

# Charter

## Hollis-Brookline

### Cooperative Facility Committee (CFC)

#### **1. Purpose:**

This document defines the charter, structure, scope & responsibilities, work product, and longevity of the Hollis-Brookline Cooperative Facility Committee.

#### **2. Background:**

The Hollis-Brookline Cooperative School Board (HBCSB) is solely accountable to oversee all aspects associated with the maintenance, management, operation, and general condition of the physical plants of the district.

There is the consensus of the School Board and Administration that many aspects of the environmental and electric delivery systems have either reached or exceeded their useful service life requiring either an upgrade or complete replacement. In addition, the school buildings lack major efficiencies which could significantly reduce operating costs while improving performance and comfort.

As part of its planning efforts, HBCSB is seeking either facility upgrades or replacements of the High School and Middle School environmental and electric delivery systems to ensure/enhance smooth and efficient operations.

#### **3. Charter:**

The HBCSB shall impanel, as its agent, a facility committee to do all appropriate studies, investigations, and recommendations on the current and future state of the environmental and electric delivery systems of the High School and Middle School buildings.

#### **4. Structure/Members:**

The Cooperative Facility Committee (CFC) shall self-organize selecting its officer positions of Chair, Vice Chair, and Secretary. The CFC shall notice all meetings and record meeting minutes available to the public. The CFC will be comprised as follows:

<b>Role</b>	<b>Member</b>	<b>Representing</b>
Appointed COOP School Board Member	<b>Robert Mann</b>	COOP School Board
Appointed COOP Budget Committee Member	<b>Raul Blanche</b>	COOP BudCom
Select SME Contractor/Vendor	<b>Dave Ely</b>	SME
Hollis Select Board Appointed Member	<b>TBD</b>	Hollis
Brookline Select Board Appointed Member	<b>Brendan Dennehy</b>	Brookline
Hollis Community Member at Large	<b>Tom Enright</b>	Hollis
Brookline Community Member at Large	<b>Ernie Pistor</b>	Brookline
SAU#41 Administration	<b>Andrew Corey</b>	Superintendent
	<b>Gina Bergskaug</b>	Assist. Superintendent
	<b>Kelly Seely</b>	Business Administrator
	<b>Lance Finamore</b>	Facilities Dir.

## **5. Scope & Responsibilities:**

The CFC is expressly impaneled to advise the School Board on capital improvements, upgrades, replacements, and enhancements to the school building's environmental and electric delivery systems.

CFC's responsibilities include but are not limited to:

- a. Conducting on-site studies, investigations, and evaluations of the building's environmental and electric delivery systems
- b. Conduct regular monthly meetings at a minimum to assess findings, next steps, and develop recommendations
- c. Engaging with approved third-party subject matter experts (SMEs)
- d. Engaging with community energy groups
- e. Engaging in Request for Comment/Request for Pricing (RFC/RFP) activities
- f. Presenting monthly updates of progress to the School Board

## **6. Work Product/Deliverables**

The work product of the CFC shall be to develop and deliver recommendations and costed plans for:

- a. Environmental and electric delivery system upgrades and/or replacements
- b. Energy efficiency options
- c. Practical clean energy options

The CFC shall deliver the final work product to the COOP School Board no later than its December 2023 meeting.

**7. Longevity:**

The CFC will be impaneled and commence its work in June 2023 pending board approval of this charter. The CFC will disband no later than April 1, 2024, unless this charter is renewed by a specific School Board action.

<b>Role</b>	<b>Member</b>	<b>Representing</b>	<b>Email</b>
Appointed COOP School Board Member	Robert Mann	COOP School Board	<a href="mailto:robert.mann@sau41.org">robert.mann@sau41.org</a>
Appointed COOP Budget Committee Member	Raul Blanche	COOP BudCom	<a href="mailto:raul.blanche@yahoo.com">raul.blanche@yahoo.com</a>
Select SME Contractor/Vendor	Dave Ely	SME	<a href="mailto:davidaely@gmail.com">davidaely@gmail.com</a>
Hollis Selectmen Appointed Member	TBD	Hollis	TBD
Brookline Selectmen Appointed Member	Brendan Dennehy	Brookline	<a href="mailto:bdenehy@brooklinenh.us">bdenehy@brooklinenh.us</a>
Hollis Community member at Large	Tom Enright	Hollis	<a href="mailto:tenright33@gmail.com">tenright33@gmail.com</a>
Brookline Community member at Large	Ernie Pistor	Brookline	<a href="mailto:epistor@charter.net">epistor@charter.net</a>
SAU #41 Administration	Andrew Corey	Superintendent	<a href="mailto:andy.corey@sau41.org">andy.corey@sau41.org</a>
	Gina Bergskaug	Assist. Superintendent	<a href="mailto:gina.bergskaug@sau41.org">gina.bergskaug@sau41.org</a>
	Lance Finamore	Facilities Dir.	<a href="mailto:lance.finamore@sau41.org">lance.finamore@sau41.org</a>
	Kelly Seely	Business Administrator	<a href="mailto:kelly.seeley@sau41.org">kelly.seeley@sau41.org</a>



ENGINEERING • COMMISSIONING

# Hollis Brookline High School

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## HVAC Assessment Report

John F. Penney, P.E.

8/7/2020

FOR REVIEW

TABLE OF CONTENTS

Part 1 Introduction.....1

Part 2 Existing Systems .....2

Part 3 Recommendations.....5

    Short Term Plan ..... 5

    Long Term Plan..... 6

Part 4 Summary of Current and Recommended Ventilation and Filtration.....8

## Part 1 Introduction

JFPCS has been hired to perform an assessment of the mechanical heating and ventilation systems of the school. Our focus will be to assess the physical condition, operable condition, ventilation capabilities and filtration capabilities of the equipment. As guidelines evolve to address the opening of school amid the COVID-19 concerns, educational facility Owners are looking to know how their mechanical systems currently operate and/or can adapt to recommended changes in ventilation and filtration. As of the writing of this report, recommendations by the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) and the Center for Disease Control and Prevention (CDC), along with the “New Hampshire Grades K-12 Back-to-School Guidance” report, all suggest increasing ventilation rates where possible and increasing filter efficiency to a Minimum Efficiency Reporting Value (MERV) of 13, where equipment will allow. Our approach is to provide information on each occupied space, the current and recommended ventilation requirements, current and recommended filter capabilities, and recommendations to adjust or upgrade systems to perform to the standards and guidelines. ASHRAE is the organization that has developed the standards for ventilation and filtration. The CDC is working with ASHRAE to formulate good practices in maintaining a safe indoor environment. This report is intended to assist in managing existing systems and to provide recommendations to upgrade and/or adjust systems where systems or equipment may not meet standards.

## Part 2 Existing Systems

Most of the classrooms in the Hollis Brookline High School are served by rooftop mounted air handling units (RTUs) that provide ventilation to the spaces. Some of the RTUs are not fitted with heating coils. Coils are located in the ductwork at each classroom or zone to temper the distributed air. Baseboard radiation is also used to heat the space. There is one heat recovery unit (HRU), three heating, ventilation and air conditioning (HVAC) units, one fan coil unit (FCU) and four unit ventilators (UVs)

The locker room across from the gym is served by a heat recovery unit. This unit has a 2" thick filter rack and currently has MERV-8 filters installed. Since this building has a maintenance contract, the filters in the building were all replaced June 8, 2020 and appeared clean. When we were on site, the outside air damper was closed. This may have been due to it being a warm day and may have been in an "exhaust only" state to prevent heat recovery, thus overheating of the spaces. Sequences of operation were not confirmed.

FCU-1 serves the Computer Lab 141 and is installed in the ceiling of the closet in the Art Room. This unit was condensing heavily onto the floor below. The existing drawings show a 12x10 duct connected to a shared louver with the unit ventilator which also serves the Art Room. We were unable to confirm this on site. This should be verified, and the airflow should be measured to determine the ventilation rate. The filter rack is 2" thick and is currently provided with MERV-8 pleated paper filters that appeared clean. Access to this unit was difficult.

HV-1 serves the cafeteria and is installed high in the janitor's closet outside of the cafeteria. Outside air enters from a louver located above the adjacent classroom. This unit has a 2" filter frame. Currently MERV-8 pleated paper filters are installed and appear to be clean. The outside air damper appeared to be approximately 5% open while we were on site. The existing drawings indicate this unit was initially set up for 15% outside air. Note that the damper position does not equal outside air percentage thus a 5% open outside air damper may translate to 15% outside air but it is impossible to know without measuring the airflow. This unit was arranged with an external face and bypass on the heating coil.

HV-2, located high in a janitor's closet off a hallway, serves several offices and a conference room on the second floor. This area appears to be part of the auditorium addition. This unit has no heating coil however there are booster coils in the supply duct to the spaces. At the time of our visit, the outside air damper was completely closed, and the return air damper was 100% open and the spaces were unoccupied. The existing drawings indicate this unit was initially set up for 15% outside air. This unit has a 2" thick filter rack and was currently provided with MERV-8 filters which appeared to be clean.

HVAC-1 is located high in a storage room on the first floor and serves the main offices and a conference room on the first floor. Outside air comes in through a duct to the roof. The outside air damper appeared to be slightly open. We were told the building management system was reading 2% open which appeared accurate. The space was minimally occupied at the time of our visit. This unit is arranged for ventilation and cooling, heat is provided by downstream heating coils in the ductwork. This unit has a 2" thick filter rack and was installed with MERV-8 filters that appear clean. Access to this unit is difficult.

HVAC-2 is located above the ceiling in a storage closet and serves the guidance offices on the first floor. The outside air damper appeared to be slightly open. We were told the building

management system was reading the outside air damper at 5% open which appeared to be accurate. The spaces were occupied during our visit. This is a ventilation and cooling only unit, heat is provided by downstream heating coils in the ductwork. This unit has a 2" thick filter rack and was provide with MERV-8 filters that appeared to be clean. Access to this unit is difficult.

HVAC-3 serves the Media Room/Library and is installed on the floor in an adjacent closet. This unit has heating and cooling coils. The outside air damper at the unit appeared to be approximately 15% open. The existing drawings indicate an outside air percentage of 15%. The drawings also indicate that there is a second outside air damper at the intake louver that should be verified is opening. We were unaware of this additional damper at the time of our visit. This unit has a 2" thick filter frame and is currently provided with 2" thick MERV-8 filters that appear clean.

RTU-1 serves several classrooms on the 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> floors. This unit does not have a heating coil but is provided with economizer control. Heating is provided through heating coils located in ductwork and finned tube radiation in the space. At the time of our visit which was early in the morning on a hot day, the outside air damper appeared to be approximately 90% open. This unit has 2" thick filter frames. The filters that were installed were 2" MERV-8 filters which appeared to be clean. Existing drawings indicate a minimum 17% outside air during occupied times.

