



IAQ Verification Report

Early Childhood Center at B.P. Mission

New London, CT

SES Project No. 24-461

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Executive Summary

Sustainable Engineering Solutions, LLC (SES) and Trueflow Testing and Balancing were retained by the Town of New London to provide professional engineering and test and balancing (TAB) services to meet the indoor air quality (IAQ) verification requirements of the state legislation Public Act No. 23-167 at the Early Childhood Center at B.P. Mission. This combined effort successfully completed the required verification as outlined in the legislation. With a focus on validating and improving indoor air quality, SES and Trueflow systematically assessed each air handling system to measure current ventilation rates, filtration rates and distribution levels compared to current ventilation standards.

Overall, the HVAC air handling systems and distribution devices are in fair condition. Significant interior modifications have been made to the spaces since installation of HVAC systems.

Currently, the majority of spaces within the building do not meet minimum ventilation requirements due to the minimum outside air damper position for each of the roof top units being below the calculated percentages. However, we believe that with simple building control system modifications, rebalancing and minor repairs, the building will satisfy all minimum ventilation requirements.

Recommendations associated with the buildings air handling units have been included in this report for the Client to review. Note that throughout this report the term “ventilation” air and “outside” are used interchangeably and are one in the same.

IAQ Verification Process

Filter Evaluation

As required by the law, the team reviewed the current level of filtration installed on each air handling system and analyzed the feasibility of increasing the filter ratings to MERV 13. A filter’s minimum efficiency reporting value, or MERV, is a rating system that measures how efficient a filter is at trapping harmful particulate matter, dust, and debris in the air. This rating system categorizes filters into a ranking from 2 to 20, with a MERV 8 being the standard. A higher MERV rating means that a filter is more efficient and MERV 13 is recommended for many commercial and industrial buildings and by state code. At its minimum, a MERV 13 filter traps less than 75% of air particles that are 0.3 to 1.0 microns in size and is at least 90% effective when the particles increase to 3 to 10 microns in size. Along with assessing the filter efficiencies, the condition of unit’s filters and proper sealing of the filter banks to eliminate bypass air was also evaluated.

Ventilation Evaluation

The amount of ventilation air delivered into interior occupied spaces is governed by the 2022 Connecticut State Building Code, which references ASHRAE Standard 62.1. This code prescribes the flow rate of ventilation air that must be supplied mechanically, or otherwise, to occupied areas based on occupancy classifications. Depending on the type of use of a space and total space area, outdoor air flow rates in cubic feet per minute (CFM) per person and square foot are defined when the



parameters are known. When total occupants per space are unknown, the code defines occupant density for each classification type in number of occupants per space floor area. The final flow rate in CFM for every occupied space can thus be calculated.

As an alternative to providing outside air mechanically to occupied spaces, the building code also allows for outside air to enter occupied areas naturally through operable windows. If the area of operable windows for an occupied space is at least 4% of the space's floor area, mechanical ventilation for that space is not required by code. However, although spaces with sufficient operable window area may satisfy code requirements, this is not a realistic way of providing adequate ventilation during periods of cold or hot weather.

The amount of outside air supplied to occupied spaces is important for occupant comfort and health because contaminants generated by people and materials in the space must be removed or they will build up to unhealthy levels. Diluting interior air with outside air reduces the concentration of carbon dioxide, volatile organic compounds (VOCs) along with various airborne viral and bacterial contaminants.

Demand Control Ventilation

In certain applications, the amount of outside air delivered to a space can be reduced if occupancy and indoor air quality can be safely monitored and controlled. This is most typically accomplished through monitoring carbon dioxide (CO₂) and occupancy sensors in the space, otherwise known as "Demand Control Ventilation" or DCV. As occupancy rises in a space, so does the amount of CO₂ as a result of the occupant's natural respiration and exhalation of CO₂. By monitoring CO₂ and occupancy status, an HVAC system can reduce the amount of outside air to a zone when levels and occupancy are low. If CO₂ levels rise above a certain threshold or occupancy is detected, the HVAC system can then increase the amount of fresh air until the levels fall back below an acceptable level. Having an operational demand control ventilation strategy in place will help reduce energy consumption of a facility while simultaneously ensuring all spaces are achieving the required fresh air requirements.

