East Haddam Public Schools

HVAC ASSESSMENT/RECOMMENDATIONS REPORT

Prepared for:

The Town of East Haddam
Board of Education

May 4, 2023
HFL File No. 2022-3021.01

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Executive Summary

Background

The East Haddam Public School system consists of East Haddam Elementary school, Nathan Hale-Ray Middle School, and Nathan Hale-Ray High School that serve approximately 1,200 students from East Haddam and Moodus. A building summary:

- Nathan Hale-Ray High School, built in 1992, 80,962 square feet, two story building.
- Nathan Hale-Ray Middle School, built in 2006, 96,953 square feet, two story building.
- East Haddam Elementary School, built in 1962, 63,484 square feet, single story building.

A kick-off meeting between members of the Board of Education's Building Committee and H.F. Lenz occurred on November 8, 2022. Among the items discussed during this meeting was desired outcomes from this project. A few discussion points highlighted during this conversation were:

- East Haddam directed H. F. Lenz to coordinate a defined priority project with a thorough study of the 3 schools' HVAC systems.
- Desired near-term projects should include upgrading existing Building Automation Systems (BAS, a.k.a., BMS, DDC, HCS) for all three schools, and replacement of the High School's existing Air-Cooled Chiller (ACC), as these systems have reached end of life and creating stress on maintenance capabilities and on-going financial burdens with repairs.
- The study of the schools' HVAC systems will provide technical assistance to East Haddam's ongoing school construction master plan efforts.
- Indoor Environmental Quality (IEQ) is a high priority for each school (e.g., increased ventilation air, thermal comfort, and acoustic comfort).
- Energy efficiency and sustainable initiatives will also be reviewed for each project.

Project Goals

The desired scope for this project includes:

- Replace existing major HVAC equipment that is close to failure or is not functioning as design was intended.
- Provide new HVAC equipment to heat, cool, and mechanically ventilate with Outdoor Air (OA) within spaces that currently use indirect or natural ventilation, and only contain heating equipment.
- Indoor Environmental Quality (IEQ) is a high priority for each school (e.g., increased ventilation air, thermal comfort, and acoustic comfort).
- Improve energy efficiency on existing systems where possible and design new systems with energy efficiency and high-performing sustainable practices in mind.

HVAC Summary

Elementary School and Early Development Center

Heating

Assessments

Heating is provided to the elementary school via heating hot water. The existing boilers, pumps, and appurtenances all appeared to be in fairly good condition. Heating hot water with glycol is pumped to unit ventilators, air-handling units (cafeteria), and rooftop units (gymnasium).

Recommendations

The existing boilers and pumps appear to have considerable useful life left in them. An improvement in the control system and control sequences may provide some energy savings for this system. One consideration for the future would be to assess the feasibility of bringing natural gas to the building, as gas-fired, condensing boilers are more efficient than oil-fired boilers.

Ventilation

Assessments

Most classrooms are currently served by unit ventilators. Many of these unit ventilators are having issues with tripping, possibly because they are oversized. One of the cafeteria air-handling units had its outdoor air louver blocked off on the roof and was not running at the time of survey. Multiple exhaust fans on the roof that appeared to be in fair condition also provide a form of ventilation to the elementary school.

Recommendations

It is recommended that the classroom unit ventilators be replaced with Dedicated Outdoor Air Systems (DOAS). The DOAS units will provide larger outdoor air flow rates that are fully air-conditioned and filtered, while also being quieter than unit ventilators located in classrooms and less likely to trip. If supplemental heating or cooling would be required, fin-tube radiation could be used in the case of supplemental heating, and a fan coil unit utilizing refrigerant could be used in the case of supplemental cooling. Supplemental heating and cooling could be designed on a classroom-by-classroom basis, if the DOAS unit's conditioned outdoor air alone will not provide enough cooling or heating.

It is recommended that the cafeteria air-handling units be replaced, as they are likely near the end of their useful life, and one of the units did not appear to be running at all.

It is recommended that the gymnasium rooftop units are also replaced, as they are likely near the end of their useful life, and are starting to show rust on the top of the units.

