover Area High School
November 28, 2017
Introduction

The following report is a brief analysis of several HVAC options for the new Dover Area High School. The information provided is for comparison and general analysis and should not be used to budget actual operational costs. This analysis is based on a typical high school of a similar size and configuration, but not the exact configuration of the proposed building. Many operational assumptions have been made for this comparison. The results represent a comparative analysis of HVAC system options.

Included in this report you will find a brief description of each option and the estimated first cost. We also included estimated energy and maintenance costs to use in the final cost analysis. The maintenance costs are based on industry standards and averages as published by ASHRAE.

HVAC General Options

There are many options available to meet the HVAC needs of the proposed school. After careful consideration and discussion with the Architect and School District, we offer the following three options for consideration:

1. Water Source Heat Pump system
2. Four Pipe Variable Air Volume (VAV) heating and cooling system
3. Geothermal Heat Pump system

We have included a brief description of all the options under consideration.
Option 1 – Water Source Heat Pump System

This system is capable of providing simultaneous heating and cooling. Each zone would have a separate heat pump unit that includes a fan and a compressor. The units would be connected together by a 2-Pipe loop water system that utilizes high efficiency gas boilers and evaporative coolers to maintain loop water temperature. Each unit rejects heat to the loop or draws heat from the loop based on the specific zone requirement.

The Classroom units would be located in mechanical closets that are accessible from the corridor. The units would be ducted and include a wall return to the mechanical room plenum.

The system would utilize fully ducted DOAS heat pump energy recovery units to precondition the ventilation air and provide air directly to the space.

Larger spaces (Gym, Cafeteria, Auditorium, etc) would utilize packaged rooftop water source heat pumps. These units would include energy recovery wheels to pretreat the ventilation air. The units would also include air side economizers to provide free cooling when possible. Office areas would be handled with standard water source heat pumps.

ADVANTAGES
- Lowest first cost option
- Simultaneous heating and cooling
- Loop piping does not require pipe insulation

DISADVANTAGES
- Outdoor evaporative cooler (tower) is required
- Additional water treatment is required for this system due to the tower/cooler
- Evaporation at the tower/cooler results excess water consumption
- Tower will need to be drained or winterized unless glycol is used
- Additional costs for distributed electrical needs
- Additional cost for building mechanical closets
- Closets take up additional classroom space

MAINTENANCE CONSIDERATIONS
- Filter replacements will need to occur in units
- Internal energy wheels will need to be periodically cleaned
- Systems are packaged and require typical annual maintenance checks and servicing
- Refrigerant based systems require staff with refrigeration maintenance knowledge
- Loop water system will require routine water treatment to maintain proper water chemistry
- Boilers and evaporative coolers require additional maintenance than the other systems considered
- Water source systems rely on evaporation and use more water and treatment than other systems
Option 2 – Four Pipe VAV Heating/Cooling System

This option provides a new four pipe heating and cooling system throughout the school. The four pipe system would include new high efficiency gas boilers and air cooled chillers. This option provides simultaneous heating and cooling.

Hot water and chilled water would be distributed to central rooftop air handlers. The rooftop units would include energy recovery wheels to precondition the ventilation air. The RTU’s would provide 55 F air to VAV boxes in each zone for cooling. A hot water reheat coil would be included to provide space heating.

Larger spaces (Gym, Cafeteria, Auditorium, etc) would utilize single zone rooftop units. These units would include energy recovery wheels to pretreat the ventilation air. The units would also include air side economizers to provide free cooling when possible.

ADVANTAGES
- High efficiency gas boilers would be utilized
- Simultaneous cooling is available
- Main plant equipment is centralized
- No added costs needed to building mechanical closets
- Maximizes floor space because systems are above the ceiling

DISADVANTAGES
- Larger equipment on the roof
- More ceiling cavity space required for ductwork systems
- Air cooled chillers can be noisy and will require special acoustical treatment
- More water treatment required do to dual piping systems
- Larger boilers are required

MAINTENANCE CONSIDERATIONS
- Filter replacements will need to occur in VAV boxes and Air Handlers
- Internal energy wheels will need to be periodically cleaned
- Rooftop units and VAV boxes require typical annual maintenance checks and servicing
- Hot water and chilled water system will require routine water treatment to maintain proper water chemistry
- Boilers require more maintenance than some of the other systems considered
- Chillers require routine maintenance
Option 3 – Geothermal Heat Pump System

This system is capable of providing simultaneous heating and cooling. Each zone would have a separate geothermal heat pump with a compressor and fan. The units would be connected together by an insulated 2-pipe loop water system that utilizes the geothermal well field for heat rejection and absorption. Each unit rejects heat to the loop or draws heat from the loop based on the specific zone requirement.