Project Approach

During the review of the school, SES took the following steps to complete the study:

- Develop an IAQ evaluation plan and conduct a kickoff meeting with the client and Trueflow to review the plan, project schedule, access, etc.
- Perform a walkthrough of the building to review the HVAC systems providing ventilation air for a condition assessment of the systems and understand any maintenance issues that may be related.
- Review available documentation for the HVAC systems that includes:
 - As-built drawings or original design drawings
 - O&M documentation for systems performance data



- Review any previous testing adjusting and balancing reports from the HVAC systems
- Review documentation describing the chronology of known problems, system failures, complaints, and alterations.
- Develop IAQ evaluation documentation for field evaluation of equipment.
- Perform field evaluation of equipment for ventilation sequence of operation and verify calibration of CO2 sensors where used (+/- 50 PPM).
- Review Trueflow's completed ventilation rate verification sheets for each space for compliance with ASHRAE 62.1
- Review the Trueflow's completed unit data sheets for each system providing ventilation air for ventilation airflows, filter condition and efficiency, damper conditions and maintenance adequacy.
- Prepare a report that summarizes the verification process, identifies any deficiencies that require correction and any recommendations to address the deficiencies found and next steps.



Participants

The participants in the IAQ verification process for this project are identified below.

Owner

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TAB Provider

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Facility Description

Building

Building:	Early Childhood Center at B.P. Mission
Location:	40 Shaw St, New London, CT 06320
Building Size (gross):	10,000 ft ² (Approximate)
Year Bought:	2021
Building Use (current):	Education



The two-story building was purchased by the New London School District in the 2021-2022 school year to be used as a pre-school throughout the day and a community center during the night. The school consists of classrooms, main office, theater and gymnasium.

Occupancy

The building is occupied Monday through Friday between 8 a.m. and 4 p.m. Special events are held on the weekends and after hours as needed for community activities. In addition, various summer programs are held at the building.

Building Automation System Description

The HVAC system has graphics for all the HVAC equipment in the building. However, the building automation system is read-only and is not currently capable of overrides, trending and performing custom control algorithms.

HVAC Systems Description

Roof Top Units

In total, four Roof Top Units (RTUs) provide ventilation, heating and cooling to all zones in the school. One of the roof top units is a multizone unit and serves multiple VAV boxes. The three other roof top units are single-zone constant volume units. All four air handling units are located outside and are in fair condition.



The RTUs mix return air from the building with fresh outside air, filters the airstream and then conditions it by heating or cooling as necessary. For the multizone unit, as the airflow requirements of the spaces change, the downstream VAV boxes will open and close their dampers accordingly.

Unit Tag	Serves	Type
RTU	Classrooms	Multi-Zone Constant Volume
RTU	Gymnasium	Single Zone Constant Volume
RTU	Theater	Single Zone Constant Volume
RTU	Main Office	Single Zone Constant Volume

Recommendations

The following recommendations were made based on the review of TAB report, ventilation comparisons to the IMC Minimum Ventilation Rates (2021) and industry best practices. Additional supporting information can be found in the Appendices of the report.

Due to the limited area of focus of the required IAQ verification and this review, SES strongly recommends verifying the condition of all related HVAC equipment components and control functionality outside of the scope of this verification, prior to implementing any modifications to the HVAC systems.

Initial Recommendations

- Recommendation #1: Repair Office RTU
- Recommendation #2: Set New Fixed Minimum Outside Air Damper Positions For Theater, Classroom and Gymnasium RTUs
- Recommendation #3: Rebalance/Repair Bathroom Exhaust Fan/s
- Recommendation #4: Filter Improvements

Recommendation #1: Repair Office RTU

During testing, adjusting, and balancing, the roof top unit intended to serve the main office area was found to be inoperable. In addition, the outside air inlet was damaged.

SES recommends that the New London HVAC department or an independent HVAC service contractor inspects the operation and condition of the unit and determines if a repair is possible. If not, the unit should be replaced.



Recommendation #2: Set New Fixed Minimum Outside Air Damper Positions For Theater, Classroom and Gymnasium RTUs

During TAB measurements, the majority of spaces in the school were found to not meet their minimum ventilation requirements.

SES recommends rebalancing the minimum outside air damper positions for the Theater, Classroom and Gym Roof Top Units.

A licensed testing and balancing contractor should be hired to set a new fixed minimum outside air position that coincides with the minimum outside air value listed in the table below.

