

I WANT MY KID IN THIS SCHOOL!

A CASE STUDY OF VENTILATION IMPROVEMENTS IN SCHOOL SETTINGS

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I WANT MY KID IN THIS SCHOOL!

A case study of ventilation improvements in school settings



1. Appreciation of the value of the team approach that includes the owner, the engineer, and the contractor.
2. Which design elements are critical to include in your next project, and which elements to leave out.
3. How to evaluate project success using pre-project and post-project data.
4. Application of codes and standards, as well as guidance for building operations during the COVID-19 pandemic.
5. How to navigate the challenges and limitations of upgrading existing school ventilation systems

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ENGINEER'S PERSPECTIVE

Follow ASHRAE 62.1-2016
Look at % OA in system.
Use energy recovery for new and retrofit

Ventilation Code: ASHRAE 62.1 2016

Minimum ventilation rates and other measures intended to provide indoor air quality that is acceptable to human occupants and that minimizes adverse health effects.
Guide the improvement of indoor air quality in existing buildings.




62.1


TABLE 62.1 Minimum Ventilation Rates in Breathing Zone
(Table 62.1.1 should read in conjunction with the accompanying notes.)

Occupancy Category	Floor Area (ft ²)	People Minimum Air Flow		Area Minimum Air Flow		School Children	
		ft ³ /min	cfm	ft ³ /min	cfm	ft ³ /min	cfm
Classroom	100	15	1.0	15	1.0	15	1.0
Classroom (up to 100)	100	15	1.0	15	1.0	15	1.0
Classroom (over 100)	100	15	1.0	15	1.0	15	1.0
Classroom (up to 100)	100	15	1.0	15	1.0	15	1.0
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FRESH AIR NEEDS TO GET TO THE BREATHING ZONE



WARM AIR SUPPLIED AT CEILING

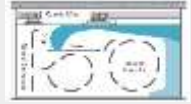


750 SF classroom with 26 occupants:

- $750 \times 0.12 \text{ CFM/sf} = 90 \text{ CFM outside air}$
- $26 \times 10 \text{ CFM/person} = 260 \text{ CFM outside air}$
- **Ventilation Effectiveness = 0.8**
- $(90 + 260) / 0.8 = 440 \text{ CFM total OA}$



COOL AIR SUPPLIED AT CEILING

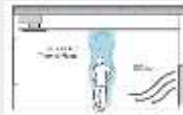


750 SF classroom with 26 occupants:

- $750 \text{ SF} \times 0.12 \text{ CFM/sf} = 90 \text{ CFM outside air}$
- $26 \times 10 \text{ CFM/person} = 260 \text{ CFM outside air}$
- **Ventilation Effectiveness = 1.0**
- $(90 + 260) / 1.0 = 350 \text{ CFM total OA} - (\text{vs. } 438!)$



DISPLACEMENT VENTILATION



750 SF classroom with 26 occupants:

- $750 \text{ SF} \times 0.12 \text{ CFM/sf} = 90 \text{ CFM outside air}$
- $26 \times 10 \text{ CFM/person} = 260 \text{ CFM outside air}$
- **Ventilation Effectiveness = 1.2**
- $(90 + 260) / 1.2 = 292 \text{ CFM total OA} - (\text{vs. } 438!)$



VENTILATION SYSTEM CATEGORIES

- Single-zone system (example: unit ventilator)
- 100% outdoor air system (example: dedicated OA system "DOAS")
- Multiple-zone recirculating system (example: VAV System)

RSU-14 EXAMPLE

750 SF classroom with 26 occupants:
 $750 \times 0.12 \text{ CFM/sf} = 90 \text{ CFM outside air}$
 $26 \times 10 \text{ CFM/person} = 260 \text{ CFM outside air}$
Ventilation Effectiveness = 0.8
 $(90 + 260) / 0.8 = 440 \text{ CFM total OA}$



800 CFM
 25% OA =
 200 CFM OA
 Need 440 CFM!



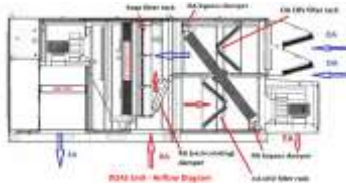
ENERGY RECOVERY

Performance Output *

System Component	WINTER		SUMMER	
	Energy	Water	Energy	Water
Energy Recovery Ventilator (ERV)	1000	0	1000	0
Variable Air Volume (VAV) System	1000	0	1000	0
...



RSU-14 : REMOVE OLD AIR HANDLER, NEW DOAS!



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ENGINEER'S PERSPECTIVE

Recommendations / Summary

- Follow ASHRAE 62.1-2016
- Look at % OA in system.
- Use energy recovery for new and retrofit

OWNER'S PERSPECTIVE



FACILITIES DEPARTMENT MISSION STATEMENT

To operate and maintain the RSU #14 properties in such a way that allows the instructional staff to focus solely on the educational deliverables without distraction from building systems or maintenance issues. This will be accomplished through planned maintenance, continued efforts to improve efficiencies, incorporating the latest energy saving technology and methods, and implementing long term solutions to operational or building issues.



