

Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58621/Page 1/November 1, 2017

Heating, Ventilation, and Air Conditioning – HVAC

Boiler Room:

The building is primarily heated by a standard efficiency dual fuel (natural gas and No. 2 fuel oil) hot water boiler heating plant. The boiler plant consists of three (3) cast iron steel sectional Weil McLain Model 88-12 Boilers equipped with Webster dual fuel burners with Autoflame controller. The boilers each have a capacity of 3753 MBH gas input/26 GPH oil input, 3,000 MBH gross output and 2608 MBH net hot water heating output. The boilers were installed in 2003, therefore are approximately 14 years old and are past the midpoint of their expected useful service life of 20-25 years. Each boiler appears to be provided with proper operating and safety controls.



Hot Water Boilers



Hot Water Pumps

The boilers currently only use natural gas. It is our understanding that the fuel oil tank has been removed, and that the existing fuel oil pumps, monitor control panel and fuel oil piping within the boiler room have been abandoned in place.



Fuel Oil Pumps



Fuel Oil Monitor Panel

Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58620/Page 2/November 1, 2017

The overall hot water piping system is schedule 40 black steel and is insulated with fiberglass insulation. Some sections of piping are uninsulated, and some piping insulation fitting may contain asbestos. Most of the hot water piping within the boiler room was installed in 2003, whereas the remainder of the hot water piping is largely original to the building and was installed circa 1957. The boiler plant generates low-pressure low temperature heating hot water, which is distributed by a primary secondary constant flow hot water piping distribution system. The hot water loop does not have glycol solution, and according to facilities staff, hot water coils have frozen in past years but not within the past three years. The hot water circulates throughout the main building hot water loop by two (2) primary/standby end suction base mounted pumps equipped with 15 hp motors that are installed in the boiler room. These pumps appear to be in good condition and were installed circa 2003. The pumps are constant flow and are not equipped with variable speed drives.

The boilers are each vented with insulated steel boiler breeching to a common breeching stack which terminates above the building roof with a single wall steel breeching equipped with a rain cap. Previously the original boilers were individually vented. Currently two of the steel breeching vents have been capped and abandoned in place.



Boiler Breeching



Boiler Breeching w/ Vent Cap

There are four ceiling suspended horizontal and one (1) vertical bladder style un-insulated expansion tanks located in the boiler room. It is our understanding that the vertical expansion tank is no longer operable and that only one (1) of the horizontal expansion tanks is connected to the system.



Expansion Tanks

Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58620/Page 3/November 1, 2017

Piping Distribution System:

The majority of hot water piping is distributed from the Boiler room to the building heating equipment through a crawlspace. Most piping appears to be insulated and painted black, except for the pipe main fittings, which could possibly contain asbestos, and the piping adjacent to the secondary pump sets. The piping adjacent to pumps P-5&6 is missing sections of insulation, and the piping adjacent to pump set, P-7&8, appears to be newer fiberglass insulation. There are two (2) sets of primary/standby secondary hot water pumps located in the basement crawlspace area. Two of the pumps, P7&8 are equipped with 10 hp motors, appear to be in fair condition and serve the Area D (Cafeteria, Gym, Locker Room) portion of the building. Two of the other pumps, P-5&P-6 are equipped with 5 hp motors, appear to be in poor condition and serve the Area A (Classroom Wing) portion of the building. The pumps are constant flow and are not equipped with variable speed drives.



Crawlspace - Hot Water Pump P-5&P-6



Crawlspace – Expansion Tank



Crawlspace - Hot Water Pump P-7&P-8



Crawlspace – Hot Water Piping

Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58620/Page 4/November 1, 2017

Automatic Temperature Controls:

