Town of Boxford
Town Hall
Boxford, MA

2019

HVAC Systems

Prepared For:

Town of Boxford
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Section 23 00 00 – Heating, Ventilating and Air Conditioning (HVAC)

GENERAL

The current HVAC system for the existing 14,000 square foot Town Hall/Library consists of two gas fired boilers, hot water circulating pumps, blower coils located in the attic, remote air cooled condensing units, a hot water distribution piping system to hot water heating equipment, refrigerant piping system, ductwork distribution systems, exhaust fans, hot water unit heaters, hot water fintube radiation and an automatic temperature control system.

The building has experienced significant heating and air conditioning related problems since it was renovated in 2004.

EXISTING CONDITIONS

The building is provided with heating from two Burnham V910 hot water boilers rated for 1,329 MBH gross output each; lead/stand hot water circulating pumps rated for 186 gpm at 60' TDH each; hot water distribution piping system and automatic controls.

The following equipment provides heating, ventilating and air conditioning to the building:

AREA	AHU/ACCU	CFM	OA CFM	COOLING	HW COIL
1ST Floor – East	AC-1/ACCU-1	2,225	645	72 MBH	183 MBH
1ST Floor – West	AC-2/ACCU-2	1,750	645	72 MBH	183 MBH
1ST /2nd Floor – Lobby	AC-3/ACCU-3	1,650	750	72 MBH	183 MBH
1ST Floor – Meeting	AC-4/ACCU-4	2,000	750	60 MBH*	183 MBH
2ST Floor – East	AC-5/ACCU-5	2,920	615	90 MBH	275 MBH
2ST Floor – Meeting	AC-6/ACCU-6	1,460	375	72 MBH	156 MBH
2ST Floor – West	AC-7/ACCU-7	2,670	735	72 MBH	183 MBH
1ST Floor – Tel/Data	AC-8/ACCU-8	555		24 MBH	

*Scheduled for 72 MBH in original design drawings

Each of the above systems, except AC-8/ACCU-8 which is a ductless split system, consists of an air handling unit in the attic with refrigerant coil, remote air cooled condensing unit at grade, interconnecting refrigerant piping, a hot water heating coil located in the supply air ductwork interconnected to the hot water distribution piping system, supply/return duct distribution systems to air outlets in the respective zone, outdoor air ductwork interconnect to the ventilation air duct distribution system and a wall mounted thermostat for zone temperature control.

At some point in the last several years, humidifiers were added to each of the systems. These systems have been largely ineffective largely because they do not have adequate capacity to provide humidification for the excessive outdoor air flows provided in the design for building ventilation.

Ventilation air was designed to be provided by SF-1, SF-2, EF-3 and EF-4; all the fans are constant volume fans that are designed to provide the scheduled outdoor air volume to each air handling system.

Bathrooms are provided with toilet exhaust by inline exhaust fans, EF-1 and EF-2, located in the attic. At the time of the building inspection it was noted that the 2nd floor bathroom fan, EF-2, was not operational and did not extend to the outdoors (exhausted directly into the attic space). Over the years, the Town has tried adding space temperature sensors in additional spaces to help provide zone temperature control.

The building is also provided with fintube radiation in the first level bathrooms, cabinet heaters in vestibules/stairs and hot water unit heaters in the storage, mechanical and attic areas of the building.

The following were noted or reported to be system operational issues:

1. Uneven heating/cooling within spaces within the same air conditioning/heating zone.
2. Ventilation air system overheats/overcools spaces and has been disabled.
3. Thermostat locations are not optimal increasing heating/cooling related issues.
4. System may have never been balanced and/or commissioned.

EVALUATION

BLW Engineers performed heating, cooling and ventilation calculations for each zone of the building; the building is provided with significantly more cooling and ventilation capacity than required.

The major issues with the heating, ventilating and air conditioning system is as follows:

1. Zoning: The units in the attic are single zone systems that each serve spaces with different uses, occupancies and have different exposures to the outdoors. Even though there are eight units that provide eight heating/cooling zones within the building, the only spaces of each zone that will truly be satisfied is the zone with the zone thermostat controlling the respective system. The existing units do not have the capacity to add variable air volume terminal units and/or reheat coils due to the limited fan capacity and the DX cooling coil.

2. Thermostat Locations: Several thermostat locations are not ideal to provide heating/cooling to each zone; thermostats are sometimes located in interior spaces or other locations that do not represent the heating/cooling requirements of the respective zone.

3. Ventilation: The ventilation air flows to each zone are excessive and significantly exceed code requirements. SF-1, SF-2, EF-3 and EF-4 are constant volume fans that are designed to provide the scheduled outdoor air volume to each air handling system. Each system operates heating or cooling upon a call from the zone thermostat, when the thermostat is satisfied it circulates

return/outdoor air until another call for heating or cooling; since the outdoor air volume is a significantly percentage of the total air flow of each system, the mixed air temperatures are very low in winter (40s) and very high in summer (85+) leading to very uneven air temperature distribution, humidification/dehumidication issues and difficulty in recovery to space temperature setpoints.

4. 2nd Floor Toilet Exhaust: the 2nd floor bathroom fan, EF-2, was not operational and did not extend to the outdoors (exhausted directly into the attic space).

5. Air Conditioning: The units were sized for the high mixed air temperatures due to the high percentage of outdoor air (up to 45% of total air flow); unfortunately, DX cooling systems do not operate well for outdoor air percentages exceeding 30 percent.

6. Balancing/Commissioning: It is not clear if the systems were ever properly balanced and/or commissioned which could be significantly impacting the operation of the system.

RECOMMENDATIONS

Option 1 – Existing System Upgrades

1. Relocate thermostats into more appropriate locations; add thermostats for averaging system operation.
2. Add controls for demand control ventilation and discharge air temperature control.
3. Add additional humidification to the building.
4. Modify supply ventilation system (F-1, F-2, EF-3 and EF-4) including variable speed controls to provide code required ventilation and/or demand control ventilation to the respective zones.
5. Repair 2nd floor toilet exhaust fan and extend to the outdoors.
6. Balance existing system to calculated airflows for heating and cooling.
7. Commission systems for proper sequence of operation.

Note: Option 1 would help alleviate some of the issues with the current system operation but will not entirely correct them; each system will still be a single zone system trying to satisfied multiple spaces within the zone.

The estimated construction costs for Option 1 is **$ 163,552.00**.

Option 2 – Existing System Replacement

1. Replace existing air cooled condensing units, refrigerant piping system, attic air handling units with new air cooled chiller, chilled water pumping/piping system, variable air volume terminal units for each zone within the building, variable air volume air handling units with hot/chilled

water coils in the attic, ductwork modifications and a new system of automatic temperature controls.

2. Add controls for demand control ventilation and discharge air temperature control.
3. Add additional humidification to the building.
4. Modify supply ventilation system (F-1, F-2, EF-3 and EF-4) including variable speed controls to provide code required ventilation and/or demand control ventilation to the respective zones.
5. Repair 2nd floor toilet exhaust fan and extend to the outdoors.
6. Balance existing system to calculated airflows for heating and cooling.
7. Commission systems for proper sequence of operation.

Note: Option 2 would be fairly invasive to the building but would be the ideal solution for the solving the noted issues; probably 3-4 weeks disruption to the entire building for the installation of replacement equipment in the attic and then 1-2 weeks of interruption of the heating or cooling for each zone or could be performed with less disruption during mild spring or fall weather.

The estimated construction costs for Option 2 is **$ 636,312.00**.

Estimated Construction Costs

Calculations