Air Conditioning

Assessments

As stated above, many of the unit ventilators are having issues with tripping, and there was mention of humidity issues, when discussing the spaces with stakeholders, which could be as a result of these units being oversized. The cafeteria air-handling units and gymnasium rooftop units were heating only.

Recommendations

As stated above, within heating recommendations, with the addition of cooling capabilities.

Middle School

Heating

Assessments

Heating is provided to the middle school via heating hot water. The existing boilers, pumps, and appurtenances all appeared to be in good condition. Heating hot water is pumped to rooftop units, heating and ventilation rooftop units, ceiling radiant panels, cabinet unit heaters, heating coils, fin tube radiators, and certain variable air volume (VAV) reheat coils.

Recommendations

Similar to the elementary school, the existing boilers and pumps appear to have considerable useful life left in them. A possible improvement that would require more study for the middle school in the control system and control sequences may provide some energy savings for this system. One consideration for the future would be to assess the feasibility of bringing natural gas to the building, as gas-fired, condensing boilers are more efficient than oil-fired boilers.

Ventilation

Assessments

Ventilation is provided to the middle school via rooftop units, heating and ventilation units (some of which are 100% outdoor air), and multiple exhaust fans located on the roof. All of this equipment is fairly new (approx. 2006 at the earliest) and appeared to be in good condition at the time of survey. Three of the heating and ventilation units (HV-1, HV-2, and HV-3) utilize an enthalpy wheel which recovers the energy from the building air being exhausted from the building to pretreat the outdoor air that is then supplied to the school.

Recommendations

All of the equipment appears to be in good condition and no replacements are recommended at this time. One possible project could be to ensure (and then resolve) that the amount of outdoor air being provided to the middle school is up to the current building standard's ventilation requirements via a study.

Air Conditioning

Assessments

Rooftop units with integral condensers provide cooling to the media center, administration/office area, computer labs, and music classroom(s). Heating and ventilation units serve a significant number of classrooms, the gymnasium, the cafeteria, and provide makeup air to the kitchen. One issue that was noted based on the building structure and south facing location, was potential for building heat gain on the 2nd floor. During subsequent discussions with stakeholders, heat gain was confirmed, with a desire for some measure of cooling to be provided.

Recommendations

To alleviate heat gain on the 2nd floor of the middle school, it is recommended that HV-2 is replaced with a DOAS rooftop unit with an integral condenser to provide cooling to the second floor. It is recommended to add VAV boxes and provide CO2 sensors for all classrooms to allow for energy saving via OA setback. One potential drawback would be increased energy costs, as it may not be feasible to include an energy wheel in the new rooftop unit, given the space constraints with where the current unit is located. Upgrading of heating hot water piping and adding a freeze protection pump, would also be deployed within any design. It would also need to be confirmed if glycol protection is used at the middle school to assess whether a freeze protection pump is even required. The preliminary cost opinion for this project ranges from $260,000 to $360,000.

High School

Heating

Assessments

Heating is provided to the high school via heating hot water. The high school is currently undergoing a boiler replacement project. The heating hot water pumps appear to near their end of useful life. Heating hot water is pumped to air-handling units, unit heaters, fin-tube radiators, and heating and ventilation units.

Recommendations

Given that the high school will have four new oil-fired boilers in the near future, it is recommended that only the pumps be considered to be replaced, as they are near the end of their useful life and are the likely failure point in a critical building system. An improvement in the control system and control sequences may provide some energy savings for the heating hot water system.

Ventilation

Assessments

Ventilation is provided to the high school via air-handling units, heating and ventilation units, and exhaust fans. Most of this equipment was located indoors in the attic space and appeared to be in okay condition. Given the approximate age of the building and these air-handling units (approx. 1992), they are likely near the end of their useful life, even though they appear to have been well maintained.

Recommendations

It is recommended that the air-handling units (and heating and ventilation units, mentioned below) be replaced with similar units, and while the design of this project is taking place, the engineers should be tasked to ensure that the new units meet the current building standard's ventilation requirements for all areas that they serve.