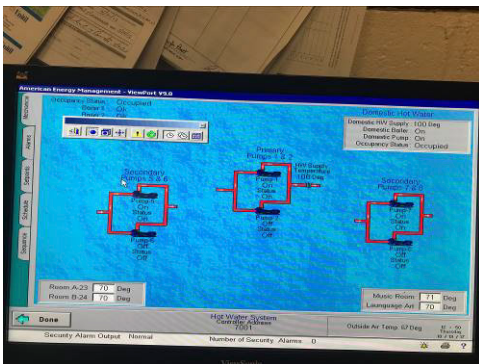
The Automatic Temperature Control (ATC) system is a combination direct digital (DDC) and pneumatic control system. The DDC components were installed by AEM (Advanced Energy Management) Inc. The DDC control system uses an Advanced Energy Management Viewport front end software with operates on Windows XP. The DDC control system was installed circa 2000, and as part of the DDC system installation the controls for the air handling units, boiler plant and unit ventilators were converted from pneumatic to DDC controls. Some heating equipment, air handling dampers and unit ventilators still operate using pneumatic controls. The pneumatic control air compressor is located in the Boiler room. Originally the building control system was largely manufactured by Johnson Controls. Overall the ATC system is antiquated in comparison to current systems, and only provides minimal monitoring, scheduling and setpoint control functionality. There is no ability for the Facility staff to make programming sequence changes for the HVAC equipment.



Pneumatic Control Panel



Pneumatic Control Air Compressor



Front End DDC Workstation



Exhaust Fan Relays and Starters

Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58620/Page 5/November 1, 2017

Rooms/zones with HVAC equipment that is controlled by the DDC system typically have newer AEM thermostat temperature sensors, whereas rooms/zone with HVAC equipment controlled by Pneumatic controls have older Johnson control pneumatic thermostats.



Typical DDC Tstat (left) and Pneumatic Thermostat (right)

Crawlspace - Air Handling and Exhaust Equipment:

There are five (5) indoor hot water heating and ventilation (HV) air handing units located in the crawlspace of the building. These units HV-5,6,7,8,13 and 14 respectively serve the Library, Library Offices, Administration offices, Girls Locker room, Boys Locker Room and Cafeteria. Black painted uninsulated ductwork is routed up from the units to the areas they serve. All of the units were installed circa 1957, and the units and associated ductwork, piping and control components appear to be in poor conditions. Most of the HV Unit fans are not equipped with pulled guards. Due to the damp crawlspace environment, unit casing, control components and ductwork show signs of visible corrosion. In addition, duck leakage is a potential concern for reduced building indoor air quality in these areas as the crawlspace area air can potential infiltrate the HV system ductwork and spread to the areas the HV units serve.



Crawlspace – HV Unit



Crawlspace – HV Unit Ductwork

Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58620/Page 6/November 1, 2017

There are approximately nine (9) utility vent set style centrifugal exhaust air fans located in the crawlspace area which generally serve classroom and bathroom exhaust air systems. The exhaust fans and ductwork are generally all original equipment and systems that were installed in 1957. The fans show visible signs of corrosion, and the ductwork is generally uninsulated, painted black and some ductwork sections shows signs of corrosion and damage. Most of the exhaust fans are not equipped with pulled guards.



Crawlspace – Exhaust Fans

Roof – Ventilation and Exhaust Equipment:

There are approximately forty-four (44) roof mounted exhaust air fans, with most fans being originally installed equipment from 1957. Some exhaust fans have been repaired and replaced since their original installation, however most of the fans are in need of replacement. There are also many intake and relief air hoods located on the roof. The intake and relief hoods serve heating and ventilation equipment and exhaust air fan systems located throughout the building.



Roof – Exhaust Fans and Intake/Relief Hoods

Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58620/Page 7/November 1, 2017

Shop Areas:

The Shop areas are typically heated and ventilated by a combination of wall mounted unit ventilators, fin tube radiation and unit heaters. The majority of equipment is originally installed equipment, circa 1957, and in need of replacement. The unit ventilators were noted to have a source of outside ventilation air, supply fans, filters, and a heating hot water coil with valve control. The general condition of the unit ventilators, unit heaters and radiation heating equipment observed were in poor condition.



Shop area Unit Ventilator



Shop Area – Fintube Radiation

Some of the shop areas are also provided with local exhaust air fan systems, such as paint booth exhaust and capture hood exhaust fan systems which generally are in poor condition. The vehicle garage shop area has a ducted exhaust air system which appears to have been abandoned in place and a wall type propeller exhaust air fan appears to provide the majority of room exhaust.