RTU-2 serves several classrooms on the second and third floor including the Music Room and Computer Room 217. This unit has economizer control. Heating coils are installed in the ductwork downstream and the classrooms it serves have finned tube radiation. At the time of our visit which was early in the morning on a hot day, the outside air damper was open to approximately 75%. According to the existing drawings, this unit should be set up with a minimum outside air percentage of 17% during occupied times. The filter frame in the unit is 2" thick and is currently installed with MERV-8 pleated paper filters that appeared clean.

RTU-3 serves the gymnasium. This unit has a heating coil and is also equipped with economizer control. The outside air damper was 100% open on the morning of a very warm day when the space was unoccupied. This unit also has a 2" thick filter frame with MERV-8 pleated paper filters. Filters appeared to be clean.

RTU-4 serves the auditorium and was installed in a 1998 addition. This unit had a heavy yellowjacket infestation in the outside air intake hampered our ability to fully review some areas of the unit. This unit is ventilation and cooling only. It appeared the outside air damper was closed off and the return air damper was 100% open. The filter rack is 2" thick and currently has 2" MERV 8 pleated paper filters installed.

RTU-5 serves a dance room. This unit is another ventilation and cooling only unit. The outside air damper position appeared to be at approximately 10% open. The linkage between the return and outside air damper is beginning to rust out. This unit has a 1" thick filter rack and current 1" MERV 8 pleated paper filters installed which appeared to be clean. It appears from opening this unit that it could be modified slightly to accept a thicker filter if required, possibly up to 3" or 4" thick.

RTU-6 serves an addition to the gym which is a Mini Gym and Weight/Exercise Room (Rooms 369A & 369B). This unit is incorrectly labeled as UV-1 on the roof. When we were on site on a very warm morning with the space unoccupied, the outside air damper was approximately 75%

open. This unit has a 2" thick filter frame and is currently installed with 2" MERV-8 pleated paper filters. Filters appear to be clean.

RTU-1C serves the classrooms in the 2004 addition. This unit also has no heating coil and instead, each classroom has a heating coil with finned tube radiation in the spaces. This unit appeared to be in 100% return mode (0% outside air) on a very warm morning. The filter frame is 4" thick and currently is provided with 2" thick MERV 8 pleated paper filters. Filters appeared to be clean. Loose fitting filters could be a concern.

RTU-2C serves the third-floor Classroom 303. No heating coil is installed in the rooftop unit. A Booster coil, located in the ceiling of the third floor, tempers the ventilation air. Space mounted finned tube radiation provides additional heat to the space. RTU-2C has a 2" filter rack and is currently provided with 2" MERV-8 filters. Filters appeared clean.

UV-1 is installed in the ceiling of Classroom 158. The return air damper appeared to be 0% open which would indicate the outside air damper was 100% open. We were unable to access any of the filters in the unit ventilators as we were told it is quite difficult to access. Usually these units have a 1" filter frame.

UV-2 is located above the ceiling and serves Rooms 154, 155 & 156. We were unable to determine the outside air damper position, but it appeared the return air damper was 0% open which would indicate the outside air damper was 100% open.

UV-3 is installed in the ceiling of the Art Room. The return damper appeared to be approximately 50% open on a day when the space was unoccupied.

UV-4 is installed in the ceiling of Art room 170. The return air damper appeared to be mostly open.

Computer Room 217 has a couple of small mini-split indoor units installed. These units have a washable mesh filter. In the classroom there is a switch that says cooling enabled on/off. Above the switch there is a note "CAUTION: Turning on the switch below brings in outside air. If you want the air conditioner to run, leave this switch off. I know it's confusing but failure to follow these directions will result in a very warm room". It is unknown what exactly this switch does, but we believe there is a damper in the ductwork that closes off ventilation air to this space. The ventilation ductwork to this space appears to be coming from RTU-2. This should be investigated further.

Additionally, there are several cabinet heaters located around the building at various locations. These heaters have no outside air associated with them. They typically take a 1" filter. The filters were likely replaced along with the rest of the filters in the building on June 8, 2020.

## Part 3 Recommendations

According to the guidelines, all ventilation systems should meet current standards for outdoor air changes and filtering efficiencies. Where outdoor air systems can accommodate increases in both volume and filter efficiency, attempts should be made to do so but within the capacities of the equipment. During times when the outdoor air temperature is above 32 deg F, air volumes can be increased with equipment that mixes outdoor air with return air such as with unit ventilators, air handling units with mixing dampers, rooftop air handlers and other similar equipment. Ventilation units such as heat recovery ventilators, energy recovery ventilators, fan coil units and cabinet unit heaters may be fixed or limited in how much ventilation air volume can be increased. Most fan coil units and cabinet unit heaters do not have outdoor air capabilities. Baseboard radiation, unit heaters and other similar terminal units have no ventilation air and may rely on either natural ventilation, such as operable windows, or air systems such as HRVs and ERVs to provide space ventilation.

The Hollis Brookline High School does have means to ventilate all the student occupied spaces, offices, and common areas. There are a few deficiencies. The best way to achieve improvement in the building environment and seek to meet the recommendations put forth by the guidelines, is to set up a short-term plan and a long-term plan. The goal is to make immediate changes to improve the abilities to provide higher levels of ventilation and filtration, while weather conditions allow, and make upgrades to equipment and systems to control the indoor air quality of each space for all weather conditions.

### Short Term Plan

The following recommendations can be implemented immediately:

1. Change all occupied/unoccupied schedules for starting ventilation of the building two hours before occupancy and allow them to run two hours after occupancy. This will provide a pre-purge and post-purge of the building. If the sequence is to provide a morning warmup, systems may need to be started earlier.
2. Make sure all filters in ventilation systems are clean and are of the highest allowable MERV rating. Where ERVs and HRVs provide 100% outdoor air, it should not be necessary to provide filters with a rating higher than what is recommended by the equipment manufacturer. Usually MERV 8 on supply and MERV 7 on returns. Filter housings should be inspected to verify filters are tight fitting, are well sealed around the filters and frames, and that close tightly along the ends with spacers and/or gaskets to allow air to only pass through the filter and not around them. Filters that become overly loaded can reduce airflow and possibly collapse. Rooftop equipment or air handlers can be subject to water or snow infiltration and may need to be checked after a weather event. Prefilters may be necessary on rooftop equipment. Allowing filters to overload will reduce airflow and may lead to poor air quality with leakage around the filters. Filters in rooftop units and air handling units could be increased in efficiency. MERV 13 filters can

be purchased to fit these AHUs. If kept clean, they can maintain close to the current airflow. There could be a delay in ordering MERV 13 filters because of a shortage of availability. Unit ventilators have a one-inch thick filter frame. MERV 13 filters are available. Pressure drops for the one-inch MERV 13 filters can be as much as three times more than the standard filter. Careful consideration should be given when using filters that could reduce airflow such that the ventilation is reduced.

3. Adjusting control on all ventilation systems may be necessary. The AHUs, RTUs and unit ventilators have temperature control of the modulating dampers. As the mixed air temperature setpoint is lowered, more outdoor air can enter. Where mixing box temperature control is possible, we recommend that the temperature be set for 55 deg F initially. In some cases, as with unit ventilators, the sequence is to maintain a space temperature setpoint. This method of controlling ventilation may require adjusting the outdoor air damper to the minimum position. This will allow you to meet ventilation standards down to subfreezing outdoor air temperature. Therefore, temperatures above 32 deg F will allow an increase in the amount of outdoor air up to 100%. This is usually referred to as economizer cooling. In this case, additional ventilation is the objective. With more outdoor air, the building will become pressurized. Each classroom has a means of relieving the pressure either through a relief damper and louver, or a system of exhaust fans that will run during the occupied schedule. When it is mild outdoors, windows can be opened. Once the space equipment goes into heating mode, windows should be closed as space comfort may be affected. If the system has mechanical cooling, it would be best to close windows if the equipment were to cycle on. Equipment needs to be sequenced such that the fan in the air handling equipment is running during the occupied hours. To have constant ventilation during occupancy, the fans need to be enabled. Once set back to unoccupied, the fan can cycle on a call for heat. Outdoor air dampers should be closed.
4. Toilet room exhaust fans should be operable. Current ventilation standards require 50 cfm/fixture of continuous exhaust. Exhaust fans should also be operated continuously during occupied hours.
5. The Gymnasium and the Cafeteria have designated air handling systems that are designed to ventilate large occupancies. These are likely spaces where CO<sub>2</sub> sensors are used to limit ventilation and save energy. Large group assemblies are not allowed under most state guidelines. For these areas, a maximum occupancy may be established by the school. Ventilation air dampers can be reset to provide a ventilation rate to accommodate the revised occupancy. The Summary of Current and Recommended Ventilation and Filtration table lists the required rate of two different occupancy levels. We can assist in determining the rate required for the expected occupancy.

## Long Term Plan

1. AHUs and UVs should undergo a controls review. In some areas, we could not verify dampers were operating according to the sequence. Where CO<sub>2</sub> sensors may be installed to control ventilation, we suggest setting the outdoor air damper to the minimum ventilation amount. Sometimes dampers are set to 0% when a CO<sub>2</sub> sensor is used.

Guidelines recommend ventilation be maintained regardless of CO<sub>2</sub> concentration. Adjustments to these systems can be provided by any service mechanical contractor. Where a Building Management System is installed, adjustments can usually be made through the control system Front End.

2. A mechanical maintenance plan should be established, documented, and have a schedule to inspect the operation of systems and replace filters and belts. Sometimes during specific times of the year, filters should be checked. After pollen season and after the leaves fall, filters should be checked and may need replacement. Usually filters require replacement about three times per year. Inspection of dampers operating properly should be checked before each heating season. Proper blade seals and actuator pressures should be checked to verify dampers seal properly which can have an impact on energy cost. Fans need to have bearings greased to ensure good rotation and long life. A fan failure is a ventilation failure.
3. Filters need to be installed properly and checked to verify air is not diverted around the filter due to improper seals in the filter frame and at the door.
4. Boilers should be serviced every year prior to the heating season to maximize efficiency. This should include cleaning the boiler sections, inspecting and adjusting the firing rate, and checking the controls. An efficiency test should be performed after each service. Controllers for boilers should be performing adjustments to water temperature based on outdoor air temperature and should shut down the boiler and pumps when outdoor temperatures rise above the need to heat the building.
5. The Summary of Current Recommended Ventilation and Filtration table shows the minimum requirement for ventilation for each space based on occupancy. The standard allows ventilation to be calculated based on the actual known occupancy, or when the occupancy is not known, a calculated occupancy based on persons per square foot is used. We have provided both values. Our reasoning is that the calculated occupancy is normally used in design. If this was the case and classroom occupancies are reduced, the ventilation rate is likely more than that required of the standard. Where actual airflow readings were taken, we have made note where ventilation rates may be deficient. Filters with higher efficiency can be purchased for the AHUs and RTU's.
6. We encountered several systems where the damper operation was questionable and, in a few cases, actuators and damper linkage were either broken or disconnected. Damper control must be maintained, inspected at least once a year, and repaired as soon as discovered. Ventilation air dampers need to be working to provide proper ventilation and to avoid excess energy use or even equipment failure such as a frozen heating coil.

