



# IAQ Verification Report

## Bennie Dover Jackson Multi-Magnet Middle School

New London, CT

SES Project No. 24-461

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Appendix A

IAQ Evaluation Sheet

Appendix B

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



## Executive Summary

Sustainable Engineering Solutions, LLC (SES) was 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 Bennie Dover Jackson Multi-Magnet Middle School facility. This effort successfully completed the required verification as outlined in the legislation. With a focus on validating and improving indoor air quality, SES systematically assessed each air handling system to measure current ventilation rates, filtration rates and distribution levels compared to current ventilation standards.

This building, which finished a major renovation & new addition in 2024, has recent documentation available for systems performance and measured airflows located in the Testing, Adjusting, and Balancing (TAB) report (Appendix-B). This report was used in the assessment process.

Overall, the facility meets or exceeds current ventilation requirements, with the exception of a few spaces identified in the recommendations section of the report.

All air handling systems are currently equipped with MERV 8 filters. State guidelines recommend upgrading to MERV 13 filtration or higher for improved air quality. This recommendation has been incorporated into the report.

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 (CO<sub>2</sub>) 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 CO<sub>2</sub> as a result of the occupant's natural respiration and exhalation of CO<sub>2</sub>. By monitoring CO<sub>2</sub> and occupancy status, an HVAC system can reduce the amount of outside air to a zone when levels and occupancy are low. If CO<sub>2</sub> 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 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 the testing, adjusting, and balancing report for each space for compliance with ASHRAE 62.1
- 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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## Facility Description

### Building

Building:	Bennie Dover Jackson Multi-Magnet Middle School
Location:	36 Waller St, New London, CT 06320
Building Size (gross):	125,000 ft <sup>2</sup>
Year Constructed:	2024 (Renovated)
Building Use (current):	Education



Between 2021 and 2024, the 125,000 square foot Bennie Dover Jackson Multi-Magnet Middle School building underwent a complete renovation. The construction project included additions to the existing building and installed air handling units, VRF systems, and more. The building consists of classrooms, administration offices, gymnasium, cafeteria, media center and other typical educational spaces.

### Occupancy

The building is occupied Monday through Friday between 7 a.m. and 3 p.m. Special events are held on the weekends and after hours as needed for extracurricular school activities. In addition, the school hosts summer school activities during the summer break.

### Building Automation System Description

The HVAC system is controlled by an Allerton Compass building automation system. This system has graphics for all the HVAC equipment and is capable of trending and performing custom control algorithms.

### HVAC Systems Description

#### Rooftop Units

In total, there are five (5) rooftop units (RTUs) in the facility. The 5 RTUs are variable-volume serving single zones.



Each RTU is sized to satisfy the total space heating, cooling, and ventilation requirements. A RTU includes a supply fan, a return fan, and MERV-8 filters for air quality improvement. The air streams are conditioned using Dx cooling, gas heat, and hot gas reheat coils for heating and cooling. The units modulate fan speeds based on the system demands.

For RTUs 1 & 3 an energy recovery wheel is installed across the outside air and exhaust air streams to enhance energy efficiency.

Unit Tag	Serves	Type	Min OA Damper Setpoint	CO2 Setpoint
RTU-1	Cafeteria	Single zone VAV	57%	800 PPM
RTU-2	Gymnasium	Single zone VAV	25%	800 PPM
RTU-3	Sport Locker Rooms	Single zone VAV	100%	800 PPM
RTU-4	Commons A wing	Single zone VAV	14%	800 PPM
RTU-5	Common areas C wing	Single zone VAV	30%	800 PPM

## Dedicated Outdoor Air System Units

The school features heating, cooling, and ventilation systems primarily consisting of Variable Refrigerant Flow (VRF) systems, Variable Air Volume (VAV) systems, and Dedicated Outdoor Air Systems (DOAS). Each zone is equipped with a VRF unit & for temperature controls and VAV unit connected to the supply and exhaust ductwork connected to a DOAS unit for ventilation. In addition to supplying ventilation air to the building, the DOAS units also provide necessary exhaust air from the classroom and bathroom spaces.