Abandoned Exhaust Ductwork



Wall Propeller Fan

There is a dust collection system for the woodworking shop; much of the ductwork is damaged and in need of replacement. The dust collector unit, which is manufactured by AAF Co. (Model D Roto Clone, Size 8) is showing signs of corrosion.

Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58620/Page 8/November 1, 2017



Wood Shop Exhaust Ductwork



Dust Collector



Exhaust Capture Hood



Paint Booth

Auditorium:

The Auditorium is served by heating and ventilation unit, HV-2, which has a capacity of 7,500 cfm and was installed in 1957. The HV unit is located in an adjacent mechanical room and the unit is ducted to overhead round supply air diffusers located in the Auditorium. The HV unit is originally installed equipment which is in need of replacement. A utility style centrifugal exhaust air fan that was installed in 1957, located in the mechanical room adjacent to the HV unit, removes exhaust air from the Auditorium.



Auditorium Supply Diffusers



Auditorium HV Unit and Exhaust Fan

Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58620/Page 9/November 1, 2017

Music Rooms:

The Music Rooms are served by heating and ventilation units, HV-3 (3,400 cfm) and HV-4 (2,750 cfm), HV units are located within mechanical closets adjacent to the Music Rooms. Utility style centrifugal exhaust air fans remove exhaust air from the music rooms. The HV unit and exhaust fans are originally installed equipment that requires replacement. Sidewall supply and exhaust air diffusers and grilles are located high on the walls of the Music rooms.



Music Rooms – Supply and Exhaust Sidewall Diffusers and Registers

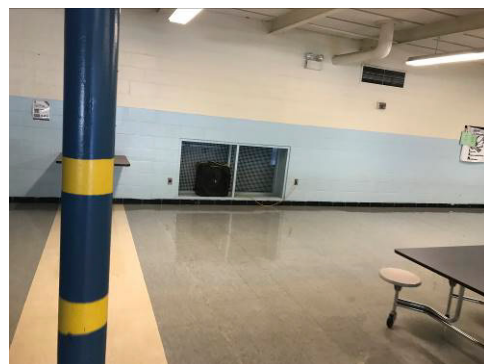
Cafeteria:

The cafeteria is served by a combination of one indoor HV unit (HV-14 – 10,200 CFM) that is located in the Crawlspace and was installed in 1957 and five (5) vertical style hot water unit ventilators. Each unit ventilator is provided with a heating hot water coil, supply fans, filters, and a source of outside ventilation air. The Cafeteria is also served by an exhaust air fan system.

It appears that a source of the supply air from the cafeteria is transferred to the kitchen via low wall mounted transfer grilles. These registers were slightly dirty, but do appear to function.



Cafeteria Unit Ventilators



Cafeteria Transfer Grille and Exhaust Grille

Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58620/Page 10/November 1, 2017

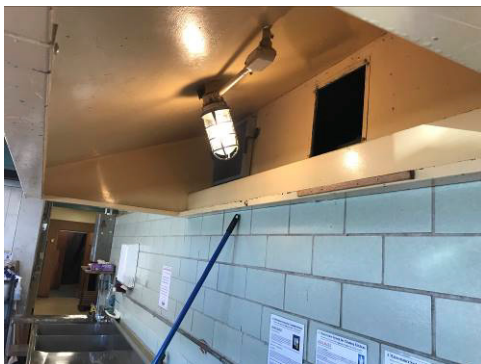
Kitchen:

The kitchen is provided with a double-sided steel kitchen exhaust hood that is located over the cooking equipment and appears to be of adequate size and height to serve the intended purposes. The kitchen hood is provided with cleanable filters, and appear to have an Ansul type fire protection system installed. As we understand it from maintenance personnel, the exhaust hood does operate; however, we cannot be certain that it operates efficiently or per code requirements.

The kitchen area is heated with wall mounted fin tube radiation heating. The kitchen does not have a direct source of make-up air ventilation other than operable windows and the transfer air from the adjacent Cafeteria. The kitchen does not have any mechanical cooling systems. Instead a large propeller stand type fan is used to provide spot cooling during warmer days while cooking and dishwashing operations are taking place. There is a canopy exhaust hood located over the dishwashing sink. There is a refrigeration cooler with air cooled condensing section located within the kitchen that adds a significant heating load to the kitchen. Consideration should be given to replacing this unit with a split system type cooler unit.