Unit Tag	Current Minimum Outside Air (CFM)	New Calculated Minimum Outside Air (CFM)
Theater	660	830
Classroom	620	1,730
Gym	465	1,510

Recommendation #3: Rebalance/Repair Bathroom Exhaust Fan/s

During review of TAB data, the following bathrooms do not meet exhaust ventilation requirements. Due to the age of the building and missing drawings, the exact exhaust fan intended to ventilate each space could not be determined. Operation of exhaust fans and condition of exhaust duct in these spaces should be reviewed.

Space	TAB Measured Exhaust (CFM)	Calculated Exhaust (CFM)
Girls Bathroom – Classroom Area	0	75
Boys Bathroom – Classroom Area	0	50

SES recommends that exhaust fans and exhaust duct connections in these spaces be reviewed for proper operation, functionality and that all connections remain.

Recommendation #4: Filter Improvements

Currently, all air handling units were found to utilize MERV 11 filters.

SES recommends replacing and upgrading all final filters to at least MERV 13 for increased filtration efficiency.



Next Steps

Review Recommendations

It is recommended that the client review this report and the proposed recommendations for further clarification, if needed and decide a course of action. SES can provide additional assistance if needed, to further analyze and develop these recommendations for future implementation, and if desired, provide commissioning of the implemented measures.



Appendix A: IAQ Evaluation Sheet

Tag	AREA SERVED	Type	Filters (1 = clean, 2 = partially loaded, 3 = dirty)		Unit Condition	Outside Air Control Method	CO2 Control?	TAB Measured			Summated OA Airflow	Calculated Min. Outside Airflow ²	% OA of TAB	Comments
			Pre-Filter Condition	Final Filter Conditon				Supply Airflow ²	Min. Outside Airflow ³	% OA				
RTU - Classroom	Classrooms	Multi-Zone Constant Volume	2	2	Fair	Fixed Outside Air Position	No	3,910	620	16%	1,725	1,730	44%	
RTU - Gym	Gym	Single Zone Constant Volume	1	1	Fair	Fixed Outside Air Position	No	3,955	465	12%	1,504	1,510	38%	
RTU - Theater	Theater	Single Zone Constant Volume	1	1	Fair	Fixed Outside Air Position	No	3,664	660	18%	828	830	23%	
RTU - Office	Office	Multi-Zone Constant Volume	1	1	Poor	Fixed Outside Air Position	No	-	-	#DIV/0!	341	350	#DIV/0!	Unit Not Running