The VRF units handle all the heating and cooling requirements within the zones, while the DOAS units provide ventilation to downstream VAV units that modulate the ventilation required to meet the spaces air quality standards.

Each DOAS is equipped with a supply fan, exhaust fan, and MERV-8 filters for air quality improvement. DOAS-1A/1B air streams are conditioned using a hot water coil, chilled water coil, and reheat hot water coil for heating and cooling. DOAS -2 air streams are conditioned using Dx cooling coil, hot gas, and hot gas reheat coil for heating and cooling. An energy recovery wheel is installed across the outside air and exhaust air streams to enhance energy efficiency. The DOAS fans operate with variable speed modulation to ensure adequate downstream airflow.

Unit Tag	Serves	Type	Min OA Damper Setpoint	CO2 Setpoint
DOAS-1A/1B	A and B Wing Rooms	Multizone VAV	100%	800 PPM
DOAS-2	D Wing Rooms	Multizone VAV	69%	800 PPM



## 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: DOAS-1A/1B Space Rebalancing
- Recommendation #2: Filter Improvements
- Recommendation #3: EF-7 Re-Balancing

### Recommendation #1: DOAS-1A/1B Space Rebalancing

During review of testing and balancing data, fifteen spaces served by DOAS-1A and 1B were measured to have ventilation airflows below the minimum calculated requirements. Note: Since units are 100% outside air, ventilation airflow is equal to the supply airflow.

Unit Tag	Room #	Category	# of Occupants	Calculated Required Ventilation Airflow	TAB Measured Airflow
DOAS-1A/1B	A-110	Art Classroom	27	465	430
DOAS-1A/1B	A-103E	Office spaces	4	28	15
DOAS-1A/1B	A-103B	Office spaces	4	28	16
DOAS-1A/1B	A-103D	Office spaces	4	28	16
DOAS-1A/1B	A-103C	Office spaces	4	28	16
DOAS-1A/1B	A-200	Lecture Classroom	21	219	120
DOAS-1A/1B	A-301C	Daycare Sickroom	3	57	46
DOAS-1A/1B	A-301B	Office spaces	4	30	16
DOAS-1A/1B	B-310C	Lecture Classroom	28	254	130
DOAS-1A/1B	B-301E	Office spaces	3	25	16
DOAS-1A/1B	B-301G	Office spaces	7	49	26
DOAS-1A/1B	B-302B	Cafeteria/fast-food dining	3	47	26
DOAS-1A/1B	B-302A	Office spaces	4	29	10
DOAS-1A/1B	B-302C	Office spaces	4	28	16
DOAS-1A/1B	B-303	Lecture Classroom	32	285	122



SES recommends rebalancing the supply branches in these zones to achieve the required ventilation airflow levels as specified above.

## Recommendation #2: Filter Improvements

Currently all DOAS and RTUs are equipped with MERV 8 filters. SES recommends replacing and upgrading all final filters to at least MERV 13 filters for increased filtration efficiency which are over 90% efficient at capturing 3 to 10 microns in size and meet modern building codes for many commercial and industrial applications.

Upgrading to MERV 13 filters will significantly improve the indoor quality by capturing finer particulate matter, reducing allergens, and ensuring compliance with current building standards, contributing to a healthier indoor environment.

## Recommendation #3: EF-7 Re-Balancing

Two zones were identified as under-exhausted, with measured exhaust airflow rates failing to meet the calculated minimum based on the square footage and number of fixtures (toilets, showers, etc.) in the space.

Unit Tag	Room #	Category	Required Exhaust Airflow	TAB Measured Airflow
EF-7	A-T202a	Toilet rooms - public	100 CFM	80 CFM
EF-7	A-T202b	Toilet rooms - public	100 CFM	75 CFM

These zones, although part of a newly constructed facility, are under-exhausted based on their square footage and classification as observed during the site walkthrough. SES recommends rebalancing the exhaust branches in these zones to achieve the required airflow as specified above.