Kitchen Exhaust Hood



Kitchen Dishwashing Area Hood



Kitchen Fin Tube Radiation and Propeller Fan

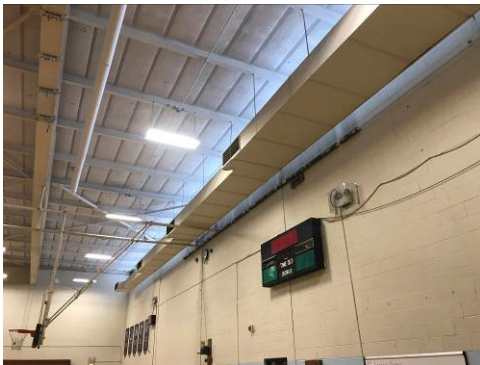
Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58620/Page 11/November 1, 2017



Kitchen Refrigeration Cooler

Gymnasium:

The gymnasium is provided with two individual air-handling units located in roof penthouse mechanical rooms. Heating and ventilation unit HV-9 serves the West half of the Gym and has a capacity of 7,500 cfm, and HV-10 serves the East half of the Gym and has a capacity of 7,500 cfm. Each unit is provided with a heating hot water coil, supply fans, filters, and a source of outside ventilation air. Each air-handling unit serves a supply air duct with side wall diffusers located high above the floor and provides heating and ventilation air to the entire space through these two supply ductwork and diffuser assemblies. Also, located within the gymnasium are individual low wall return air registers, which return the supply air back to each air-handling unit exhaust air fan located within the same mechanical room. These registers were noted to be slightly damaged and dirty and generally in need of replacement.



Gym Supply Duct and Diffusers



Gym Return Register



Penthouse Mech Rm - Gym HV Unit



Penthouse Mech Rm – Gym Exhaust Fan

Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58620/Page 12/November 1, 2017

Multi-Purpose Gymnasium:

The Multi-purpose gymnasium is provided with two individual air-handling units located in roof penthouse mechanical rooms. Heating and ventilation unit HV-11 serves the West half of the gym and has a capacity of 4,000 cfm, and HV-12 serves the East half of the Gym and has a capacity of 4,000 cfm. Each unit is provided with a heating hot water coil, supply fans, filters, and a source of outside ventilation air. Each air-handling unit serves a supply air duct with side wall diffusers located high above the floor and provides heating and ventilation air to the entire space through these two supply ductwork and sidewall diffuser assemblies. Also, located within the gymnasium are individual low wall return air registers, which return the supply air back to each air-handling unit exhaust air fan located within the same mechanical room. These registers were noted to be slightly damaged and dirty and generally in need of replacement.



Multi-Purpose Gym Supply Diffusers



Multi-Purpose Gym – Return Register



Multi-Purpose Gym HV Unit

Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58620/Page 13/November 1, 2017

Locker Areas:

Both the girls and the boys locker rooms are each served by an indoor heating and ventilation air-handling unit, which includes a hot water heating coil, supply fan, filters, and a source of outside ventilation air. Ventilation air is provided overhead through a supply distribution system to various diffusers located throughout. The HV units are located in the crawlspace area and appear to be in poor condition. HV-8 serves the Girl's locker room and has a capacity of 5,825 cfm and HV-13 serves the Boy's locker room and has a capacity of 5,600 cfm. There are also side wall mounted and overhead exhaust air grilles that are connected to exhaust air. The system appeared to be functioning properly, however the diffusers, ductwork and fans appear to be originally installed equipment and systems that should be replaced. The locker rooms are also heated by perimeter wall mounted fin tube radiation heating.



Typical Locker Room Fintube



Typical Locker Room Exhaust

Library:

The Library and adjacent Library offices are heated and ventilated by two (2) indoor heating and ventilation units located in the crawlspace area below the Library, and are ducted to sidewall supply air diffusers. HV-5 serves the Library and has a capacity of 1,750 cfm and HV-6 serves the library offices and has a capacity of 1,880 cfm. Both units appear to be in poor condition and were installed in 1957. The Library is also heated with supplemental perimeter fin tube radiation heating, and is air conditioned by window AC units.