Part 4 Summary of Current and Recommended Ventilation and Filtration

Hollis Brookline High School

Room	SF	Ceiling Height Feet	# Students	ASHRAE # Students	Current Vent. Standard ASHRAE 62.1	Current Vent. Standard ASHRAE # Students 62.1	Current Vent. Design	Ventilation Equipment Serving Space	Exhaust Requirements ASHRAE 62.1	Exhaust Design	Filter Eff. Current	Max Filter Eff.	Recommendations
Computer Lab 141	1314	8	20	33	447	610		Heating Coil BC-6	0		2" MERV 8	MERV 13	Note 3
Locker 348	944	8			170	170	0	HRU-1	472	750	2" MERV 8	MERV 13	Note 2
Locker 349	820	8			98	98	0	HRU-1	410	700	2" MERV 8	MERV 13	Note 2
Bathroom 334	440	8			26	26	0	HRU-1	900	975	2" MERV 8	MERV 13	Note 2
Bathroom 333	295	8			35	35	0	HRU-1	375	380	2" MERV 8	MERV 13	Note 2
Gym 339	9350	20	500	719	8354	11091	2040	RTU-3			2" MERV 8	MERV 13	Note 12
Music Room 329	1275	20	30	45	453	599	340	RTU-2			2" MERV 8	MERV 13	Note 4
Music Office 324	120	10	1	1	15	15	23	RTU-2			2" MERV 8	MERV 13	Note 4
Classroom 332	660	10	20	23	349	388	119	RTU-2			2" MERV 8	MERV 13	Note 4
Classroom 327	660	10	20	23	349	388	119	RTU-2			2" MERV 8	MERV 13	Note 4
Classroom 323	800	10	20	28	370	470	145	RTU-2			2" MERV 8	MERV 13	Note 4
Classroom 321	660	10	20	23	349	388	119	RTU-2			2" MERV 8	MERV 13	Note 4
Classroom 223	840	10	20	29	376	494	129	RTU-2			2" MERV 8	MERV 13	Note 4
Classroom 222	815	10	20	29	372	479	129	RTU-2			2" MERV 8	MERV 13	Note 4
Classroom 225	925	10	20	32	389	543	153	RTU-2			2" MERV 8	MERV 13	Note 4
Classroom 224	775	10	20	27	366	455	119	RTU-2			2" MERV 8	MERV 13	Note 4
Classroom 221	850	10	20	30	378	499	129	RTU-2			2" MERV 8	MERV 13	Note 4
Classroom 216	785	10	20	27	368	461	136	RTU-2			2" MERV 8	MERV 13	Note 4
Computer 217	740	10	20	26	361	435	128	RTU-2			2" MERV 8	MERV 13	Notes 4 & 5
Classroom 201	850	10	20	30	378	499	136	RTU-2			2" MERV 8	MERV 13	Note 4
Classroom 202	835	10	20	29	375	491	136	RTU-2			2" MERV 8	MERV 13	Note 4
Office(?) 218	230	10	2	2	30	30	38	RTU-2			2" MERV 8	MERV 13	Note 4
Staff Break 229	790	10	6	6	97	94	100	CH-5			1" MERV 8	MERV 8	Verify OA Flow
Media/Library 205	3900	10	75	98	1523	1804	585	HVAC-3			2" MERV 8	MERV 13	Note 1
Librarian 206	220	10	2	2	29	29	45	HVAC-3			2" MERV 8	MERV 13	Note 1
Library Study 207	235	10	6	6	110	109	45	HVAC-3			2" MERV 8	MERV 13	Note 1
Library Study 208	155	10	4	4	73	72	23	HVAC-3			2" MERV 8	MERV 13	Note 1
Library Study 209	280	10	6	7	117	130	54	HVAC-3			2" MERV 8	MERV 13	Note 1
Classroom 317	650	10	20	23	348	382	119	RTU-1			2" MERV 8	MERV 13	Note 4
Classroom 318	700	10	25	25	418	411	143	RTU-1			2" MERV 8	MERV 13	Note 4
Classroom 300	700	10	25	25	418	411	146	RTU-1			2" MERV 8	MERV 13	Note 4
Classroom 301	1100	10	25	39	478	646	204	RTU-1			2" MERV 8	MERV 13	Note 4
Classroom 304	1050	10	25	37	470	617	204	RTU-1			2" MERV 8	MERV 13	Note 4
Classroom 307	1125	10	25	39	481	661	221	RTU-1			2" MERV 8	MERV 13	Note 4
Classroom 309	1125	10	25	39	481	661	221	RTU-1			2" MERV 8	MERV 13	Note 4
Classroom 310	470	10	15	16	258	276	85	RTU-1			2" MERV 8	MERV 13	Note 4
Room 322 (Office?)	260	10	2	2	64	64	38	RTU-1			2" MERV 8	MERV 13	Note 4
Room 204	640	10	15	22	284	376	113	RTU-1			2" MERV 8	MERV 13	Note 4
Room 203	710	10	15	25	294	417	107	RTU-1			2" MERV 8	MERV 13	Note 4
Room 134	410	10	12	14	212	241	65	RTU-1			2" MERV 8	MERV 13	Note 4
Room 147	425	10					50	RTU-1			2" MERV 8	MERV 13	Note 4
Room 148	125	10					20	RTU-1			2" MERV 8	MERV 13	Note 4
Storage? 148a	55	10					8	RTU-1			2" MERV 8	MERV 13	Note 4

### Hollis Brookline High School

Room	SF	Ceiling Height Feet	# Students	ASHRAE # Students	Current Vent. Standard ASHRAE 62.1	Current Vent. Standard ASHRAE # Students 62.1	Current Vent. Design	Ventilation Equipment Serving Space	Exhaust Requirements ASHRAE 62.1	Exhaust Design	Filter Eff. Current	Max Filter Eff.	Recommendations
Room 149	340	10					48	RTU-1			2" MERV 8	MERV 13	Note 4
Room 151	440	10					56	RTU-1			2" MERV 8	MERV 13	Note 4
Room 137	130	10	1	1	16	16	15	RTU-1			2" MERV 8	MERV 13	Note 4
Room 138	185	10	2	2	26	26	26	RTU-1			2" MERV 8	MERV 13	Note 4
Conference 101	425	10	6	21	69	165	75	HVAC-1			2" MERV 8	MERV 13	
Office 112	205	10	1	1	22	22	29	HVAC-1			2" MERV 8	MERV 13	
Office 108	140	10	1	1	17	15	14	HVAC-1			2" MERV 8	MERV 13	
Office 102	205	10	1	1	22	22	36	HVAC-1			2" MERV 8	MERV 13	
Office 103	225	10	1	1	23	24	38	HVAC-1			2" MERV 8	MERV 13	
Office 134	290	10	1	1	28	31	53	HVAC-1			2" MERV 8	MERV 13	
Office 107	115	10	1	1	15	12	18	HVAC-1			2" MERV 8	MERV 13	
Reception 106	420	10	2	2	44	45	86	HVAC-1			2" MERV 8	MERV 13	
Office 105	180	10	1	1	20	19	30	HVAC-1			2" MERV 8	MERV 13	
Office 127	270	10	1	1	27	29	56	HVAC-2			2" MERV 8	MERV 13	
Office 126	145	10	1	1	17	15	26	HVAC-2			2" MERV 8	MERV 13	
Office 125	180	10	1	1	20	19	32	HVAC-2			2" MERV 8	MERV 13	
Office 124	180	10	1	1	20	19	32	HVAC-2			2" MERV 8	MERV 13	
Office 123	140	10	1	1	17	15	25	HVAC-2			2" MERV 8	MERV 13	
Office 121	190	10	1	1	21	20	36	HVAC-2			2" MERV 8	MERV 13	
Storage 119	205	10	0	0	15	15	18	HVAC-2			2" MERV 8	MERV 13	
Office 122	185	10	1	1	20	20	26	HVAC-2			2" MERV 8	MERV 13	
Office 129	175	10	1	1	19	19	26	HVAC-2			2" MERV 8	MERV 13	
Office 128	270	10	1	1	27	29	52	HVAC-2			2" MERV 8	MERV 13	
Spec. Ed. 155	255	10	10	9	163	150	50	UV-2			1" MERV 8	MERV 8	Note 8
Spec. Ed. 156	295	10	10	10	169	173	50	UV-2			1" MERV 8	MERV 8	Note 8
Spec. Ed. 154	255	10	10	9	163	150	50	UV-2			1" MERV 8	MERV 8	Note 8
Science 158	1152	10	25	40	485	677	570	UV-1	1152	900	1" MERV 8	MERV 8	Note 8
Art Room 163	1250	10	25	25	594	594	760	UV-3	875	700	1" MERV 8	MERV 8	Note 7
Cafeteria	2960	10	252	296	3029	3441	-	HV-1			2" MERV 8	MERV 13	Note 13
Mini Gym	4500	20	25	32	1638	1800		RTU-6			2" MERV 8	MERV 13	
Fitness Center	2950	20	20	30	721	959		RTU-6			2" MERV 8	MERV 13	
Classroom 303	1375	10	20	48	353	705	640	RTU-2C			2" MERV 8	MERV 13	
Art 170	1344	10	25	27	615	638	560	UV-4	941	0	1" MERV 8	MERV 8	Notes 7 & 8
*Room Numbers below based on addition plans - may not be accurate													
Classroom 302	1350	10	25	47	515	793	272	RTU-1C			4" MERV 8	MERV 13	Note 9
Classroom 301	900	10	25	32	448	529	129	RTU-1C			4" MERV 8	MERV 13	Note 9
Classroom 305	1365	10	25	48	517	802	204	RTU-1C			4" MERV 8	MERV 13	Note 9
Classroom 307	1365	10	25	48	517	802	204	RTU-1C			4" MERV 8	MERV 13	Note 9
Classroom 201	810	10	25	28	434	476	148	RTU-1C			4" MERV 8	MERV 13	Note 9
Classroom 204	910	10	25	32	449	535	122	RTU-1C			4" MERV 8	MERV 13	Note 9
Classroom 205	920	10	25	32	451	541	122	RTU-1C			4" MERV 8	MERV 13	Note 9
Classroom 209	840	10	25	29	439	494	143	RTU-1C			4" MERV 8	MERV 13	Note 9
Classroom 210	840	10	25	29	439	494	91	RTU-1C			4" MERV 8	MERV 13	Note 9