Air Conditioning

Assessments

Cooling is provided to the high school via chilled water. The existing 110 ton air-cooled chiller appears to be in poor condition and needs to be replaced. The two chilled water pumps and the system components (air separator, buffer tanks) all appeared to be in fair to poor condition. The heating and ventilation units serve several a significant portion of the building.

Recommendations

It is recommended that the existing 110 ton air-cooled chiller be replaced with a 130 ton air-cooled chiller, with a view to adding a second 130 ton air-cooled chiller in the short-to-medium term future. It is also recommended that the existing chilled water pumps and the system components be replaced in when the air-cooled chiller is replaced.

It is recommended that the school district decides their priorities for which areas of the high school should be transitioned from heating and ventilation units only to being provided with cooling. It is recommended that all of the heating and ventilation units (priority areas first) be replaced with air-handling units that include a chilled water cooling coil to provide some comfort cooling.

Priorities By School

Elementary School

Item #	Recommended Scope	Budget Range
V-ES	Boiler Blend Controls Upgrade	$ 60 K - $ 120 K
I-ES	Replace classroom UVs with Fan Coil Units (FCUs) and Dedicated Outdoor Air Systems (DOASs)	$ 1.9 million - $ 2.2 million
II-ES	Building Automation Upgrade	$ 500 K - $ 700 K
IV-ES	Replace Cafeteria Air-Handling Units	$ 90 K - $ 110 K
III-ES	Replace Gymnasium Rooftop Air-Handling Units	$ 250 K - $ 325 K
	Elementary School Total:	$ 3.3 million - $ 3.5 million

Middle School

Item #	Recommended Scope	Budget Range
IV-MS	Boiler Blend Controls Upgrade	$ 60 K - $ 120 K
I-MS	Replace 2nd Floor Unit with DOAS	$ 420 K - $ 520 K
III-MS	Building Automation Upgrade	$ 0.8 million - $ 1.1 million
II-MS	Replace Existing Rooftop HV units with DOAS Equipment	$ 815 K - $ 920 K
	Middle School Total:	$ 2.1 million - $ 2.7 million

High School

Item #	Recommended Scope	Budget Range
VII-HS	Install New Heating Hot Water Pumps	$ 95 K - $ 115 K
VIII-HS	Install New Domestic Hot Water Storage Tank	$ 40 K - $ 60 K
I-HS	Replace Existing Air-Cooled Chiller	$ 500 K to $ 550 K
II-HS	Replace Underground Piping from Chiller to Mechanical Room	$ 85 K - $ 125 K
III-HS	Replace Chilled Water Pumps	$ 100 K - $ 125 K
IX-HS	Building Automation Upgrade	$ 650 K - $ 875 K
V-HS	Replace H&V Units with DOAS with Cooling	$ 1.6 million - $ 1.8 million
VI-HS	Replace AHUs with New	$ 515 K - $ 650 K
IV-HS	Add Second Air-Cooled Chiller to Provide Cooling Infrastructure to Entire High School	$ 480 K - $ 530 K
	High School Total:	$ 4.1 million - $ 4.8 million

Priorities by District

Item #	School	Recommended Scope	Budget Range
V-ES	Elementary School	Boiler Blend Controls Upgrade	$ 60 K - $ 120 K
IV-MS	Middle School	Boiler Blend Controls Upgrade	$ 60 K - $ 120 K
I-ES	Elementary School	Replace classroom UVs with Fan Coil Units (FCUs) and Dedicated Outdoor Air Systems (DOASs)	$ 1.9 million - $ 2.2 million
II-ES	Elementary School	Building Automation Upgrade	$ 500 K - $ 700 K
IV-ES	Elementary School	Replace Cafeteria Air-Handling Units	$ 90 K - $ 110 K
VII-HS	High School	Install New Heating Hot Water Pumps	$ 95 K - $ 115 K
VIII-HS	High School	Install New Domestic Hot Water Storage Tank	$ 40 K - $ 60 K
I-HS	High School	Replace Existing Air-Cooled Chiller	$ 500 K to $ 550 K
II-HS	High School	Replace Underground Piping from Chiller to Mechanical Room	$ 85 K - $ 125 K
III-HS	High School	Replace Chilled Water Pumps	$ 100 K - $ 125 K
IX-HS	High School	Building Automation Upgrade	$ 650 K - $ 875 K
I-MS	Middle School	Replace 2nd Floor Unit with DOAS	$ 420 K - $ 520 K
III-ES	Elementary School	Replace Gymnasium Rooftop Air-Handling Units	$ 250 K - $ 325 K
III-MS	Middle School	Building Automation Upgrade	$ 0.8 million - $ 1.1 million
V-HS	High School	Replace H&V Units with AHUs with Cooling	$ 1.6 million - $ 1.8 million
VI-HS	High School	Replace AHUs with New	$ 515 K - $ 650 K
IV-HS	High School	Add Second Air-Cooled Chiller to Provide Cooling Infrastructure to Entire High School	$ 480 K - $ 530 K
II-MS	Middle School	Replace Existing Rooftop HV units with DOAS Equipment	$ 815 K - $ 920 K
		District Grand Total:	**$ 9.5 million - $ 11.0 million**