Library - Window AC Units and Fin Tube



Library Supply Diffusers

Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58620/Page 14/November 1, 2017

Classrooms:

Classrooms are typically provided with wall-mounted vertical discharge unit ventilators, which include a hot water heating coil with valve control, a source of outside ventilation air, supply fans and filters. These units were installed in 1957 and are in poor condition. Overall there are approximately seventy-five unit ventilators installed throughout the building, with the majority being installed in classroom areas. Exhaust air grilles are typically located low within an architectural enclosure on the interior corridor side of the classroom. The exhaust air grilles are ducted to exhaust air ductwork and fan systems located in the crawlspace areas below the Classrooms. Many classrooms also have supplemental fin tube radiation heating along the exterior perimeter walls. Most of the unit ventilators are controlled by the DDC system and much of the hot water radiation heating is controlled by the pneumatic control system.



Classroom Unit Ventilator



Classroom Exhaust Grille

The Science Classroom has an old fume hood and exhaust air fan system which appears to have been originally installed equipment and in poor physical condition. Many of the Classrooms observed appear to have window air conditioners installed



Science Classroom Fume Hood



Classroom Fintube Radiation

Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58620/Page 15/November 1, 2017



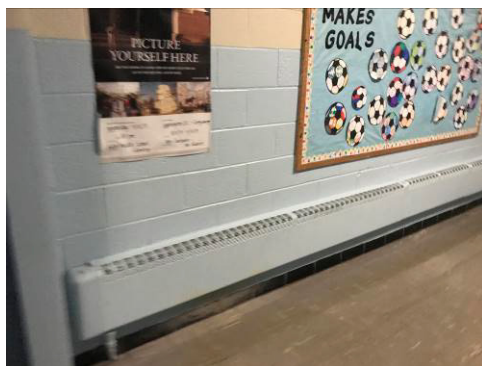
Classroom – Unit Ventilator Louvers and Window AC Units



Horizontal Classroom Unit Ventilators

Corridors:

The various circulating corridors throughout the building do not appear to be provided with code required ventilation air. Ventilation air is required by code in corridors, therefore this condition should be corrected. Majority of corridors are heated by hot water fin tube radiation equipment which appears to be originally installed equipment that has exceeded its expected service life.



Corridor – Fin Tube Radiation Heating

Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58620/Page 16/November 1, 2017

Restrooms:

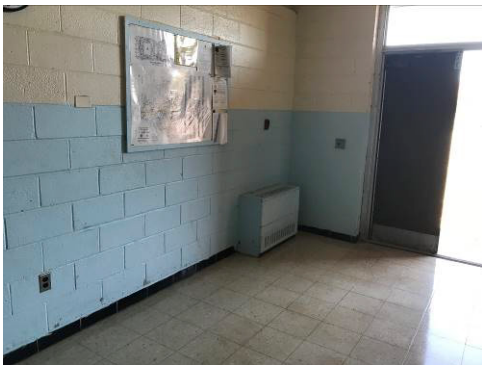
The restrooms observed during our site visit appear to be properly exhausted with exhaust air fan systems. Make up air for larger restrooms is typically provided by door grilles. Restrooms are typically heated by fin tube radiation heating. The exhaust air and heating systems appear to be original to the building, circa 1957, and therefore should be replaced.



Restroom – Exhaust Grille and Fintube Radiation Heating

Door Entrances and Vestibules:

The individual entranceways throughout the building are typically heated by a combination of hot water cabinet style unit heaters, convectors, or hot water fin tube radiation heating. These cabinet heaters and fintube enclosure generally were noted to be slightly dirty and some had damaged casing; however, we understand most of the units do operate. The entranceways are not provided with any vestibule interlocks and therefore infiltration air does circulate throughout when the doors are open. It is recommended that vestibule interlocks be provided at each doorway and all cabinet heaters be replaced with a higher output unit.