Hollis Brookline High School

Room	SF	Ceiling Height Feet	# Students	ASHRAE # Students	Current Vent. Standard ASHRAE 62.1	Current Vent. Standard ASHRAE # Students 62.1	Current Vent. Design	Ventilation Equipment Serving Space	Exhaust Requirements ASHRAE 62.1	Exhaust Design	Filter Eff. Current	Max Filter Eff.	Recommendations
Classroom 211	965	10	25	34	457	567	122	RTU-1C			4" MERV 8	MERV 13	Note 9
Classroom 102	780	10	25	27	430	458	122	RTU-1C			4" MERV 8	MERV 13	Note 9
Classroom 103	935	10	25	33	453	549	122	RTU-1C			4" MERV 8	MERV 13	Note 9
Classroom 110	840	10	25	29	439	494	122	RTU-1C			4" MERV 8	MERV 13	Note 9
Classroom 111	970	10	25	34	458	570	122	RTU-1C			4" MERV 8	MERV 13	Note 9
Classroom 109	915	10	25	32	450	538	122	RTU-1C			4" MERV 8	MERV 13	Note 9
Auditorium	9000	20	1000	1350	6925	9113	-	RTU-4			2" MERV 8	MERV 13	Note 10 & 13
Dance Room	2800	10	75	98	1148	1435	510	RTU-5			1" MERV 8		Note 11 & 14
Conference Rm 213		10		0	0	0	17% OA	HV-2			2" MERV 8	MERV 13	Note 9
Office 211		10		0	0	0	17% OA	HV-2			2" MERV 8	MERV 13	Note 9
Office 209		10		0	0	0	17% OA	HV-2			2" MERV 8	MERV 13	Note 9
Office 208													
Office 206													

- Note 1: Verify operation of dampers at OA louvers when unit operates in occupied mode
- Note 2: Outside Air damper never opened when on site. Sequence may need to be verified.
- Note 3: Unable to determine ventilation to FCU-1. Existing drawings indicate ventilation through a 12x10 duct
- Note 4: Design outdoor volume is lower than current standard. Adjust as necessary.
- Note 5: There is a manual switch indicating "Cooling Enabled." This needs to be verified. Suspect ventilation is altered.
- Note 6: Not used.
- Note 7: It appears there is no exhaust in this room. The standard requires that art rooms have exhaust.
- Note 8: Could not access to verify filter.
- Note 9: Appears unit is in occupied. Could verify damper minimum position.
- Note 10: Damper operation needs to be confirmed. Access hindered by bees nest.
- Note 11: Damper linkage failure appears possible due to corrosion
- Note 12: Design ventilation for gym appears adequate for current use.
- Note 13: Design does not indicate volume.
- Note 14: This unit should be reviewed for filter size. A 2" filter is normally associated with this equipment.



ENGINEERING • COMMISSIONING

# Hollis Brookline Middle School

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## HVAC Assessment Report

John F. Penney, P.E.

8/13/2020

FOR REVIEW

TABLE OF CONTENTS

Part 1 Introduction.....1

Part 2 Existing Systems .....2

Part 3 Recommendations.....5

    Short Term Plan ..... 5

    Long Term Plan..... 6

Part 4 Summary of Current and Recommended Ventilation and Filtration.....8

## Part 1 Introduction

JFPCS has been hired to perform an assessment of the mechanical heating and ventilation systems of the school. Our focus will be to assess the physical condition, operable condition, ventilation capabilities and filtration capabilities of the equipment. As guidelines evolve to address the opening of school amid the COVID-19 concerns, educational facility Owners are looking to know how their mechanical systems currently operate and/or can adapt to recommended changes in ventilation and filtration. As of the writing of this report, recommendations by the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) and the Center for Disease Control and Prevention (CDC), along with the “New Hampshire Grades K-12 Back-to-School Guidance” report, all suggest increasing ventilation rates where possible and increasing filter efficiency to a Minimum Efficiency Reporting Value (MERV) of 13, where equipment will allow. Our approach is to provide information on each occupied space, the current and recommended ventilation requirements, current and recommended filter capabilities, and recommendations to adjust or upgrade systems to perform to the standards and guidelines. ASHRAE is the organization that has developed the standards for ventilation and filtration. The CDC is working with ASHRAE to formulate good practices in maintaining a safe indoor environment. This report is intended to assist in managing existing systems and to provide recommendations to upgrade and/or adjust systems where systems or equipment may not meet standards.

## Part 2 Existing Systems

The Hollis-Brookline Middle School mechanical system is composed of two large Energy Recovery Ventilator (ERV) units. These units handle ventilation air for the building addition. This addition is made up primarily of classrooms with common space and toilet rooms. These rooms are heated by baseboard radiation or radiant ceiling panels. The original building is served by several classroom Unit Ventilators (UV) and Air Handling Units (AHU). Each UV serves a single classroom. Several air handling units and fan coil units heat and ventilate the administrative office areas, classrooms, and the large multipurpose rooms. Many of the units were not tagged or labeled and may be referred to by the equipment type and/or rooms served in this report.

Room 101 Science is served by a ceiling hung unit ventilator. The unit contained one damper actuator and linkage which appeared to be intact and in good working condition. The dampers were set in a 100% return air (RA) position. The filter is a single 1" fiberglass panel that appeared clean but has a low MERV rating.

Classroom 102 is served by a ceiling hung unit ventilator. The damper actuator and linkage appeared to be intact and in good working condition. The damper position was set in a 10% outside air (OA) position. The filter in this unit was cut from larger filters and taped together. The filter is of low MERV rating.

Classroom 103 Life Science is also served by a ceiling-hung unit ventilator. The unit was not running. The building management system was checked to ensure the unit was in occupied mode to prevent an override of operation. We were unable to start the unit. The linkage on the damper actuator is broken and needs to be repaired. The filter in this unit is cut from fiberglass panel filters and arranged to fit the filter frame. The filter appears clean.

Classroom T-8 is served by a ceiling-hung unit ventilator. The unit was found to be excessively noisy. It is likely the unit is not in operation during occupied times due to this noise. Damper actuators appeared to be in good working condition. The dampers were set at approximately 50% OA. The filter is of low MERV rating and adjusted to fit the filter frame.

Classroom 105 Tech Ed is served by a ceiling-hung unit ventilator. The unit contains a damper actuator with linkage between the OA and RA dampers. The unit is a different model than other ventilators in the building. It was not possible to view damper position for this unit. However, the indicator on the actuator pointed to 30%. It was unclear whether this percentage was open or closed. The filter was of low MERV rating and appeared clean.

Classroom 106 Industrial Arts is served by a ceiling-hung unit ventilator. The damper actuators and linkage appeared to be in good working order. We could not determine the damper position. The two 1" filters are low MERV rating fiberglass panels and appropriately sized for this unit.

Classroom 107 Robotics is served by two unit ventilators. The classroom is only in operation during the hours of 6pm to 9pm. The OA damper was 100% open. The actuator is broken, and the shaft did not turn. The 1" filter appeared clean but of low MERV rating. On the second unit, the actuator appeared to be in good condition. The damper position was set at 90% RA. The filter was not installed. Support for the filter appeared to be missing. There is a thermostat for each unit.

Classrooms 108 Art, 109 Health, and 110 Home Ec. are served by a single ducted heating, cooling, and ventilation RTU (Tagged XRTAC). The damper position was set to 100% RA. The damper linkages and actuators appeared to be in good working condition. There are 2" pleated filters with a MERV rating of 8. The filters were in need of replacement.

Classroom 108 Art is served by two ceiling-hung unit ventilators. There are no actuators to control the dampers in these units. The filters were found displaced for both of these units. A support for the filters appeared to be missing.

Classroom 109 Health is served by two ceiling-hung unit ventilators. The first unit has a single 1" filter that appeared to need replacing. The damper was set in a 100% RA position. No actuator exists on this unit to control the damper position. The second unit filter was found to be out of position. The damper was set at approximately 90% RA. The unit contained a single actuator with damper linkage. The linkage was broken and was found temporarily zip-tied to provide some control of the dampers. It may be likely the unit was unable to achieve a fully closed RA position due to this arrangement.

Classroom 110 Home Ec. is served by a single unit ventilator. The unit was missing both the damper actuator and linkage. The damper was fixed at 80% OA. The 1" fiberglass panel filter appeared to be properly fitted and appeared clean.

Classroom 112 Computer Lab is served by a single ventilation rooftop unit (Tagged RTAC-1). The 2" filters appeared to need replacement. The unit is missing an actuator to control the OA damper. The space is heated with fin tube radiation.

Offices 120-124 are served by RTAC-2. This is a single ventilation and cooling RTU. The actuator to control the dampers was missing and the OA damper was fixed at 10% open. The 2" pleated MERV 8 filters appeared to need replacement. The space is heated by baseboard radiation.

Rooms 130-144 are office/administrative areas served by RTAC-3. This unit is a single ventilation and cooling RTU. This unit was not running. The damper actuator was missing, and the OA damper was fully closed. The offices are heated with baseboard radiation.

HRU-1 is a heat recovery ventilator that serves several classrooms on the main and lower floors of the addition. When the unit was shut off, it was observed that the OA damper did not close. Several of the filters were severely damaged and others in need of changing. It is possible wind and rain infiltration may have caused the filters to collapse. Return airflows were found to be much lower than supply which may result in low transfer of heat exchanged.

HRU-2 also serves several classrooms on the main and lower floors of the addition. These filters were found to be blown out possibly from wind and rain infiltration. The damper was in the fully open position when the unit was running and closed properly when the unit was turned off. Linkages and actuators appeared to be in good condition. Filters need to be replaced.

HV-1 is an RTU which serves the multipurpose room. The damper was set at 90% RA. Damper actuators and linkages appeared in good condition. The 2" MERV 8 filters appear to have been recently replaced. The unit was not operating.

RTU-1 is a ventilation and cooling only unit. The damper was set at 100% RA. A damper actuator is missing from the unit, as well as the linkage between dampers leaving no control. The 2" MERV 8 filters need replacement.

RTU-2 is a cooling and ventilation only unit which serves the Library and other adjacent rooms. The damper was set to 100% RA. This unit damper actuator and linkage appeared to be intact. The 2" MERV 8 filters appeared clean.