## 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	CO2 Control?	Design		TAB Measured			Summated OA Airflow	Calculated Min. Outside Airflow <sup>2</sup>	% OA of TAB	Comments
				Supply Airflow	Min. Outside Airflow	Supply Airflow <sup>2</sup>	Min. Outside Airflow <sup>3</sup>	% OA				
RTU-1	Cafeteria	Single Zone VAV	Yes	10,500	6,300	11,125	6,375	57%	2,755	2,760	25%	
RTU-2	Gymnasium	Single Zone VAV	Yes	14,000	3,600	14,750	3,725	25%	11,226	11,230	76%	
RTU-3	Sports locker rooms	Single Zone VAV	No	3,000	3,000	2,853	2,853	100%	540	550	19%	
RTU-4	Common areas	Single Zone VAV	Yes	8,400	900	6,818	966	14%	296	300	4%	
RTU-5	Common areas C Wing	Single Zone VAV	No	6,000	1,400	4,924	1,458	30%	306	310	6%	
DOAS-1A/1B	A-Wing Rooms	Multizone VAV	No	26,480	N/A	27,180	27,180	100%	13,597	13,600	50%	Downstream VAV boxes are programmed for CO2 control.
DOAS-2	D-Wing Rooms	Multizone VAV	No	9,875	9,875	9,875	6,818	69%	1,751	1,760	18%	Downstream VAV boxes are programmed for CO2 control.