The Classroom units would be located in mechanical closets that are accessible from the corridor. The units would be ducted and include a wall return to the mechanical room plenum.

The system would utilize fully ducted DOAS geothermal heat pump energy recovery units to precondition the ventilation air and provide air directly to the space.

Larger spaces (Gym, Cafeteria, Auditorium, etc) would utilize packaged rooftop geothermal heat pumps. These units would include energy recovery wheels to pretreat the ventilation air. The units would also include air side economizers to provide free cooling when possible. Office areas would be handled with geothermal heat pumps.

A major part of the cost of this system is the well field. An analysis of the soil geology will be required to determine if the site is adequate for a Geothermal System. We have estimated the well field size and cost based on other Geothermal Systems installed in similar facilities. If this option is selected for further consideration, a test bore will be required to determine the actual soil conditions and the conductivity. That information is necessary to properly size the well field and finalize the actual cost.

ADVANTAGES

- Considered a “Green” HVAC system
- Simultaneous heating and cooling
- Boiler and cooler are not required
- Onsite fossil fuels are not required
- No associated site noise with this system
- Lowest operational cost
- Lowest maintenance cost

DISADVANTAGES

- High first cost
- Major site disturbance would occur with the new well field
- Well field takes up potential site expansion space
- Piping system will need to be insulated
- Glycol is required in the piping system
- Additional costs for distributed electrical needs
- Additional cost for building mechanical closets
- Closets take up additional classroom space

MAINTENANCE CONSIDERATIONS
- Filter replacements will need to occur in units
- Internal energy wheels will need to be periodically cleaned
- Systems are packaged and require typical annual maintenance checks and servicing
- Refrigerant based systems require staff with refrigeration maintenance knowledge
- Loop water system will require routine water treatment and glycol level monitoring to maintain proper water chemistry
- Since there is not a boiler or tower/cooler, overall maintenance is reduced

**System Option Life Cycle Cost Summary**

The following is a general comparative summary of the options based on typical square footage costs for the systems as well as estimated operational costs. Estimated system costs are based on available recent bidding history as well as the 2017 Means Cost Estimating books. The Annual Operational cost estimates listed include both estimated utility costs and the estimated maintenance costs. Utility costs are based on the current average cost of electric and gas in central Pennsylvania. Maintenance costs are based on ASHRAE standards. These numbers are for comparative purposes only and do not represent the actual costs. They should be used for a general system comparison only.

<table>
<thead>
<tr>
<th>Option</th>
<th>HVAC System</th>
<th>HVAC System Cost/SF</th>
<th>Arch and Elec Cost Impact per SF</th>
<th>Total First Cost</th>
<th>Annual Maintenance Cost</th>
<th>Annual Utility Cost</th>
<th>Annual Operational Cost</th>
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<tbody>
<tr>
<td>1</td>
<td>Water Source HP</td>
<td>$28.00</td>
<td>$2.25</td>
<td>$8,772,500</td>
<td>$86,062</td>
<td>$264,562</td>
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<td>2</td>
<td>Four Pipe VAV Heating/Cooling System</td>
<td>$30.00</td>
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<td>3</td>
<td>Geothermal Heat Pump System</td>
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<td>$234,961</td>
<td>$306,634</td>
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Based on the above information, Option 2 is determined to be the economical selection considering cost and payback.
Summary

There are other items that must also be considered when selecting systems. We have included a brief list of some other recommendations based on various criteria as follows.

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Recommended System</th>
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<tbody>
<tr>
<td></td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Choice</td>
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<tr>
<td>Lowest Annual Operating Cost</td>
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<tr>
<td>Lowest First Cost</td>
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<tr>
<td>Lowest Maintenance Cost</td>
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<tr>
<td>Best Year-Round Comfort</td>
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<td>Lowest Classroom Noise</td>
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<tr>
<td>Maximize Classroom Floor Space</td>
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<tr>
<td>Lowest Exterior Equipment Noise</td>
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<tr>
<td>Least Site Impact</td>
<td>1 &amp; 2</td>
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</table>

1. Water Source Heat Pumps  
2. Four Pipe VAV Heating/Cooling System  
3. Geothermal Heat Pumps

The selection process for the HVAC system should include a review of the economics, the above criteria, as well as other intangible factors.