IMC 2021 Ventilation Assessment

Unit Tag	Room #	Category	Infiltration	ZoneArea, Az, per space (SF)	Zone Population, Pz, per space	People OA Rate in Breathing Zone, Rp (CFM/person)	Area OA Rate in Breathing Zone, Ra (CFM/SF)	Default Occupant Density	Breathing Zone OA (CFM) Vbz=RpPz+RaAz	Table 6-2 Zone Air Distribution Effectiveness	Zone OA Flow, Voz	Min. Ventilation Airflow (CFM)	Actual Supply Airflow (CFM)	RTU % OA	Actual Ventilation Airflow (CFM)	Ventilation Difference (CFM)	Code Satisfied?
RTU - Classroom	Classroom 1A	Classrooms (ages 5 to 8)	0	372	18	10	0.12	25	225	1	225	225	194	16%	31	(194)	No
RTU - Classroom	Classroom 1B	Classrooms (ages 5 to 8)	0	387.5	14	10	0.12	25	187	1	187	187	481	16%	77	(110)	No
RTU - Classroom	Classroom 3	Classrooms (ages 5 to 8)	0	275.5	10	10	0.12	25	133	1	133	133	458	16%	73	(60)	No
RTU - Classroom	Classroom 4	Classrooms (ages 5 to 8)	0	275.5	10	10	0.12	25	133	1	133	133	476	16%	76	(57)	No
RTU - Classroom	Corridor from Main lobby to Stairwell A	Corridors	0	96	10	0	0.06	0	6	1	6	6	141	16%	23	17	Yes
RTU - Classroom	Corridor from Stairwell A to Stairwell B	Corridors	0	289.25	20	0	0.06	0	17	1	17	17	179	16%	29	11	Yes
RTU - Classroom	Elevator Lobby	Office spaces	0	95	5	5	0.06	5	31	1	31	31	56	16%	9	(22)	No
RTU - Classroom	Nurse's Office	Daycare Sickroom	1	263.5	10	10	0.18	25	147	1	147	147	274	16%	44	(104)	No
RTU - Classroom	Room 6	Classrooms (ages 5 to 8)	1	356.5	18	10	0.12	25	223	1	223	223	0	16%	-	(223)	No
RTU - Classroom	Classroom next to stairwell A	Classrooms (ages 5 to 8)	1	399.9	14	10	0.12	25	188	1	188	188	0	16%	-	(188)	No
RTU - Classroom	Classroom 4A	Classrooms (ages 5 to 8)	1	370.5	16	10	0.12	25	204	1	204	204	648	16%	104	(101)	No
RTU - Classroom	Classroom 4B	Classrooms (ages 5 to 8)	1	370.5	15	10	0.12	25	194	1	194	194	347	16%	56	(139)	No
RTU - Classroom	Classroom 4B Office	Office spaces	1	63	2	5	0.06	5	14	1	14	14	70	16%	11	(3)	No
RTU - Classroom	Corridor from Stairwell A to Stairwell B	Corridors	0	289.25	20	0	0.06	0	17	1	17	17	47	16%	8	(10)	No
RTU - Classroom	Corridor from elevator to Stairwell A	Corridors	0	96	10	0	0.06	0	6	1	6	6	34	16%	5	(0)	No
RTU - Gym	Cafe	Cafeteria/fast-food dining	0	1155.75	40	7.5	0.18	100	508	1	508	508	1750	12%	210	(298)	No
RTU - Gym	Gymnasium	Gym, sports arena (play area)	0	1086.75	40	20	0.18	7	996	1	996	996	1287	12%	154	(841)	No
RTU - Office	Site Manager Office	Office spaces	1	100	6	5	0.06	5	36	1	36	36	0	0%	-	(36)	No
RTU - Office	Main Office Reception	Reception areas	1	130	2	5	0.06	30	18	1	18	18	0	0%	-	(18)	No
RTU - Office	Speech Room	Office spaces	0	64	6	5	0.06	5	34	1	34	34	0	0%	-	(34)	No
RTU - Office	Psychologist Office	Office spaces	0	56	2	5	0.06	5	13	1	13	13	0	0%	-	(13)	No
RTU - Office	Main Lobby	Main entry lobbies	0	518.5	25	5	0.06	10	156	1	156	156	0	0%	-	(156)	No
RTU - Office	Corridor from Main Lobby to Kitchen	Corridors	0	396	25	0	0.06	0	24	1	24	24	0	0%	-	(24)	No
RTU - Office	Kitchen	Kitchen (cooking)	1	165	4	7.5	0.18	20	60	1	60	60	0	0%	-	(60)	No
RTU - Theater	Theatre	Music/theater/dance	0	1345.5	73	10	0.06	35	811	1	811	811	2918	18%	525	(285)	No
RTU - Theater	Theatre Second floor office	Office spaces	0	126.5	2	5	0.06	5	18	1	18	18	181	18%	33	15	Yes

Unit Tag	Room #	Category	ZoneArea, Az, per space (SF)	TAB Exhaust CFM	# of Toilets	Calc'd Exhaust CFM	Ventilation Difference (CFM)	Code Satisfied?	Comments
	Boys BR Across 1B	Toilet rooms - private	71	51	2	50	1	Yes	
	Girls BR Across 1B	Toilet rooms - private	71	57	2	50	7	Yes	
	Staff Restroom across 1B	Toilet rooms - private	68	48	1	25	23	Yes	
	BR in Nurse's Office	Toilet rooms - private	33	64	1	25	39	Yes	
	Boys BR across from Room 6	Toilet rooms - private	71	89	2	50	39	Yes	
	Girls BR	Toilet rooms - private	144	0	3	75	(75)	No	
	Boys BR	Toilet rooms - private	117	0	2	50	(50)	No	
	Girls BR across Room 6	Toilet rooms - private	76	90	2	50	40	Yes	
	Staff Restroom across from Room 6	Toilet rooms - private	63	77	1	25	52	Yes	

Notes

No fresh air requirements for public bathrooms, only exhaust. Exhaust is 50 CFM or 70 CFM per water closet or urinal. If exhaust fan is intermittent than the higher value is used.

No fresh air requirements for private bathrooms, only exhaust. Exhaust is 25 CFM or 50 CFM per water closet or urinal. If exhaust fan is intermittent than the higher value is used.

No fresh air requirements for shower rooms, only exhaust. Exhaust is 20 CFM or 50 CFM per shower head. If exhaust fan is intermittent than the higher value is used.