IMC 2021 Ventilation Assessment

Unit Tag	Room #	Construction Drawing 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) Vz=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?	CFM per SF
DOAS-1A/1B	A-110	A-110	Art Classroom	0	1083	27	10	0.18	20	465	1	465	465	430	100%	432	(33)	No	195
DOAS-1A/1B	A-110B	A-110b	Art Classroom	0	177	2	10	0.18	20	52	1	52	52	175	100%	183	131	Yes	32
DOAS-1A/1B	A111	A111	Lecture Classroom	0	1093	26	7.5	0.06	65	261	1	261	261	395	100%	395	134	Yes	66
DOAS-1A/1B	A-101	A-101	Lecture Classroom	0	1178	26	7.5	0.06	65	266	1	266	266	480	100%	485	219	Yes	71
DOAS-1A/1B	A-102	A-102	Music/theater/dance	0	1359	35	10	0.06	35	432	1	432	432	560	100%	569	137	Yes	82
DOAS-1A/1B	A-103	A-103	Reception areas	0	218	3	5	0.06	30	28	1	28	28	50	100%	50	22	Yes	13
DOAS-1A/1B	A-103A	A-103A	Conference rooms	0	303	10	5	0.06	68	68	1	68	68	100	100%	100	32	Yes	
DOAS-1A/1B	A-103F	A-103F	Office spaces	0	140	1	5	0.06	5	13	1	13	13	15	100%	16	3	Yes	
DOAS-1A/1B	A-103E	A-103E	Office spaces	0	139	4	5	0.06	5	28	1	28	28	15	100%	15	(13)	No	8
DOAS-1A/1B	A-103B	A-103B	Office spaces	0	140	4	5	0.06	5	28	1	28	28	15	100%	16	(12)	No	8
DOAS-1A/1B	A-103D	A-103D	Office spaces	0	140	4	5	0.06	5	28	1	28	28	15	100%	16	(12)	No	8
DOAS-1A/1B	A-103C	A-103C	Office spaces	0	132	4	5	0.06	5	28	1	28	28	15	100%	16	(12)	No	8
DOAS-1A/1B	A-109	A-109	Music/theater/dance	0	308	8	10	0.06	35	99	1	99	99	150	100%	154	55	Yes	19
DOAS-1A/1B	A-108	A-108	Lecture Classroom	0	313	6	7.5	0.06	65	64	1	64	64	160	100%	161	97	Yes	19
DOAS-1A/1B	A-104	A-104	Lecture Classroom	0	555	24	7.5	0.06	65	213	1	213	213	335	100%	339	126	Yes	33
DOAS-1A/1B	A105	A105	Lecture Classroom	0	602	21	7.5	0.06	65	194	1	194	194	335	100%	335	141	Yes	36
DOAS-1A/1B	A107	A107	Lecture Classroom	0	470	5	7.5	0.06	65	66	1	66	66	200	100%	208	142	Yes	28
DOAS-1A/1B	A-106	A-106	Reception areas	0	269	3	5	0.06	30	31	1	31	31	45	100%	47	16	Yes	16
DOAS-1A/1B	B-210	B-210	Lecture Classroom	0	724	29	7.5	0.06	65	261	1	261	261	365	100%	365	104	Yes	43
DOAS-1A/1B	B-209	B-209	Lecture Classroom	0	1136	29	7.5	0.06	65	286	1	286	286	1,040	100%	1,070	784	Yes	68
DOAS-1A/1B	B-208	B-208	Office spaces	0	225	8	5	0.06	5	54	1	54	54	110	100%	114	60	Yes	14
DOAS-1A/1B	B-207	B-207	Lecture Classroom	0	1101	29	7.5	0.06	65	284	1	284	284	100	100%	1,013	729	Yes	66
DOAS-1A/1B	B-206	B-206	Lecture Classroom	0	767	30	7.5	0.06	65	271	1	271	271	360	100%	365	94	Yes	46
DOAS-1A/1B	B-205	B-205	Lecture Classroom	0	738	29	7.5	0.06	65	262	1	262	262	360	100%	368	106	Yes	44
DOAS-1A/1B	B-204	B-204	Lecture Classroom	0	742	25	7.5	0.06	65	232	1	232	232	360	100%	362	130	Yes	45
DOAS-1A/1B	B-203	B-203	Lecture Classroom	0	741	25	7.5	0.06	65	232	1	232	232	360	100%	363	131	Yes	44
DOAS-1A/1B	B-202	B-202	Lecture Classroom	0	739	25	7.5	0.06	65	232	1	232	232	360	100%	368	136	Yes	44
DOAS-1A/1B	B-201	B-201	Lecture Classroom	0	739	25	7.5	0.06	65	232	1	232	232	360	100%	365	133	Yes	44
DOAS-1A/1B	A-200	A-201	Lecture Classroom	0	1023	21	7.5	0.06	65	219	1	219	219	120	100%	120	(99)	No	61
DOAS-1A/1B	A-205	A-205	Lecture Classroom	0	539	21	7.5	0.06	65	190	1	190	190	400	100%	400	210	Yes	32
DOAS-1A/1B	A-202	A-202	Lecture Classroom	0	545	17	7.5	0.06	65	160	1	160	160	255	100%	258	98	Yes	
DOAS-1A/1B	A-204	A-204	Lecture Classroom	0	708	20	7.5	0.06	65	192	1	192	192	360	100%	361	169	Yes	
DOAS-1A/1B	A-203	A-203	Lecture Classroom	0	750	18	7.5	0.06	65	180	1	180	180	360	100%	375	195	Yes	
DOAS-1A/1B	A-300	A-301	Main entry lobbies	0	204	7	5	0.06	10	47	1	47	47	85	100%	85	38	Yes	12
DOAS-1A/1B	A-301F	A-301F	Office spaces	0	328	3	5	0.06	5	35	1	35	35	125	100%	127	92	Yes	20
DOAS-1A/1B	A-301E	A-301E	Daycare Sickroom	0	122	2	10	0.18	25	42	1	42	42	45	100%	46	4	Yes	22
DOAS-1A/1B	A-301D	A-301D	Daycare Sickroom	0	123	3	10	0.18	25	52	1	52	52	45	100%	45	(7)	No	22