Field Observations

H.F. Lenz has visited the three schools during the request for qualifications process, as well as during a separate in-depth on-site assessment of existing operations and current system condition/capabilities. Here is a summary of the key findings by building:

Common Observations

- Number 2 fuel oil is burned to provide heating hot water and domestic hot water for all three buildings.
- The High School boilers are undergoing replacement in 2022 after failing during the previous heating season.
- The BAS in all schools could benefit from modern upgrades, such as non-proprietary software and hardware that many contractors and technicians can install and service. The degree of upgrade is required based on the age and condition of the existing control system, coupled with lack of availability of replacement parts.

Elementary School and Early Development Center

- Classrooms contain Unit Ventilators (UVs) that provide outdoor air to the space along with heating from a central Heating Hot Water plant, and cooling from DX coils in the space, and condensing units outdoors adjacent to the classrooms.

- Classrooms also have perimeter heating using finned-tube radiation in enclosures against the exterior walls and between the UVs.

- Exhaust fans collect ventilation air brought in by the UVs and exhaust if from the building.
- Two (2) AHUs atop the Gymnasium roof provide heating and ventilation air to that space.

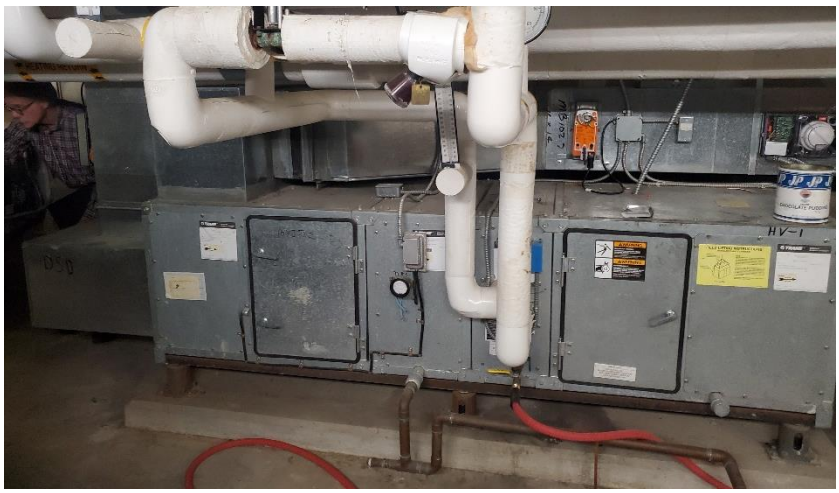
Middle School

- The HVAC system uses four (4) Rooftop Units (RTUs), which are a space- and function-optimized AHU, to provide heating, outdoor air ventilation, and Direct refrigerant Expansion (DX) cooling to Office, Library, Computer Labs, and Music spaces. Four (4) rooftop-located Heating and Ventilation (HV) units provide outdoor air and heating to the Gym, Cafeteria, and Kitchen spaces. Three (3) HV units with enthalpy energy recovery condition classroom spaces and are designed to provide 100 percent outdoor air. Multiple EFs exhaust non-recirculation air from the building. All equipment appears to be in fair to good condition.

- Perimeter heating is provided by radiant panels located in the ceiling adjacent to exterior walls.