Corridors are .06 CFM/sf only

Locker rooms are exhaust only at 0.5 CFM/sf

Corridors are .06 CFM/sf only



Appendix B: International Mechanical Code Minimum Ventilation Rates (2021) per ASHRAE 62.1

Minimum Ventilation Rates in Breathing Zone		People Outdoor Air Rate <i>R_p</i>	Area Outdoor Air Rate <i>R_a</i>	Default Values (Occupant Density)	Air Class	OS (6.2.6.1.4)	Comments
Occupancy Classification	Category	cfm/person	cfm/sf	#/1000sf			
Educational Facilities	Art Classroom	10	0.18	20	2	No	
Educational Facilities	Classrooms (ages 5 to 8)	10	0.12	25	1	No	
Educational Facilities	Classrooms (ages 9 plus)	10	0.12	35	1	No	
Educational Facilities	Computer Lab	10	0.12	25	1	No	
Educational Facilities	Daycare Sickroom	10	0.18	25	3	No	
Educational Facilities	Daycare (through age 4)	10	0.18	25	2	No	
Educational Facilities	Auditoriums	5	0.06	150	0		
Educational Facilities	Lecture Classroom	7.5	0.06	65	1	Yes	Per ASHRAE, lecture classrooms are spaces with low space generated emissions and hard surfaces. Little off gassing so reduced levels. Most standard classrooms will be lecture classroom type.
Educational Facilities	Lecture hall (fixed seats)	7.5	0.06	150	1	Yes	University style (see occupant density)
Educational Facilities	Libraries	5	0.12	10	n/a	No	
Educational Facilities	Media Center	10	0.12	25	1	No	
Educational Facilities	Multiuse assembly	7.5	0.06	100	1	Yes	
Educational Facilities	Music/theater/dance	10	0.06	35	1	Yes	
Educational Facilities	Science laboratories	10	0.18	25	2	No	
Educational Facilities	University/college laboratories	10	0.18	25	2	No	
Educational Facilities	Sports locker rooms	0	-0.7	0	0	No	
Educational Facilities	Wood/metal shop	10	0.18	20	2	No	
Food and Beverage	Bars, cocktail lounges	7.5	0.18	100	2	No	
Food and Beverage	Cafeteria/fast-food dining	7.5	0.18	100	2	No	
Food and Beverage	Kitchen (cooking)	7.5	0.18	20	2	No	
Food and Beverage	Restaurant dining rooms	7.5	0.18	70	2	No	
Private Dwellings	Toilet rooms - private	0	0	0	0		
Offices	Conference rooms	5	0.06	50	1	Yes	
Offices	Main entry lobbies	5	0.06	10	1	Yes	
Offices	Office spaces	5	0.06	5	1	Yes	
Offices	Reception areas	5	0.06	30	1	Yes	
Offices	Telephone/data entry	5	0.06	60	1	Yes	
Public spaces	Corridors	0	0.06	0			
Public spaces	Shower room	0	0	0			
Public spaces	Toilet rooms - public	0	0	0			
Public Assembly Spaces	Auditorium seating area	5	0.06	150	1	Yes	
Public Assembly Spaces	Libraries	5	0.12	10	1	No	
Public Assembly Spaces	Toilet rooms - public	0	0	0			
Sports and Entertainment	Bowling alley (seating)	10	0.12	40	1	No	
Sports and Entertainment	Disco/dance floors	20	0.06	100	2	Yes	
Sports and Entertainment	Gambling casinos	7.5	0.18	120	1	No	
Sports and Entertainment	Game arcades	7.5	0.18	20	1	No	
Sports and Entertainment	Gym, sports arena (play area)	20	0.18	7	2	No	
Sports and Entertainment	Health club/aerobics room	20	0.06	40	2	No	
Sports and Entertainment	Health club/weight room	20	0.06	10	2	No	
Sports and Entertainment	Spectator areas	7.5	0.06	150	1	Yes	
Sports and Entertainment	Stages, studios	10	0.06	70	1	Yes	
Sports and Entertainment	Swimming (pool and deck)	0	0.48	0	2	No	

Minimum Exhaust Rates				
Occupancy Classification	Category	CFM/fixture	CFM/SF	Comments
Educational Facilities	Toilet rooms - public	50	0	20
Educational Facilities	Toilet rooms - private	25	0	
Educational Facilities	Shower rooms	20	0	
Educational Facilities	Sports locker rooms	0	0.5	