DOAS-1A/1B	A-301C	A-301C	Daycare Sickroom	0	149	3	10	0.18	25	57	1	57	57	45	100%	46	(11)	No	27
DOAS-1A/1B	A-301B	A-301B	Office spaces	0	161	4	5	0.06	5	30	1	30	30	15	100%	16	(14)	No	10
DOAS-1A/1B	A-301h	A-301h	Daycare Sickroom	0	449	4	10	0.18	25	121	1	121	121	220	100%	236	115	Yes	81
DOAS-1A/1B	A-302	A-303	Lecture Classroom	0	231	12	7.5	0.06	65	104	1	104	104	160	100%	162	58	Yes	14
DOAS-1A/1B	A-301	A-302	Office spaces	0	970	16	5	0.06	5	138	1	138	138	180	100%	180	42	Yes	58
DOAS-1A/1B	B-310B	B-310B	Conference rooms	0	261	9	5	0.06	50	61	1	61	61	135	100%	139	78	Yes	16
DOAS-1A/1B	B-310	B-310	Media Center	0	1692	42	10	0.12	25	623	1	623	623	1,548	100%	1,543	920	Yes	203
DOAS-1A/1B	B-310C	B-310c	Lecture Classroom	0	728.12	28	7.5	0.06	65	254	1	254	254	130	100%	130	(124)	No	44
DOAS-1A/1B	B-309	B-309	Office spaces	0	131.37	4	5	0.06	5	28	1	28	28	310	100%	310	282	Yes	8
DOAS-1A/1B	B-308	B-308	Lecture Classroom	0	198.36	22	7.5	0.06	65	177	1	177	177	335	100%	336	159	Yes	12
DOAS-1A/1B	B-301A	B-301A	Reception areas	0	231.4	3	5	0.06	30	29	1	29	29	50	100%	55	26	Yes	14
DOAS-1A/1B	B-301E	B-301E	Office spaces	0	160.74	3	5	0.06	5	25	1	25	25	15	100%	16	(9)	No	10
DOAS-1A/1B	B-301F	B-301F	Office spaces	0	88.74	3	5	0.06	5	20	1	20	20	15	100%	16	(4)	No	5
DOAS-1A/1B	B-301C	B-301C	Cafeteria/fast-food dining	0	182	3	7.5	0.18	100	55	1	55	55	125	100%	125	71	Yes	33
DOAS-1A/1B	B-301J	B-301J	Conference rooms	0	227.48	11	5	0.06	50	69	1	69	69	95	100%	106	34	Yes	14
DOAS-1A/1B	B-301	B-301	Reception areas	0	1189.61	11	5	0.06	30	126	1	126	126	150	100%	157	31	Yes	71
DOAS-1A/1B	B-301G	B-301G	Office spaces	0	238.68	7	5	0.06	5	49	1	49	49	25	100%	26	(23)	No	14
DOAS-1A/1B	B-302	B-302	Reception areas	0	87.22	6	5	0.06	30	35	1	35	35	40	100%	42	7	Yes	5
DOAS-1A/1B	B-302B	B-302B	Cafeteria/fast-food dining	0	136.17	3	7.5	0.18	100	47	1	47	47	25	100%	26	(21)	No	25
DOAS-1A/1B	B-302A	B-302A	Office spaces	0	145.08	4	5	0.06	5	29	1	29	29	10	100%	10	(19)	No	9
DOAS-1A/1B	B-302C	B-302C	Office spaces	0	140.76	4	5	0.06	5	28	1	28	28	15	100%	16	(12)	No	8
DOAS-1A/1B	B-302D	B-302D	Conference rooms	0	203.05	12	5	0.06	50	72	1	72	72	70	100%	72	(0)	No	12
DOAS-1A/1B	B-302E	B-302E	Office spaces	0	133.92	3	5	0.06	5	23	1	23	23	60	100%	60	37	Yes	8
DOAS-1A/1B	B-307	B-307	Lecture Classroom	0	767	25	7.5	0.06	65	234	1	234	234	360	100%	362	128	Yes	46
DOAS-1A/1B	B-306	B-306	Lecture Classroom	0	769.36	28	7.5	0.06	65	256	1	256	256	360	100%	362	106	Yes	46
DOAS-1A/1B	B-305	B-305	Lecture Classroom	0	767	26	7.5	0.06	65	241	1	241	241	360	100%	362	121	Yes	46
DOAS-1A/1B	B-303	B-303	Lecture Classroom	0	755.37	32	7.5	0.06	65	285	1	285	285	120	100%	122	(163)	No	45
DOAS-1A/1B	B-303A	B-303A	Lecture Classroom	0	220.15	12	7.5	0.06	65	103	1	103	103	120	100%	122	19	Yes	13
DOAS-1A/1B	B-304	B-304	Lecture Classroom	0	1078.56	27	7.5	0.06	65	267	1	267	267	500	100%	503	236	Yes	65
DOAS-1A/1B	AC-402	AC-402	Office spaces	0	278.88	7	5	0.06	5	52	1	52	52	75	100%	76	24	Yes	17
DOAS-1A/1B	A-403	A-403	Lecture Classroom	0	774.36	24	7.5	0.06	65	226	1	226	226	360	100%	361	135	Yes	46
DOAS-1A/1B	A-402	A-402	Lecture Classroom	0	474.76	16	7.5	0.06	65	148	1	148	148	255	100%	255	107	Yes	28
DOAS-1A/1B	A-404	A-404	Lecture Classroom	0	767	24	7.5	0.06	65	226	1	226	226	350	100%	350	124	Yes	46
DOAS-1A/1B	A-405	A-405	Lecture Classroom	0	452.25	23	7.5	0.06	65	200	1	200	200	805	100%	820	620	Yes	27
DOAS-1A/1B	A-401	A-401	Lecture Classroom	0	1116.49	28	7.5	0.06	65	277	1	277	277	365	100%	376	99	Yes	67
DOAS-1A/1B	B-401	B-401	Lecture Classroom	0	807.69	30	7.5	0.06	65	273	1	273	273	375	100%	381	108	Yes	48
DOAS-1A/1B	B-415	B-415	Lecture Classroom	0	1238.25	35	7.5	0.06	65	337	1	337	337	525	100%	551	214	Yes	74
DOAS-1A/1B	B-403	B-403	Lecture Classroom	0	416.05	14	7.5	0.06	65	130	1	130	130	375	100%	381	2		