Entryway – Hot Water Cabinet Unit Ventilator (left) and Convector(right)

Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58620/Page 17/November 1, 2017

Administration Offices and Nurse's Office:

The main administration office area is heated and ventilated by an indoor heating and ventilation unit, HV-7 – 870 cfm) that is located in the crawlspace below the office area. The administration area is also heated by supplemental fin tube radiation heating and is primarily air conditioned by window AC units. The HV unit and fin tube radiation are originally installed equipment, circa 1957. One of the teacher's offices is air conditioned by a Window AC unit that is installed in an interior wall. This unit can cause condensate to drop from the unit and on to the floor during humid days. The Nurse's office is air conditioned by a ductless split system AC unit.



Administration Office



Office with Window AC installed in Interior Wall



Nurse's Office Ductless AC unit

Building and Grounds Office Area:

The Buildings and Grounds office area is primarily heating, ventilated and air conditioned by a packaged rooftop unit equipped with gas fired heating and direct expansion electric cooling. The unit was manufactured by Trane, has a capacity of 5 tons and was installed circa 2001. The unit appears to be in fair condition, but is nearing the end of its expected useful service life of 15-20 years. The B&G office area is also heated by supplemental hot water fintube radiation.

Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58620/Page 18/November 1, 2017



B&G Office - Packaged Rooftop Unit



B&G Office Supply Diffusers



B&G Office Fintube Radiation

Community Health Area:

The Community Health area is primarily heated by perimeter fin tube radiation heating, and is air conditioned by a combination of Window AC and ductless split system AC units. Ventilation air is provided by a combination of operable windows and a ceiling suspended energy recovery (ERV) unit. The ductless split system unit and ERB unit appear to have been installed approximately 3-4 years ago.



Community Health – Ductless AC Unit and Associated Roof Condensing Units

Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58620/Page 19/November 1, 2017



*Community Health - Window AC Unit
and Fintube Radiation*



Community Health – ERV Unit

Recommendations for Renovation and Repair Project:

Based upon our site visit observations and review of existing condition drawings we offer the following recommendations for repair and replacement of the existing HVAC systems:

- Existing hot water boilers should be replaced with high efficiency gas fired condensing hot water boiler plant consisting of (3) new hot water gas-fired condensing boilers, associated breeching, accessories, pumps and controls. The new pumps should be equipped with VFD drives and provided with differential pressure controls and power wiring to replace the three (3) sets of existing hot water pumps (Quantity of 6 pumps).
- All existing heating and ventilation units (Qty. of 14) should be replaced. Consideration should be given to adding energy recovery to the HV units, and possibly adding air conditioning to the new units. These units presently serve the Gym, Multi-Purpose Gym, Library and library offices, Cafeteria, Locker rooms, Music Rooms, Auditorium and Administration office. It is highly recommended that replacement units are not installed within crawlspace areas due to difficulty for service and maintenance, and the potential for reduced service life of the equipment.
- A dedicated make-up air unit should be installed for the Kitchen, and the existing Kitchen and Dishwasher hoods and exhaust air fans system should be replaced.
- All existing unit ventilators should be replaced (Qty. of 75). Adding new CO2 demand ventilation and/or energy recovery should be considered as part of a potential UV replacement project. Under a large building renovation project, potential alternative HVAC systems should be studied as part of a potential solution to replace the Unit Ventilators and Window AC unit that currently serve the Classrooms.
- All existing originally installed exhaust air fans should be replaced with new exhaust air fans.
- All originally installed existing HVAC system ductwork and piping should be replaced and new insulated ductwork and piping should be installed.
- New cabinet unit heaters and/or convectors should be installed at Entryways.

Fuller Middle School Feasibility Study
Framingham, MA
HVAC Existing Conditions Systems Report
J#680 015 00.00
L#58620/Page 20/November 1, 2017

- New fume hood and exhaust air system should be provided for Science classrooms if required.
- The Shop area HVAC systems should be replaced including Unit ventilators, exhaust air systems and the dust collector unit and associated ductwork.
- Ventilation air system should be provided for the corridors and classroom/office areas that lack mechanical ventilation.
- The existing direct digital control building energy management system should be replaced and upgraded to a full DDC system. Existing pneumatic controls should be removed.
- All new HVAC systems should be tested, adjusted, balanced and commissioned.