High School

- The High School HVAC systems use Air Handling Units (AHUs) to supply Outdoor Air (OA) ventilation, heating, and sometimes cooling, to the spaces in the building. Separate Exhaust Fans (EFs) exhaust air from the building that cannot be recirculated, such as air from laboratory or shop classrooms.



- Perimeter heating from finned-tube radiation units provide space heat and fight cold air drafts along tall windows.

- Seven (7) AHUs (tagged as ACUs - Air Conditioning Unit) provide space OA ventilation, heating, and cooling using chilled water produced by an existing 110 ton air-cooled chiller. An eighth AHU/ACU provides only heating and ventilation to the Computer Rooms. The existing chiller is 15 years old, has needed minor repairs, and appears to be at the end of its useful life.

Equipment Assessments

Elementary School and Early Development Center

- Cafeteria Air-Handling Units - Near the end of useful life. One was not being utilized at all and the outdoor air louver was blocked off.
- Classroom UVs and CUs - tripping and possibly oversized with humidity issues - need replacements
- Gymnasium rooftop units, appeared to be near end of useful life and in need of replacement
- Boilers, pumps, etc. appeared to be in fairly good condition

Middle School

- Most of the air-handling equipment was located on the roof. These all appeared to be in fairly good condition.
- Boilers, pumps, etc. appeared to be in fairly good condition.

High School

- The air-handling equipment was located indoors in attic. For their age, the equipment appeared to be in fairly good condition, but the risk of failures and replacements being required is greater with their age.
- Existing boilers were in the process of being replaced at the time of the field visit. Two new Crown boilers had already been installed and appeared to be brand new and in good condition.
- The existing heating hot water pumps are close to the end of their useful life and should be replaced.
- The existing domestic water tank is close to the end of its useful life and should be replaced.
- The existing air-cooled chiller is close to the end of its useful life and should be replaced. Note that the condenser coils on the air-cooled chiller were in need of a cleaning, which could impact the chiller's performance. The existing chilled water pumps are also close to the end of their useful lives and should be replaced.

Recommended Scopes of Work

Elementary School and Early Development Center

I. **Replace classroom UVs with Fan Coil Units (FCUs) and Dedicated Outdoor Air Systems (DOASs) - $ 1.9 million to $ 2.2 million**

a. Each existing UV provides heating and OA ventilation to its classroom. Cooling is also provided via an exterior mounted f.
b. These units will be replaced with DOAS that can provide larger OA air flow rates that are fully conditioned (heated, cooled, and filtered.)
c. If a space requires heating and/or cooling beyond that provided by the DOAS, supplemental equipment, such as perimeter finned-tube radiation or refrigerant or chilled water Fan Coil Units (FCUs), will be installed.

II. **Building Automation System (BAS, a.k.a., BMS, DDC, HCS) Upgrade Project - $ 500 K to $ 700 K**

a. Replace all sensors, actuators, valves, and dampers as necessary to replace existing HVAC controls with electric/computer HVAC control (BAS).

b. Any pneumatic HVAC controls should be replaced because they have become obsolete due to the advanced capabilities and low cost of electric and computer-based HVAC controls. Replacement parts and software for pneumatic controls are difficult to obtain, as are people with adequate knowledge to operate and maintain them.

c. Elementary School BAS: $ 514K to $ 686K

III. **Replace Gymnasium Units with New Rooftop Units with Cooling - $ 250 K - $ 325 K**

a. Replace two rooftop gymnasium units (heating and ventilation only) with new rooftop units with integral DX cooling.

IV. **Replace Cafeteria Units with New - $ 90 K - $ 110 K**

a. Replace two suspended cafeteria units with new in same locations.

V. **Boiler Blend Control Upgrade Project - $ 60 K to $ 120 K**

a. Install return water blending controls on all boilers to protect against thermal shock and significantly improve boiler lifespans. The boilers at all three schools are cast-iron boilers that can be damaged by low return water temperatures. Blend control mixes colder return water with hotter supply water to maintain a minimum water temperature that enters the boiler.