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Unit Tag	Room #	Construction Drawing 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) Vz=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?	CFM per SF
DOAS-2	C-202	C-202	Lecture Classroom	0	524	22	7.5	0.06	65	196	1	196	196	285	69%	288	92	Yes	31
DOAS-2	C-203	C-203	Lecture Classroom	0	609	25	7.5	0.06	65	224	1	224	224	300	69%	320	96	Yes	37
DOAS-2	C-204	C-204	Lecture Classroom	0	560	22	7.5	0.06	65	199	1	199	199	320	69%	337	138	Yes	34
DOAS-2	C-205	C-205	Lecture Classroom	0	265	10	7.5	0.06	65	91	1	91	91	197	69%	136	45	Yes	16
DOAS-2	C-201a	C-201a	Cafeteria/fast-food dining	0	578	17	7.5	0.18	100	231	1	231	231	245	69%	255	24	Yes	104
DOAS-2	B-211	B-211	Lecture Classroom	0	873	21	7.5	0.06	65	210	1	210	210	510	69%	533	323	Yes	52
DOAS-2	B-212	B-212	Lecture hall (fixed seats)	0	1852	60	7.5	0.06	150	561	1	561	561	890	69%	924	363	Yes	111
RTU-1	C-107	C-101	Cafeteria/fast-food dining	0	5566	195	7.5	0.18	100	2,464	1	2,464	2,464	9,900	57%	10,321	7,857	Yes	1,002
RTU-1	C-102	C-102	Stages, studios	0	1013	23	10	0.06	70	291	1	291	291	600	57%	648	357	Yes	61
RTU-2	C103	C104	Gym, sports arena (play area)	0	10145	470	20	0.18	7	11,226	1	11,226	11,226	14,000	25%	14,750	3,524	Yes	1,826
RTU-3	C110	C110	Health club/weight room	0	1337	22	20	0.06	10	520	1	520	520	1,440	100%	1,459	939	Yes	80
RTU-3	C108A	C108A	Office spaces	0	76	1	5	0.06	5	10	1	10	10	65	100%	67	57	Yes	5
RTU-3	C107A	C107A	Office spaces	0	90	1	5	0.06	5	10	1	10	10	65	100%	65	55	Yes	5
RTU-4	AC012	A-C102	Main entry lobbies	0	1608	40	5	0.06	10	296	1	296	296	4,500	14%	4,520	4,224	Yes	96
RTU-5	Stairwell	S-T205	Corridors	0	244	15	0	0.06	0	15	1	15	15	1,500	30%	1,575	1,560	Yes	15
RTU-5	Corridor	C-106	Corridors	0	260	15	0	0.06	0	16	1	16	16	500	30%	504	488	Yes	16
RTU-5	Open lobby area	C-C106	Main entry lobbies	0	994	40	5	0.06	10	260	1	260	260	1,000	30%	1,073	813	Yes	60
RTU-5	Balcony	C206A	Main entry lobbies	0	20	3	5	0.06	10	16	1	16	16	1,000	30%	1,045	1,029	Yes	1