RTU-3 is a cooling and ventilation only unit which serves a few rooms behind the stage. A duct mounted heating coil is located upstream of the unit. The damper was in 100% RA. The 2" filters appeared to be clean.

There are several exhaust fans throughout the building. They appear to be sequenced to operate during occupancy. The boys and girls locker rooms have supply and return/exhaust airflows that appeared unbalanced. Spaces may be positively pressurized and should be negative. Specific exhaust from the arts, science, and industrial arts rooms were not reviewed.

## Part 3 Recommendations

According to the guidelines, all ventilation systems should meet current standards for outdoor air changes and filtering efficiencies. Where outdoor air systems can accommodate increases in both volume and filter efficiency, attempts should be made to do so but within the capacities of the equipment. During times when the outdoor air temperature is above 32 deg F, air volumes can be increased with equipment that mixes outdoor air with return air such as with unit ventilators, air handling units with mixing dampers, rooftop air handlers and other similar equipment. Ventilation units such as heat recovery ventilators, energy recovery ventilators, fan coil units and cabinet unit heaters may be fixed or limited in how much ventilation air volume can be increased. Most fan coil units and cabinet unit heaters do not have outdoor air capabilities. Baseboard radiation, unit heaters and other similar terminal units have no ventilation air and may rely on either natural ventilation such as operable windows or air systems such as HRVs and ERVs to provide space ventilation.

The Hollis Brookline High School does have means to ventilate all the student occupied spaces, offices, and common areas. There are a few deficiencies. The best way to achieve improvement in the building environment and seek to meet the recommendations put forth by the guidelines, is to set up a short-term plan and a long-term plan. The goal is to make immediate changes to improve the abilities to provide higher levels of ventilation and filtration, while weather conditions allow, and make upgrades to equipment and systems to control the indoor air quality of each space for all weather conditions.

### Short Term Plan

The following recommendations can be implemented immediately:

1. Change all occupied/unoccupied schedules for starting ventilation of the building two hours before occupancy and allow them to run two hours after occupancy. This will provide a pre-purge and post-purge of the building. If the sequence is to provide a morning warmup, systems may need to be started earlier.
2. Make sure all filters in ventilation systems are clean and are of the highest allowable MERV rating. Where ERVs and HRVs provide 100% outdoor air, it should not be necessary to provide filters with a rating higher than what is recommended by the equipment manufacturer. Usually MERV 8 on supply and MERV 7 on returns. Filter housings should be inspected to make sure filters are tight fitting and they are well sealed around the filters and frames, and that they close tightly along the ends with spacers and/or gaskets to allow air to only pass through the filter and not around them. We found several terminal units that were not fitted with the proper size and type filter. Unfortunately, that does not make it easy to stock a standard filter size. The filter needs to fit properly to be effective. Filters that become overly loaded can reduce airflow and possibly collapse. There are a few air handling units where it appeared to have occurred. Rooftop equipment and air handlers are sometimes subject to water or snow infiltration,

they may need to be checked after a weather event. Prefilters may be necessary on rooftop equipment. There is usually a place to mount a metal mesh filter in the intake hood of an RTU. Allowing filters to overload will reduce airflow and may lead to poor air quality because of leakage around the filters. Filters in rooftop units and air handling units could be increased in efficiency. MERV 13 filters can be purchased to fit any RTU or AHU. If kept clean, they can maintain close to the current airflow. There could be a delay in ordering MERV 13 filters because of a shortage of availability. Unit ventilators have a one-inch thick filter frame. MERV 13 filters are available. Pressure drops for the one-inch MERV 13 filters can be as much as three times that of a standard filter. Careful consideration should be given when using filters that could reduce airflow such that the ventilation is reduced.

3. Adjusting control on all ventilation systems may be necessary. The AHUs and unit ventilators have temperature control of the modulating dampers. As the mixed air temperature setpoint is lowered, more outdoor air can enter. We recommend that the temperature be set for 55 deg F initially. In some cases, as with unit ventilators, the sequence is to maintain space temperature setpoint. This method of controlling ventilation may require adjusting the outdoor air damper to the minimum position. This will allow you to meet ventilation standards down to subfreezing outdoor air temperatures. Therefore, temperatures above 32 deg F will allow an increase in the amount of outdoor air up to 100%. This is usually referred to as economizer cooling. In this case, additional ventilation is the objective. With more outdoor air, the building will become pressurized. Each classroom has a means of relieving the pressure either through a relief damper and louvers, or a system of exhaust fans that will run during the occupied schedule. When it is mild outdoors, windows can be opened. Once the space equipment goes into heating mode, windows should be closed as space comfort may be affected. If the system has mechanical cooling, it would be best to close windows if the equipment were to cycle on. Equipment needs to be sequenced such that the fan in the air handling equipment is running during the occupied hours. To have constant ventilation during occupancy the fans need to be enabled. Once set back to unoccupied, the fan can cycle on a call for heat. Outdoor air dampers should be closed.
4. Toilet room exhaust fans should be operable during occupied hours. Current ventilation standards require 50 cfm/fixture of continuous exhaust
5. ERVs and HRVs are designed to provide 100% outdoor air directly to classrooms through the ceiling or wall diffusers or grilles. Original balance reports should indicate the balanced volume. Where it was possible, measurements were taken and recorded in the Summary of Current and Recommended Ventilation and Filtration table. Where volumes are lower than calculated minimums, we indicated a deficiency.

## Long Term Plan

1. AHUs and UVs should undergo a controls review. In some areas we could not verify dampers were operating according to the sequence. Where CO<sub>2</sub> sensors are installed to control ventilation, we suggest setting the outdoor air damper to the minimum ventilation amount. Sometimes dampers are set to 0% open when a CO<sub>2</sub> sensor is used.

Guidelines recommend ventilation be maintained regardless of CO<sub>2</sub>. Adjustments to these systems can be provided by any service mechanical contractor. Where a Building Management System is installed, adjustments can usually be made through the controls system front end.

2. A mechanical maintenance plan should be established, documented, and have a schedule to replace filters and belts. Sometimes during specific times of the year, filters should be checked. After pollen season and after the leaves fall, filters should be checked and may need replacement. Usually filters require replacement about three times per year. Inspection of dampers operating properly should be checked before each heating season. Proper blade seals and actuator pressures should be checked to verify dampers seal properly which can have an impact on energy cost.
3. Filters need to be installed properly and checked to verify air is not diverted around the filter due to improper seals in the filter frame and at the door. Some fans need to have bearings greased to ensure good rotation and long life.
4. Boilers should be serviced every year prior to the heating season to maximize efficiency. This should include cleaning the boiler sections, inspecting and adjusting the firing rate, and checking the controls. An efficiency test should be performed after each service. Controllers for boilers should be performing adjustments to water temperature based on outdoor air temperature and should shut down the boiler and pumps when outdoor temperatures rise above the need to heat the building.
5. The Summary of Current Recommended Ventilation and Filtration table shows the minimum requirement for ventilation for each space based on occupancy. The standard allows ventilation to be calculated based on the actual known occupancy, or when the occupancy is not known, a calculated occupancy based on persons per square foot is used. We have provided both values. Our reasoning is that the calculated occupancy is normally used in design. If this were the case and classroom occupancies are reduced, the ventilation rate is likely more than that required of the standard. Where actual airflow readings were taken, we have made note where ventilation rates may be deficient. Filters with higher efficiency can be purchased for the AHUs and RTUs.
6. Several of the terminal units within the building appear to have reached their useful life. Replacement may be a better approach than rebuilding. Review of the Existing Systems section for a description of the units we note as being in poor condition.

Part 4 Summary of Current and Recommended Ventilation and Filtration

Hollis Brookline Middle School

Room	SF	Ceiling Height Feet	# Students	ASHRAE # Students	Current Vent. Standard ASHRAE 62.1	Current Vent. Standard ASHRAE # Students 62.1	Current Vent. Design	Ventilation Equipment Serving Space	Current Exhaust	Exhaust Requirements ASHRAE 62.1	Filter Eff. Current	Max Filter Eff.	Recommendations
101 Science	823	9	20	21	435	442	450	Ceiling UV			1" Fiberglass	1" Merv 8	Note 1,2,3,11
T8 (104?) Science	1590	9	20	40	608	855		Ceiling UV			1" Fiberglass	1" Merv 8	Note 1,8,11
105 Tech Ed	713	9	20	14	357	285		Ceiling UV			1" Fiberglass	1" Merv 8	Note 1,11
103 Life Science	1390	9	20	49	354	712		Ceiling UV			1" Fiberglass	1" Merv 8	Note 1,2,11
102 Classroom	1065	9	20	37	330	546	450	Ceiling UV			1" Fiberglass	1" Merv 8	Note 1,11
108 Art	1135	12	20	23	505	539		Ceiling UV (x2)	0	794.5	1" Fiberglass	1" Merv 8	Note 1,2,11
109 Health	980	12	20	34	324	502		Ceiling UV			1" Fiberglass	1" Merv 8	Note 1,2,11
110 Home Ec	1105	9	20	39	333	566		Ceiling UV			1" Fiberglass	1" Merv 8	Note 1,2,11
T11 Conference	310	9	50	16	537	192		FCU			No section	No section	Note 1,4,11
106 Industrial Arts	1240	9	20	43	529	822	950	Ceiling UV	0	620	1" Fiberglass	1" Merv 8	Note 11
107 Robotics	1060	9	20	37	330	543		Term.Air Blender			1" Fiberglass	1" Merv 8	Note 1,2,9,11
108 Art	1135	9	20	23	505	539		RTU			2" Merv 8	2" Merv 13	Note 1,3,11
109 Health	980	9	20	34	324	502		RTU		686	2" Merv 8	2" Merv 13	Note 1,3,11
110 Home Ec	1105	9	20	39	333	566		XRTAC-5			2" Merv 8	2" Merv 13	Note 1,3,11
Gym	6900	20	150	483	2910	7073	5500	EF/OA louver			No filter	No filter	Note 10
					0	0		XFC-1			2" Merv 8	2" Merv 13	Note 1,2
Offices 130-147	1900	9	20	10	378	299		XRTAC-3			2" Merv 8	2" Merv 13	Note 1,2
Offices 120-124	760	9	5	4	71	65		XRTAC-2			2" Merv 8	2" Merv 13	Note 1,2
112 Computer Ed	855	9	20	21	151	158		XRTAC-1			2" Merv 8	2" Merv 13	Note 1,2
18 Classroom	300	9	20	11	273	154	65	HRU-2	63		2" Merv 8	2" Merv 8	Note 1,4,11
17 Classroom	450	9	20	16	284	231	205	HRU-2	100		2" Merv 8	2" Merv 8	
16 Classroom	450	9	20	16	284	231	190	HRU-2	120		2" Merv 8	2" Merv 8	
15 Spanish Class	1000	9	20	35	325	513	290	HRU-2	215		2" Merv 8	2" Merv 8	
Boys WC	324	9	0	0	19	19	170	HRU-1	56	450	2" Merv 8	2" Merv 8	Note 4
U3 Custodian	40	9	0	0	40	40		HRU-1	100	40	2" Merv 8	2" Merv 8	
Corridor Addition 2fl	3014	9	0	0	226	226	970	HRU-1/2	871		2" Merv 8	2" Merv 8	
14 Classroom	725	9	20	25	304	372	*500	HRU-1	500		2" Merv 8	2" Merv 8	Note 6,11
U4 Utility	43	9	0	0	0	0		HRU-1	90	43	2" Merv 8	2" Merv 8	
Girls WC	324	9	0	0	19	19	175	HRU-1	54	450	2" Merv 8	2" Merv 8	Note 4
13 French Class	740	9	20	26	306	379	275	HRU-2	245		2" Merv 8	2" Merv 8	Note 4,11
T-3 Teachers	300	9	8	8	73	69	145	HRU-2			2" Merv 8	2" Merv 8	Note 4,11
T1 WC	50	9	0	0	0	0		HRU-1	60	50	2" Merv 8	2" Merv 8	
T2 WC	50	9	0	0	0	0		HRU-1	98	50	2" Merv 8	2" Merv 8	
12 Computer	845	9	20	21	151	156	364	HRU-1	130		2" Merv 8	2" Merv 8	
11 Math Classroom	790	9	20	28	309	405	308	HRU-1	175		2" Merv 8	2" Merv 8	
10 S.S. Classroom	800	9	20	28	310	410	290	HRU-1	155		2" Merv 8	2" Merv 8	
9 Classroom	810	9	20	28	311	415	300	HRU-1	170		2" Merv 8	2" Merv 8	
8 Classroom	870	9	20	30	315	446	364	HRU-1	175		2" Merv 8	2" Merv 8	
7 Classroom	870	9	20	30	315	446	306	HRU-1	135		2" Merv 8	2" Merv 8	
6 Classroom	810	9	20	28	311	415	304	HRU-1	153		2" Merv 8	2" Merv 8	
5 Classroom	820	9	20	29	312	420	370	HRU-1	83		2" Merv 8	2" Merv 8	
4 Classroom	810	9	20	28	311	415	370	HRU-1	139		2" Merv 8	2" Merv 8	
RTU-1					0	0		RTU-1			2" Merv 8	2" Merv 13	Note 2,3,11
202 Library	3085	9	40	77	385	571	1818	RTU-2	1990		2" Merv 8	2" Merv 13	Note 2,3,11