INDOOR ENVIRONMENTAL QUALITY (IEQ)

Recent Efforts

- Dimmable and Programmable LED Lighting
- Upgraded DDC Controls
- Ventilation Improvements
- Expanded Preventative Maintenance



COVID 19

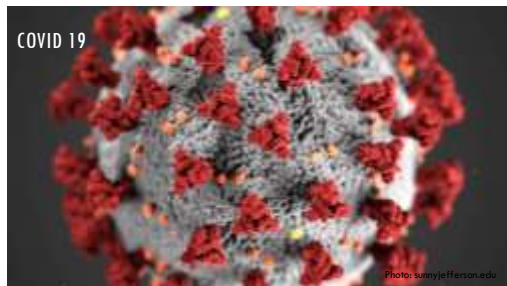


Photo: sunnyjefferson.edu

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WHY VENTILATION AND FILTRATION

- Existing CO2 Levels
- Measurable
- Controllable
- Seamless for Educational Staff
- Long Term Impact After Covid
- Opportunity to Reduce Energy Usage



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EDUCATIONAL STAFF

- Focus on Students
- Too Cold is 70
- Too Hot is 73



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2021 WINDHAM PRIMARY SCHOOL VENTILATION IMPROVEMENT

- Building Originally Constructed in 1989
- Kindergarten Through 3rd Grade
- Approximately 850 Students and Staff
- Building Size: 93,000 SF

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PRIMARY SCHOOL BUILDING HVAC

- Ventilation Systems
- Four VAV System with Central Air Handlers
 - Serving the Classrooms
 - One Constant Volume System
 - Serving the Gym and Cafeteria



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EXISTING SYSTEM CHALLENGES

Windham Primary School

Heating

- System struggled to heat during a design day while supplying the required fresh air
- VAV terminal units provide all the heat
- Poor temperature uniformity and swings

Cooling

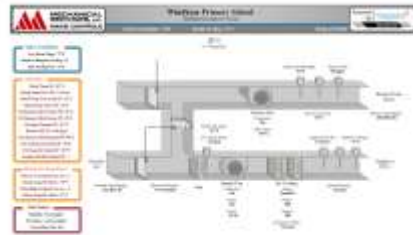
- System overloaded during a design day while providing the required fresh air
- Poor temperature uniformity



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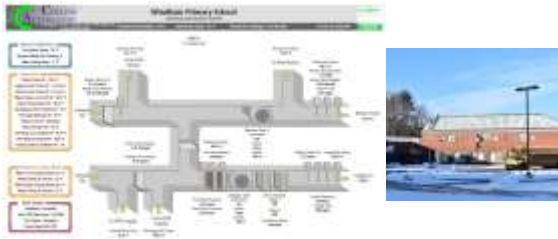
ORIGINAL VAV AIR HANDLER



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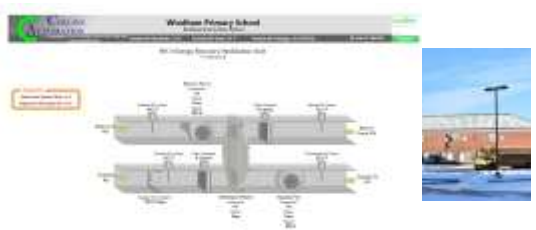
UPDATED VAV AIR HANDLER



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NEW ENERGY RECOVERY SYSTEM

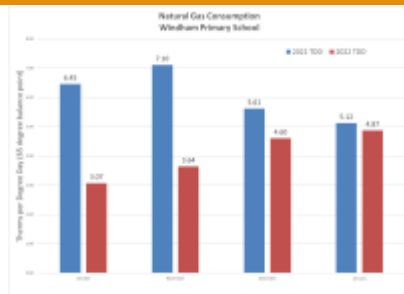


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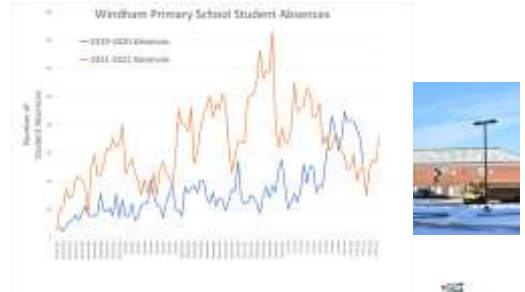
POST UPGRADE — WHAT HAPPENED?

How did the change impact operations and IEQ?



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2022 WINDHAM MANCHESTER SCHOOL VENTILATION IMPROVEMENT

- Building Originally Constructed in 1972
- Renovated in 2000
- Houses 4th and 5th Grades
- Approximately 450 Students and Staff
- Building Size: 52,000 SF

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EXISTING MANCHESTER SCHOOL BUILDING HVAC

- Three Roof Top Units with VAV - Classrooms
- One Constant Volume Roof - Gym
- One 1973 Indoor Unit - Cafe

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PROPOSED NEW MANCHESTER SCHOOL BUILDING HVAC

- Five DOAS System
- VAV for Classrooms, Offices, and Cafe
- Constant Volume for Gym
- Designed to Provide 34% to 62% Outside Air

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CONTRACTOR'S PERSPECTIVE



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PROJECT CHALLENGES

Windham Primary School

- Limited Downtime for Changes
- Space for New Equipment
- Delivery of Equipment
- Coordination with Trades



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LIMITED SPACE

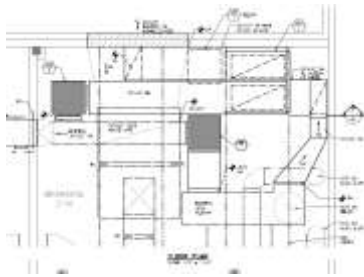
Existing Machine Room



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LIMITED SPACE

Machine Room with New Equipment



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LIMITED SPACE

Machine Room with New Equipment



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QUESTIONS?



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- Russ Martin, P.E. - M-Co Engineering Plus – Design of Primary School Upgrade
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- Collins Automation – Controls and BAS Vendor
- Sevee & Maher Engineers, Inc. (SME)/Environmental Safety & Hygiene Associates, LLC (ESHA) – IAQ Testing



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