Unit Tag	Room #	Construction Drawing Room #	Category	ZoneArea, Az, per space (SF)	TAB Exhaust CFM	# of Toilets	# of Shower Heads	Calc'd Exhaust CFM	Ventilation Difference (CFM)	Code Satisfied?	Comments
EF-10	CT205	CT205	Toilet rooms - private	85	103	2		50	53	Yes	
EF-11	Boys Bathroom	B-T302a	Toilet rooms - public	299.04	404	5		250	154	Yes	
EF-11	Girls Bathroom	B-T302b	Toilet rooms - public	298.15	412	5		250	162	Yes	
EF-11	Boys bathroom	B-T406a	Toilet rooms - public	265.44	412	5		250	162	Yes	
EF-11	Girls bathroom	B-T406b	Toilet rooms - public	283.91	401	5		250	151	Yes	
EF-12	Mens Bathroom	C-T106a	Toilet rooms - public	189	367	5		250	117	Yes	
EF-12	Womens Bathroom	C-T106b	Toilet rooms - public	201	352	5		250	102	Yes	
EF-13	Boys Bathroom	B-T301	Toilet rooms - private	36.54	77	1		25	52	Yes	
EF-13	Mens Private Bathroom	B-415a	Toilet rooms - private	57.33	77	1		25	52	Yes	
EF-13	Womens Private Bathroom	B-415b	Toilet rooms - private	42.84	73	1		25	48	Yes	
EF-13	Girls Bathroom	B-T402a	Toilet rooms - public	126.15	150	2		100	50	Yes	
EF-13	Mens Bathroom	B-T402b	Toilet rooms - public	125.56	156	2		100	56	Yes	
EF-7	Faculty AT101c	A-T101c	Toilet rooms - private	62	50	1		25	25	Yes	
EF-7	Girls AT101a	A-T101a	Toilet rooms - public	218	302	4		200	102	Yes	
EF-7	Boys AT101b	A-T101b	Toilet rooms - public	218	300	4		200	100	Yes	
EF-7	AT104	AT104	Toilet rooms - private	82	70	1		25	45	Yes	
EF-7	Mens Bathroom	AT205a	Toilet rooms - private	41	82	1		25	57	Yes	
EF-7	Womens Bathroom	AT205b	Toilet rooms - private	44	80	1		25	55	Yes	
EF-7	A-T202a	A-T202a	Toilet rooms - public	149	80	2		100	(20)	No	
EF-7	A-T202b	A-T202b	Toilet rooms - public	151	75	2		100	(25)	No	
EF-7	Shower	A-T301a	Sports locker rooms	100	108	1	1	50	58	Yes	
EF-7	Mens Bathroom	A-T303a	Toilet rooms - private	45	70	1		25	45	Yes	
EF-7	Womens Bathroom	A-T303b	Toilet rooms - private	40	71	1		25	46	Yes	
EF-8	Boys Bathroom	CT201A	Toilet rooms - public	225	350	7		350	-	Yes	
EF-8	Girls Bathroom	CT201B	Toilet rooms - public	224	360	6		300	60	Yes	
RTU-3	Girls Bathroom	C-T108	Toilet rooms - public	144	151	3		150	1	Yes	
RTU-3	Boys Bathroom	C-T107	Toilet rooms - public	145	150	3		150	-	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 exhasut 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<sub>p</sub></i>	Area Outdoor Air Rate <i>R<sub>a</sub></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	<i>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.</i>
Educational Facilities	Lecture hall (fixed seats)	7.5	0.06	150	1	Yes	<i>University style (see occupant density)</i>
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	