Hollis Brookline Middle School

Rooms behind stage		9			0	0		RTU-3			2" Merv 8	2" Merv 13	Note 2,3,11
Multipurpose room	4245	20	160	425	1455	3438	2880	HV-1	2890		2" Merv 8	2" Merv 13	Note 1,2,3,11
HRU-1					0	0		HRU-1			2" Merv 8	2" Merv 8	Note 1,2,3,4,11
HRU-2					0	0		HRU-2			2" Merv 8	2" Merv 8	Note 1,2,3,4,11
220 Special Ed	95	9	10	3	132	49	0	RTU-2	0		2" Merv 8	2" Merv 13	Note 3
221 Room off library	150	9	3		24	9	0	RTU-2	0		2" Merv 8	2" Merv 13	
200 Robotics	170	9	20	6	263	87	0	RTU-2	0		2" Merv 8	2" Merv 13	
215 Classroom	365	9	20	13	277	187	265	HRU-2	195		2" Merv 8	2" Merv 8	Note 1,2,3,4,11
214 Classroom	346	9	20	12	276	177	205	HRU-2	165		2" Merv 8	2" Merv 8	
213 Large Office	380	9	2	2	33	32	180	HRU-2	260		2" Merv 8	2" Merv 8	
Addition 2fl Corridor	2340	9	0	0	176	176	585	HRU-1/2	685		2" Merv 8	2" Merv 8	
L6 Girls WC	324	9	0	0	0	0	206	HRU-1	170	450	2" Merv 8	2" Merv 8	
212 Resource Room	805	9	6	4	78	68	385	HRU-1	112		2" Merv 8	2" Merv 8	
211 Grade 8	800	9	20	28	310	410	280	HRU-1	115		2" Merv 8	2" Merv 8	
210 Grade 7	825	9	20	29	312	423	280	HRU-1	138		2" Merv 8	2" Merv 8	
Boys WC	324	9	0	0	0	0	210	HRU-1	120	450	2" Merv 8	2" Merv 8	
209 Classroom	800	9	20	28	310	410	335	HRU-1	130		2" Merv 8	2" Merv 8	
208 Classroom	800	9	20	28	310	410	365	HRU-1	110		2" Merv 8	2" Merv 8	
206 Classroom	860	9	20	30	315	441	405	HRU-1	110		2" Merv 8	2" Merv 8	
207 Classroom	800	9	20	28	310	410	440	HRU-1	100		2" Merv 8	2" Merv 8	
205 Corridor	100	9	0	0	8	8	165	HRU-1			2" Merv 8	2" Merv 8	
205 Classroom	346	9	20	12	276	177	335	HRU-1	90		2" Merv 8	2" Merv 8	
204 Classroom	360	9	20	13	277	185	405	HRU-1	0		2" Merv 8	2" Merv 8	
T-16	440	9	2	2	37	37	0	RTU-2	0		2" Merv 8	2" Merv 13	Note 1,2,3,4,11
T-17 WC	56	9	0	0	0	0		EF-4	135	50	NA	NA	
T-18 WC	78	9	0	0	0	0		EF-4	98	50	NA	NA	
WC near MPR	35	9	0	0	0	0			0				Note 3,4
L-3 Boys WC		9	0	0	0	0			0				Note 3,4
L-4 Girls WC		9	0	0	0	0			0				Note 3,4
Boys locker room	630	9	0	0	0	0	560	XFC-1	535	493	2" Merv 8	2" Merv 13	Note 4,11
Girls locker room	735	9	0	0	0	0	515	XFC-2	310	418	2" Merv 8	2" Merv 13	Note 4,11
T-14 lock off. Girls	110	9	2	1	17	12		XEJ	110	0	NA	NA	Note 4,11
Stage	1355	16	20	47	181	556	*	EF-6/Passive OA			NA	NA	Note 7,11
Boys locker office	140	9	1	1	12	12		No RA grille					Note 4

- Note 1: Replace filter. Consult filter manufacturer for custom-sized Merv-11 or 13 filters to fit unit.
- Note 2: Provide maintenance to unit to ensure linkages and actuators are present and in working order.
- Note 3: Ensure unit is connected to BMS and in operation during occupied times.
- Note 4: Increase ventilation and/or exhaust. Re-balance system.
- Note 5: Equipment part of cooking exhaust and makeup air system. No measurements taken.
- Note 6: Area locked/inaccessible
- Note 7: Temper ventilation air while exhaust fan is in operation.
- Note 8: Excessive noise from unit. Provide maintenance to ensure unit is not disengaged while in occupied mode.
- Note 9: Coordinate with maintenance staff location of equipment.
- Note 10: Ensure appropriate accessories are installed with equipment to ensure proper operation.
- Note 11: Upgraded filter may reduce airflow to unit.



## Windy Hill Associates

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### Energy Upgrade Findings and Proposal

**Hollis Brookline Middle School, Hollis Brookline High School, Captain Samuel Douglass Academy,  
and Richard Maghakian Memorial School**

October 1, 2019

Dick Henry of DDH Energy Consulting, LLC and David Ely of Windy Hill Associates toured the subject buildings to investigate the condition of the thermal shell and mechanical systems. Dick investigated the mechanical systems while David concentrated on the thermal envelope. The tour was cursory, lasting approximately 2 hours at each facility. Moving forward a more in-depth analysis will be performed.

Generally speaking the buildings function well as educational facilities, appear to be structurally sound and are worth improving rather than razing and re-building. Consider that the cost of renovation is typically less than \$100 per sq ft (HPS was \$33) where the cost of new construction is over \$300 per sq ft. These renovations can add 30 to 50 years to the life of the buildings. The goal is to reduce energy consumption, increase comfort, reduce health risks/absenteeism and overall improve educational environment.

HBHS and CSDA are newer and as such have fewer envelope and mechanical issues. That said there are areas which are deficient and can be improved. Additional research will reveal how well the envelopes are insulated and air sealed. Windows in each of these facilities are double glazed, and seal failure is an ongoing problem. The thermal properties of the existing windows are unknown. A typical omission in the thermal strategy is perimeter foundation insulation which would keep floor edges warm in winter. Roof insulation is at or below current energy code requirements. Wall insulation is unknown until further research is conducted.

HBMS and RMMS are older buildings and have more room for improvement. RMMS has clapboard siding which is at the end of its functional life affording the opportunity to boost the insulation from the outside. HBMS has a brick façade and more investigations will be required to determine what insulation strategy makes the most sense there. We've assumed there is block core insulation and possibly an inch of rigid insulation which does not meet current energy code. Roof insulation in both buildings is as yet undetermined.

The following pages describe in more detail strategies and school-by-school findings and proposed remediation strategy.

Respectfully submitted,

David Ely, AIA

## **Thermal Envelope at Four SAU 41 Schools**

Dick Henry and David Ely had cursory tours of 4 schools in Hollis and Brookline; CSDA, RMMS, HBHS, and HBMS. Dick focused on the mechanical aspects of the schools while David observed the thermal envelope.

### **Background**

The four schools were constructed between 1961 and 2001. There have been various additions over time. The Brookline schools both have pitched roofs insulated above the ceiling. The Hollis schools have flat roofs with rigid insulation above the roof deck. All schools except RMMS are block with primarily brick veneer, RMMS is block with wood clapboard siding. HBHS is a 3 story building while the other three schools are one-story or have a partial floor above or below the main floor.

All four schools are burning number two heating oil in old boilers many of which were installed when the school was first built. None of the boilers we looked at would be considered high efficiency. All systems were hydronic hot water systems some feeding unit ventilators and some feeding simple single pass fin tube heat emitters. Presumably many of the air handling units also had some form of heat coil also fed by the boilers to provide backup heat if necessary.

### **Shell Improvements**

The first step in any retrofit project would be to reduce heating and cooling loads by better insulating and air sealing the building shell. Once load is reduced re-evaluating the heating plant makes sense. Several approaches could be explored, and combinations of these approaches could be implemented on a school by school basis.