Middle School

I. **Replace 2nd Floor Units with DOAS, providing AC to 2nd Floor - $420 K to $520 K**

   a. Existing equipment provides heating and ventilation only to the 2nd floor area. Upgrading to DOAS with Heat Pumps, would provide energy efficient Heating, Ventilation (additional outside air and free cooling mode), and Air Conditioning for the 2nd floor area.

II. **Replace Existing Rooftop HV units with DOAS Equipment - $ 815 K to $ 920 K**

   a. Replacing heating and ventilation AHUs with DOASs can enhance IEQ through mold control, enhanced thermal comfort, and improved infectious disease control when necessary.

III. **Building Automation System (BAS, a.k.a., BMS, DDC, HCS) Upgrade Project - $ 0.8 million to $ 1.1 million**

   a. Replace all sensors, actuators, valves, and dampers as necessary to replace existing HVAC controls with electric/computer HVAC control (BAS).

   b. Any pneumatic HVAC controls should be replaced because they have become obsolete due to the advanced capabilities and low cost of electric and computer-based HVAC controls. Replacement parts and software for pneumatic controls are difficult to obtain, as are people with adequate knowledge to operate and maintain them.

   c. Middle School BAS: $ 785K to $ 1.05M

IV. **Boiler Blend Control Upgrade Project - $ 60 K to $ 120 K**

   a. Install return water blending controls on all boilers to protect against thermal shock and significantly improve boiler lifespans. The boilers at all three schools are cast-iron boilers that can be damaged by low return water temperatures. Blend control mixes colder return water with hotter supply water to maintain a minimum water temperature that enters the boiler.

High School

I. **Replace existing Air-Cooled Chiller - $ 500 K to $ 550 K**
   a. Demolish the existing chiller.
   b. Install new 130 ton chiller in existing chiller space. Identify space adjacent to the existing chiller for an additional future 130 ton chiller.

II. **Replace Underground Piping from Chiller to Mechanical Room $ 85 K - $ 125 K**
   a. Demolish underground (UG) piping from the existing chiller to the mechanical room.
   b. Install new 6" diameter UG chilled water piping from the new and future chill locations to the mechanical room.

III. **Replace Chilled Water Pumps - $ 100 K - $ 125 K**
   a. Demolish two existing chilled water pumps and install two new chilled water pumps in the same location.

IV. **Add Second Air-Cooled Chiller - $ 480 K - $ 530 K**
   a. A central chilled water system will be able to dehumidify outdoor air before it enters the building. Space air with excessive humidity levels significantly increases the risk that mold or mildew will grow inside those spaces.
   b. Indoor Environmental Quality (IEQ) will be enhanced by minimizing mold and mildew growth, as well as thermal comfort.

V. **Replace H&V Units with DOAS units with Cooling - $ 1.6 million - $ 1.8 million**
   a. Replace the nine (9) existing heating and ventilation units to DOAS units with a cooling coil.
   b. Indoor Environmental Quality (IEQ) will be enhanced by minimizing mold and mildew growth, as well as thermal comfort.

VI. **Replace AHUs with New - $ 515 K - $ 650 K**
   a. Replace seven (7) air-handling units with new units that have 100% outdoor air capabilities.
   b. AHUs that can provide up to 100 percent fully conditioned outdoor air can also enhance IEQ and promote infectious disease control when necessary.

VII. **Install New Heating Hot Water Pumps - $ 95 K - $ 115 K**
   a. Demolish two existing heating hot water pumps and install two new heating hot water pumps in the same location.

VIII. **Install New Domestic Hot Water Storage Tank - $ 40 K - $ 60 K**
   a. Demolish 1000 gallon domestic hot water storage tank and install new 1000 gallon domestic hot water storage tank in the same location.

IX. Building Automation System (BAS, a.k.a., BMS, DDC, HCS) Upgrade Project - $ 650 K to $ 875 K

a. Replace all sensors, actuators, valves, and dampers as necessary to replace existing HVAC controls with electric/computer HVAC control (BAS).

b. Any pneumatic HVAC controls should be replaced because they have become obsolete due to the advanced capabilities and low cost of electric and computer-based HVAC controls. Replacement parts and software for pneumatic controls are difficult to obtain, as are people with adequate knowledge to operate and maintain them.