### **Windows**

Windows are for the most part in need of replacement in all schools with the possible exceptions of HBHS and CSDA. If it is determined that some windows are fit to remain they should have perimeter air sealing verified. Newer windows are much more energy efficient, and triple glazed units are available which provide additional energy efficiency and comfort. Most of the existing windows are double glazed.

### **Foundations**

Foundations are all cast concrete generally with no insulation around the concrete floor first floor slabs. These are, for the most part, in reasonable condition. Perimeter insulation from below grade to at least the top of the floor slab will greatly reduce the thermal break which can cause a cold slab edge or in some cases condensation.

## **Walls**

The older construction likely has little to no insulation in the walls. Brick and block construction typically has a layer of rigid insulation between the wythes, although older buildings may have none. Walls in the four buildings range in thickness from 12" to 16". Some brick is newer and in good condition with nice architectural style. The older buildings have less character in the brick. Increasing the insulation in a newer brick and block wall which is in good condition with good architectural character is difficult. Older brick which lacks character can be covered over as we did at HPS.

Insulating from the outside is preferable to insulating from the inside; keeping the mass of masonry inside the insulation helps keep temperatures even and reduces the heating load by taking advantage of the "flywheel effect".

## **Roofs**

RMMS and CSDA have pitched roofs with insulation above the ceiling. This leaves a large volume which is outside the thermal envelope but inside the weather barrier. The volumes are ostensibly vented, but for the volume the venting may not be enough. If adequate venting is not provided condensation can occur on the underside of the roof deck causing black mold. In addition, if the insulation above the ceiling is not robust, continuous or allows air infiltration warm interior air can escape to the attic melting snow which will then freeze at the eaves causing ice dams.

The interstitial space between ceiling and roof is most likely unusable due to the configuration of the trusses. Also multi-story educational buildings are not allowed unless they are sprinklered.

HBMS and HBHS have "flat" roofs which are typically insulated above the roof deck with rigid insulation. When roofs are due for replacement it is prudent to evaluate and add insulation to bring them up to at least R-30 or more. When solar panels are going onto a roof it's a good idea to re-roof first with a long warranty roof to prevent having to remove and reinstall the solar panels to fix the roof.

## **Air Sealing**

Air sealing is of prime importance when upgrading the thermal envelope. Gaps around windows and doors, doors which don't fit properly, abandoned or improper vents, penetrations which are unsealed all contribute to infiltration, heat loss and dis-comfort. If existing windows and doors are to be left in place they should be air sealed at the perimeter. Rooftop equipment including vents should be evaluated and upgraded. A blower door test which pressurizes the building can assist in locating air leaks.

## **Mechanical Air Conditioning**

Early on in the process of our evaluation the question of air conditioning should be discussed. We believe that the suggested modifications of these buildings may lengthen their useful lives by 30 to 50 years. If everyone agrees with this projection, then air conditioning needs to be considered seriously as the number of days above 75° F during the fall and spring months of the school year will increase significantly over the next 50 years and the number of days over 90° F in the summer months may more than triple during that same time period.

Another ancillary benefit of air conditioning is dehumidification which will also help to extend the useful life of these buildings once the shell is properly air sealed, insulated and mechanically ventilated. Such dehumidification will also help to preserve both electric and physical items such as computers and books within the building.

### **Heat Pumps – ground source or air source?**

We believe that the use of heat pumps which can heat, cool, the building makes a great deal of sense. For the smaller buildings air source heat pumps make the most sense but for the high school and the middle school it may be worth considering a ground source heat pump system. One of the advantages of ASHPS is they can be added incrementally over time to individual rooms as the need arises.

### **Heat Recovery Ventilation (HRV or ERV)**

From our initial survey it is unclear whether the High School and the Middle school have heat recovery ventilation. Neither of the other two schools do. Heat Recovery Ventilation (HRV) or Energy Recovery Ventilation (ERV) can capture up to 85% of the heat energy usually exhausted to the outdoors through conventional ventilation equipment. Maintaining humidity levels between 35% and 60% can make the educational space much more comfortable and reduce unnecessary heating and cooling.

### **Solar Panels to reduce purchased electricity**

The principle reason why heat pumps of any kind may make economic sense is the ability to combine them with roof top solar. The middle school and the high school have a great deal of flat roof space and the other two schools have considerable south facing sloping roofs all of which would be ideal for solar collectors. The middle school could support almost 750 kW of panels and produce \$150,000 of electricity a year. This would be enough to possibly cover its heating and electricity load for the year though some battery storage may be required in the near future when the price of battery storage has come down. We believe that this cost drop may occur in the next two to three years so may be in time for this project. The high school is slightly larger and could accommodate 850 kW of panels and produce about \$173,000 per year again more than enough to cover their electric bill for

the year and possibly ASHP usage as well. Past ten-year average bill for HBHS was \$118,500/yr. or 800 MWh/yr. The panels would produce 1,020 MWh/yr. The two smaller schools have less roof surface available but solar could still contribute significantly to reducing the electric load on the buildings.

### **Switching from Oil to Propane**

In the event that the school boards do not want to convert to solar driven heat pumps the solar panels could be sized to meet electric demand only. We would then evaluate the benefits of converting or replacing the existing oil boilers with propane. Propane burns cleaner and when bought in large volumes may be less expensive than oil on a cost per Btu basis. Also, most propane is produced domestically so is less prone to price volatility caused by international events in the mid-east. The larger the volume of propane that the towns and the school district can collectively purchase the more likely they are to get a lower more stable price for the future.

Propane is burnt in gas fired boilers and generally burns at a higher efficiency than oil and requires less maintenance than oil boilers. Although propane is stored in underground tanks similar to oil there is much less hazard of leaks, as any leaking propane turns to gas and is dissipated in the air. Oil on the other hand can leak into local aquifers and cause a huge problem that is difficult to remedy. Sooner or later all the underground oil storage tanks for each of the four schools will need to be replaced at considerable cost to the district. Switching to propane soon would avoid this future cost and ongoing liability.

### **High Efficiency heat emitters**

If the school boards decide to stay with hydronic heating we will provide a comprehensive evaluation of the heat emitters in each school. Again, once the shell of the building is improved the heating load will drop and fewer radiators (heat emitters) will be needed in each room. Going to modern high efficiency heat emitters allows the same amount of heat to be transferred to a room but far more efficiently so the drop-in temperature of the circulating water is much greater (higher delta T) and this in turn helps the boilers operate more efficiently. More efficient heating of each room allows the amount of air circulated by the ventilation unit to be dropped significantly as well, (because the room no longer relies on heat provided by ventilation) saving additional electric energy of fan motors in the roof top ventilation units

### **Controls – Building Management Systems (BMS)**

We will also evaluate the control systems in each of the buildings. These are good at the High School and possibly at the Middle School but poor to rudimentary at the other two schools. Excellent control systems save money in a number of ways, they can be adjusted from a central system, can automatically respond to outside temperature on an hourly basis, can prohibit individual room manipulation of temperature outside of a pre-determined range, and can highlight potential maintenance issues before they become a problem.

## **Commissioning**

We will recommend strongly that each entire system be recommissioned and tested and balanced at time of completion of the project. Short term recommissioning of existing systems may also prove cost effective while funding for the entire project is considered over the next two to three years. We will make both of these recommendations in our initial evaluation report.

## **Electric Usage & Wiring**

Our report will evaluate all electrical usage including lighting, computers, day light harvesting, existing air conditioning and motors. We did not observe any high efficiency motors in our initial cursory inspection and no variable speed drives in the elementary schools. We did not spend enough time on site to see if variable speed drives were installed at the High school and middle school. Reducing electric loads with better pumps and fan motors, lap top computers, variable speed drives, excellent building management systems, and lighting makes any solar installation all the more cost effective.

We will take a look at the wiring in each building as the more modern educational environment has a much larger demand for electricity than when some of these buildings were built. Also with the addition of solar panels wiring needs to be modified to accept this new source of energy.

## **Evaluating Historical Data**

The district has kept excellent energy usage data and costs for the past 12 years. This will provide us with an excellent baseline against which to evaluate alternatives for each of the four schools. To some extent this will give us a better idea of what long term costs to the district may look like for future planning purposes. But it is important to understand that some of these buildings are quite old so end of life replacements of certain HVAC equipment as well as shell upgrades will be necessary no matter what the school board decides.

## **Should these buildings be renovated?**

### **Cost Benefits of Renovation vs new construction**

Two other concepts should be kept in mind. First, are these buildings functioning well in their educational capacity? We asked this question of each principal and they all said yes the buildings were working well with the exception of the High Scholl which the vice-principal felt worked well but was getting crowded. The fact that each building works well as an educational facility is an important basic principle because it means that extending the lives of these four buildings by 30 to 50 years will be much less expensive than razing the buildings and building new. In a 2015 report on school construction costs, New England had the highest new construction costs in the country at \$400/sq foot. A proper renovation of these four solid existing buildings can be accomplished at a fraction of this cost. This is where the true savings lies.

Focusing on energy efficiency will bring certain savings over the next fifteen years but those savings alone should not be expected to pay for the entire cost of renovation.

## **Non-Monetary Benefits**

The second concept to keep in mind is that there are many non-monetary educational benefits from retrofitting these buildings.

- **Comfort:** In every single building principals complained that some rooms were too hot and some too cold and that these day to day, week to week, and season to season changes had an adverse impact on the students, their teachers and the administrative staff.
- **Health:** Proper control of humidity can eliminate mold issues. Filtered fresh air at proper temperature eases asthma, reduces the incidence of flu and colds. Increased health reduces absenteeism in students and teachers. Although we did not observe any air quality issues of note in our preliminary visit, getting air exchange right and reducing buildup of CO<sub>2</sub> has a distinct benefit to the learning environment.
- **Reduce Noise:** An appropriate and thorough renovation of these buildings can solve many of these problems. In addition, when thoroughly insulating a building from the outside and implementing better heating, cooling, and ventilation solutions can significantly reduce both outside ambient noise as well as interior mechanical noise. A quieter environment is a better learning environment.

## **Hollis Brookline Middle School**

### **Existing Conditions:**

HBMS is a one and two story facility located in the Hollis village. It has 92,033 sq ft and was constructed in the '60's with additions in 1963, 1975 and 2004. The walls are brick and block with vinyl "shingle" accents. It has flat roofs with mechanical equipment located there. The building is protected throughout by an automatic sprinkler system.

Exterior walls are block and brick of varying ages. Newer walls will be more likely to have insulation, although quantity and R-value will likely fall short of the required code minimums. Brick is typically in fair to good condition, with older portions showing some deterioration.

The roof is typically steel bar joist construction with presumably metal deck and insulation above that. The building is on a generally north-south axis with relatively few obstructing trees making the roof an ideal location for solar panels.

In 2012 the building was audited for Energy Star and almost passed. The building has had indoor air quality testing and has passed. The principal reported that the interior rooms are typically too warm while exterior rooms are too cold. The lights are due for upgrading to more efficient LED fixtures.

### **Remediation Strategy:**

We propose to do an in-depth analysis of the building's thermal envelope including foundation, walls, roof, windows and doors. This will include review of archival construction documents and verification to determine what is in place for insulation, windows and air sealing. We'll do a blower door test to determine air infiltration. We may need to do small areas of destructive testing to look into walls and do some core testing of the roof to determine the insulation levels present. We will propose a general remediation strategy based on our findings. Strategies could include additional insulation, over-cladding portions, window and door replacement, air sealing, solar panels and mechanical upgrades. The goal will be to increase thermal efficiency and comfort without compromising architectural features, and extend the life of the building by 30 to 50 years. This strategy will be the basis for Schematic Design and Construction Documents which will be addressed in a subsequent proposal when the scope has been defined.

We'll ask Building Science Corporation for evaluation and opinions on problem areas and strategies. We'll provide design and construction documents for remediation measures. We'll assist you in locating a contractor or construction manager. We'll be available for construction administration and project close-out.

## Hollis Brookline High School

### Existing Conditions:

HBHS is a 145,000 sq ft building which was built in 1997 with an addition in 2001. It's a three story building made primarily of brick and block with an upper floor of EIFS stucco. The principal reports that the facility functions well except that they are tight on space. The condition of the brick is excellent. Comfort is OK except in September and May, the swing seasons. There is limited AC in the building, and personal fans are not allowed. Sometimes the south side of the building is hot and the north side cold. There are 900 students and 100 staff. The building is protected throughout by an automatic sprinkler system. All roofs are flat.

Windows are architecturally arranged and do not typically overpower the classrooms. Being a newer building the windows are also newer. There is some chalking on the aluminum frames, and some panes with broken seals have had to be replaced. Sills and lintels in the brick portion are cast concrete and appear to be in good condition.

Exterior walls are block and brick and probably have rigid insulation between with an air space, although quantity of insulation and R value will not be known until more research is done. The upper portions are EIFS panels; again the insulation value will not be known until more research is done. There are a few areas of curtain wall framing with glazing and spandrel panels which we'll also investigate for thermal properties.

The roof is flat, steel bar joists, metal deck, insulation and membrane. Roofing is being replaced section by section. No mold or mildew has been reported, although there are some roof leaks. Insulation values are unknown until more research is done. We recommend not replacing more roofing until we have made insulation upgrade recommendations which are best accomplished during re-roofing. There are relatively few obstructing trees making the roof an ideal location for solar panels.

### Remediation Strategy:

As this is a newer building we assume it was built to more stringent standards than older buildings and therefore more energy efficient. That said we will investigate the insulation/air sealing strategy and make recommendations.

We propose to do an in-depth analysis of the building's thermal envelope including foundation, walls, roof, windows and doors. This will include review of archival construction documents and verification to determine what is in place for insulation, windows and air sealing. We'll do a blower door test to determine air infiltration. Strategies could include window and door replacement, air sealing, solar panels and mechanical upgrades. The goal will be to increase thermal efficiency and comfort without compromising architectural features, and extend the life of the building by 50 years or more. This strategy will be the basis for Schematic Design and Construction Documents which will be addressed in a subsequent proposal when the scope has been defined.

We'll ask Building Science Corporation for evaluation and opinions on problem areas and strategies. We'll provide design and construction documents for remediation measures. We'll assist you in locating a contractor or construction manager. We'll be available for construction administration and project close-out.

## **Captain Samuel Douglass Academy**

### **Existing Conditions:**

CSDA is a single level building located in a rural portion of Brookline NH. It has 49,421 sq ft and was built in 1999 and 2000. It has brick and block walls and wood truss pitched roof. The principal reports that the facility functions well as a school. The HVAC system has been challenging, and there are some rooms near the ramp which are cold in winter; the south side is warmer, the north side cooler. There are 241 students and 48 staff. The building does not have a sprinkler system.

The roof is pitched and constructed of wood trusses. There is a large volume in the roof which is unused due to the truss configuration and lack of sprinkler system in the building preventing upper floor development by code. Insulation is at the ceiling line with the entire roof being cold. Given the size of the roof and hip configuration it's doubtful there is sufficient ventilation flow to meet code. The roofing is asphalt shingles which appear to be in good condition. There are gutters which are insufficient for the area of roof they serve. There is ice build-up at the valleys.

Site drainage is an issue between the wings separated by the ramp, and ponding often occurs after a heavy rain. In some cases the water could be above the floor level although no intrusion has been reported. Often the principal and an assistant will shovel when it gets too deep.

A curious feature is a through-wall vent in most rooms. It consists of a one block high (8") x 6' long louvered vent. In some places it has been blocked with rigid insulation.

There is a serious lack of storage.

The biggest issue with this school, besides drainage, is the HVAC system.

### **Remediation Strategy:**

As this is a newer building we assume it was built to more stringent standards than older buildings and therefore more energy efficient. That said we will investigate the insulation/air sealing strategy and make recommendations.

We propose to do an in-depth analysis of the building's thermal envelope including foundation, walls, roof, windows and doors. This will include review of archival construction documents and verification to determine what is in place for insulation, windows and air sealing. We'll do a blower door test to determine air infiltration. We will design a remediation strategy based on our findings. Strategies could include additional insulation, window and door replacement, air sealing including

the through wall vents, solar panels and mechanical upgrades. The goal will be to increase thermal efficiency and comfort without compromising architectural features, and extend the life of the building by 50 years or more.

We'll ask Building Science Corporation for evaluation and opinions on problem areas and strategies. We'll provide design and construction documents for remediation measures. We'll assist you in locating a contractor or construction manager. We'll be available for construction administration and project close-out.

## **Richard Maghakian Memorial School**

### **Existing Conditions:**

RMMS is a single level school except for a partial lower level. It is located in the village in Brookline, NH. It has 57,263 sq ft, and was built in 1961 with additions in 1967, 1988, 1992 and 1995. It is clapboard sided on block walls and a pitched roof. The principal reports that the school functions well. There are 330 students and 60 staff. The building is not sprinklered. The heating system is old and problematic. There is an odd smell in room 10 possibly coming from under the carpet. The entrance/office relationship is problematic, and there is a desire for a conference room on the lower level which will be addressed in a separate proposal.

Windows are older, double hung and many rooms have oversized glazing disproportionate to the classroom size. Many seals have broken. The windows are in poor condition and are ready for replacement.

Exterior walls are block with clapboard siding for the most part, the exceptions being the upper portion of the gymnasium which is metal panels, and the south entrance which is masonry. The gables are also clapboard siding with large vents. The principal reports that classroom walls are cold, possibly due to lack of insulation. The foundation is cast concrete and is not insulated which could result in cold floor slab edges.

The roof is mostly pitched, probably truss construction, framing materials are to be determined. There is a very large volume in the roof which is unused probably due to truss configuration and lack of sprinkler system in the building precluding multi-floor occupancies by code. The roofing is asphalt shingles. There is a portion of flat roof with membrane over the kitchen area. This roof is due for replacement – we recommend getting an insulation upgrade when that is done.

### **Remediation Strategy:**

We propose to do an in-depth analysis of the building's thermal envelope including foundation, walls, roof, windows and doors. This will include review of archival construction documents and verification to determine what is in place for insulation, windows and air sealing. We'll do a blower door test to determine air infiltration. We will design a remediation strategy based on our findings. Strategies could include additional insulation, window and door replacement, air sealing, solar

panels and mechanical upgrades. The goal will be to increase thermal efficiency and comfort without compromising architectural features, and extend the life of the building by 20-50 years.

Because this building has clapboard siding there is a unique opportunity to add insulation to the outside of the existing block walls and install new siding. We can air seal at the same time, and replace windows for a very tight well-insulated building.

We assume there is insulation in the ceiling leaving the truss portion of the roof uninsulated. We will observe this insulation and recommend a strategy to supplement or replace it, and air seal simultaneously. Attic ventilation will be verified and a comprehensive strategy to prevent ice dams and mold will be developed.

We'll ask Building Science Corporation for evaluation and opinions on problem areas and strategies. We'll provide design and construction documents for remediation measures. We'll assist you in locating a contractor or construction manager. We'll be available for construction administration and project close-out.

**Scope of work for all buildings:**

- Obtain and review archive construction documents, and verify existing conditions for structure, insulation, mechanical equipment, windows and doors.
- Review historic energy use to determine the Energy Use Intensity (EUI).
- Perform blower door tests on portions of the buildings if practical to determine the extent of air leakage.
- Perform thermal imaging to determine the presence of insulation and locate air leaks.
- Use data loggers to identify specific problems in specific rooms to evaluate efficacy of existing and proposed strategies.
- Analyze existing mechanical equipment to determine efficacy and efficiency.
- Tour the buildings for an in-depth review and verification of existing documents and conditions.
- Tour the buildings with Kohta Ueno of Building Science Corp. to assist in determining problem areas and best course of action for remediation.
- Meet again with principals, maintenance staff and others to identify problem areas and understand what needs to be done to improve the thermal efficiency.
- Provide school-by-school reports outlining our in-depth findings and proposed remediation strategies. This will be the basis for design work which will be covered in subsequent proposals as requested.

**Timing:**

We are available to start this project in the winter. We will require about 2-4 months to complete our investigations and reports. We can do one or multiple schools concurrently.

**Fee for Services:**

The fee is broken per school. The fee includes services of Windy Hill Associates and DDH Energy Consulting, LLC to perform the analyses described above. These will form the basis for additional design work which will be addressed in a future proposal when the scopes are known. The fee includes ordinary office expenses, travel and printing. The fee does not include other consultants' services which might be required or requested. We propose to work on an hourly basis with a cap for each facility of \$8,500 for WHA and \$7,200 for DDH.

Data Logger Rental: \$ 1,600

The fee for blower door testing is:

HBMS:	\$ 3,700
HBHS	4,400
CSDA	3,000
RMMS	<u>3,300</u>
Total	\$14,400

The fee for Kohta Ueno of Building Science Corp is to be determined based on our findings and his level of participation.

If you are in agreement and would like to proceed please sign one copy and return it to our office.

Thank you, we look forward to working on these exciting projects.

Very truly yours,

David Ely, AIA

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Accepted by:

Date: