

Colorado Springs School District 11 Facilities

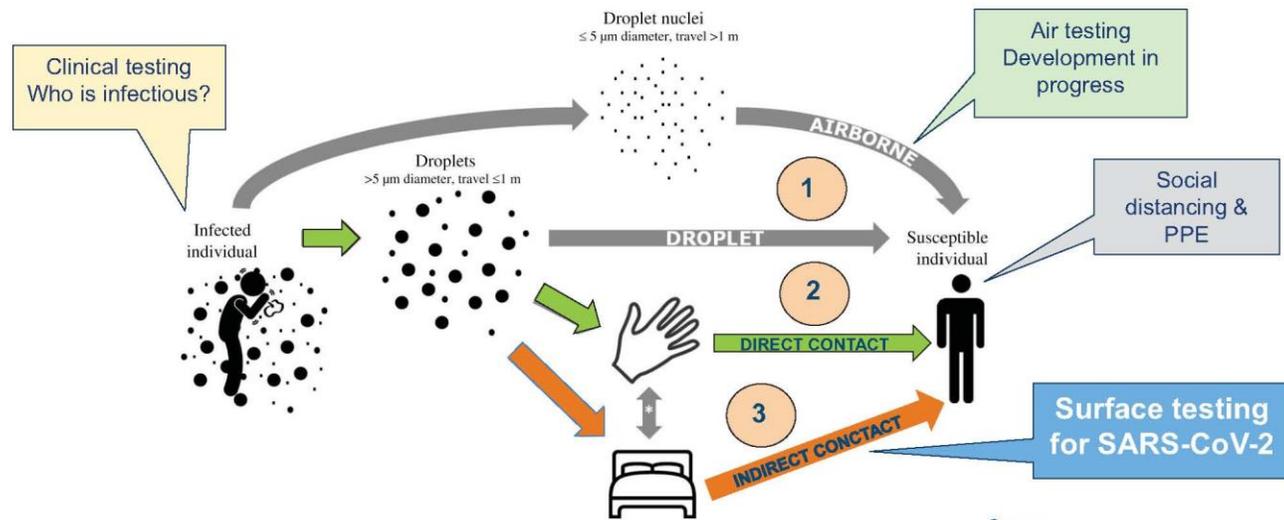
COVID-19 HVAC Strategy

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Capital Program Manager



Virus Transmission

SARS-CoV-2 Transmission



Source:
Otter et al., 2016, J. Hospital Infect.

Brought to you by TRC

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- Current data suggests main transmission vector is airborne

Topics

- Repair HVAC Systems
 - Ventilation Focused
- Increase Outside Air (OSA)
- Morning/Evening Purge
- Increase Filtration?
- Other Considerations
 - Disinfection
 - Humidity Control

Repair HVAC Systems

- **District-Wide HVAC Assessment**
 - Six teams of two (One BAS Operator and One Tech)
 - 8 business days
 - 4M square feet
- **Assessment Focus**
 - Outside Air Damper Operation/Condition
 - Return Air Damper Operation/Condition
 - Supply/Return/Exhaust Fan Operation
 - Controls Issues
 - Electrical Issues
 - Other Issues?

Repair HVAC Systems

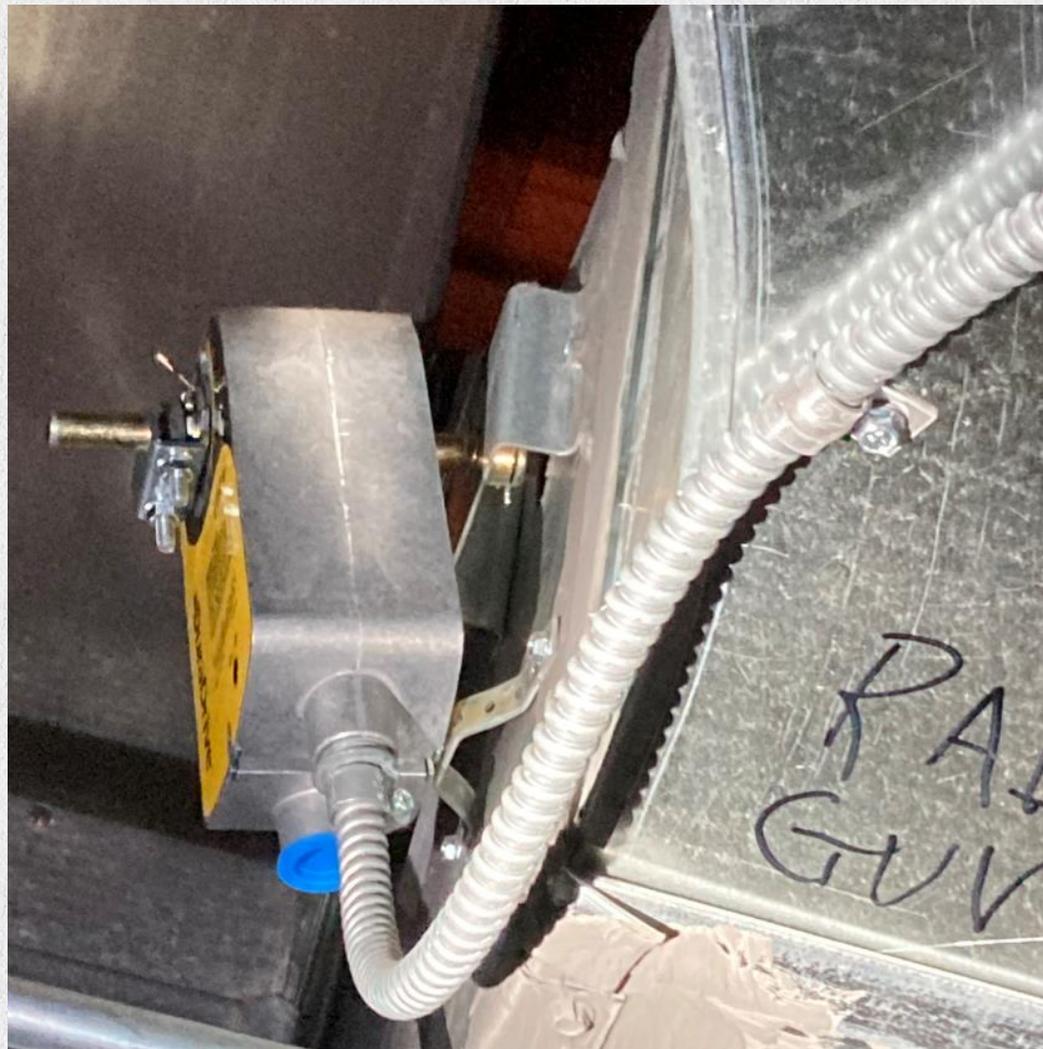
Coronado High School						
Room Numb	Labels from Floor Plan	Equipment ID	OSA Damper Working? 1 = Yes 0 = No	Equipment Issue?	Notes	
410	Classroom	MAU-S2	?	<ol style="list-style-type: none"> Exhaust pipe rotted off, need replaced. No power to controller, COM issue. Could not check operation. Scheduled to run 24/7. Change to 6 AM to 6 PM. 	Building B (I/A) Located on roof (from rm 403) in penthouse.	
413		MZU-S1	1	<ol style="list-style-type: none"> Outside Air says "Down". Scheduled to run 24/7. Change to 6 AM to 6 PM. 	Building B (I/A) Needs new Filters. Located on roof (from rm 403) in penthouse.	
413A		RTU-B1	1	<ol style="list-style-type: none"> Outside Air says "0.00F". SF Motor and belt need replaced. Motor smells like its burning. Found power off to unit. Scheduled to run 24/7. Change to 6 AM to 6 PM. 	Building B (I/A) Located on roof (from rm 403) in penthouse.	
500J		DE-3	1		Building D Located in Mezzanine on 2nd Floor. South Side.	
500K		DS-7	N/A	No Dampers	Building D Located in Mezzanine on 2nd Floor. South Side.	
501	Gymnasium	HV-2E	0	<ol style="list-style-type: none"> OSA Sensor is "Down". Unit is operational. One of two SF belts are worn out. Replace both belts. Dampers do not function. 	Building D Located in Mezzanine on 2nd Floor. North Side.	
501A		HV-2W	1	OSA Sensor is "Down". Unit is operational.	Building D Located in Mezzanine on 2nd Floor. North Side.	
502	Gymnasium	DS-2	0	Dampers do not operate. Pneumatics issue? Dampers do not operate. Pneumatics issue?	Building D Located in Mezzanine on 2nd Floor. North Side.	
502A		DS-1	0	OSA temp reads "Down".	Building D Located in Mezzanine on 2nd Floor. North Side.	
508		DS-6	0	Dampers do not operate. Pneumatics issue?	Building D Located in Mezzanine on 2nd Floor. South Side.	
509		DS-8	0	Dampers do not operate. Pneumatics issue?	Building D Located in Mezzanine on 2nd Floor. South Side.	
511	Classroom	DS-7	0	Dampers are not operational. Pneumatic issues?	Building D Located in Mezzanine on 2nd Floor. North Side.	
512		DS-9	1		Building D Located in Mezzanine on 2nd Floor. North Side.	



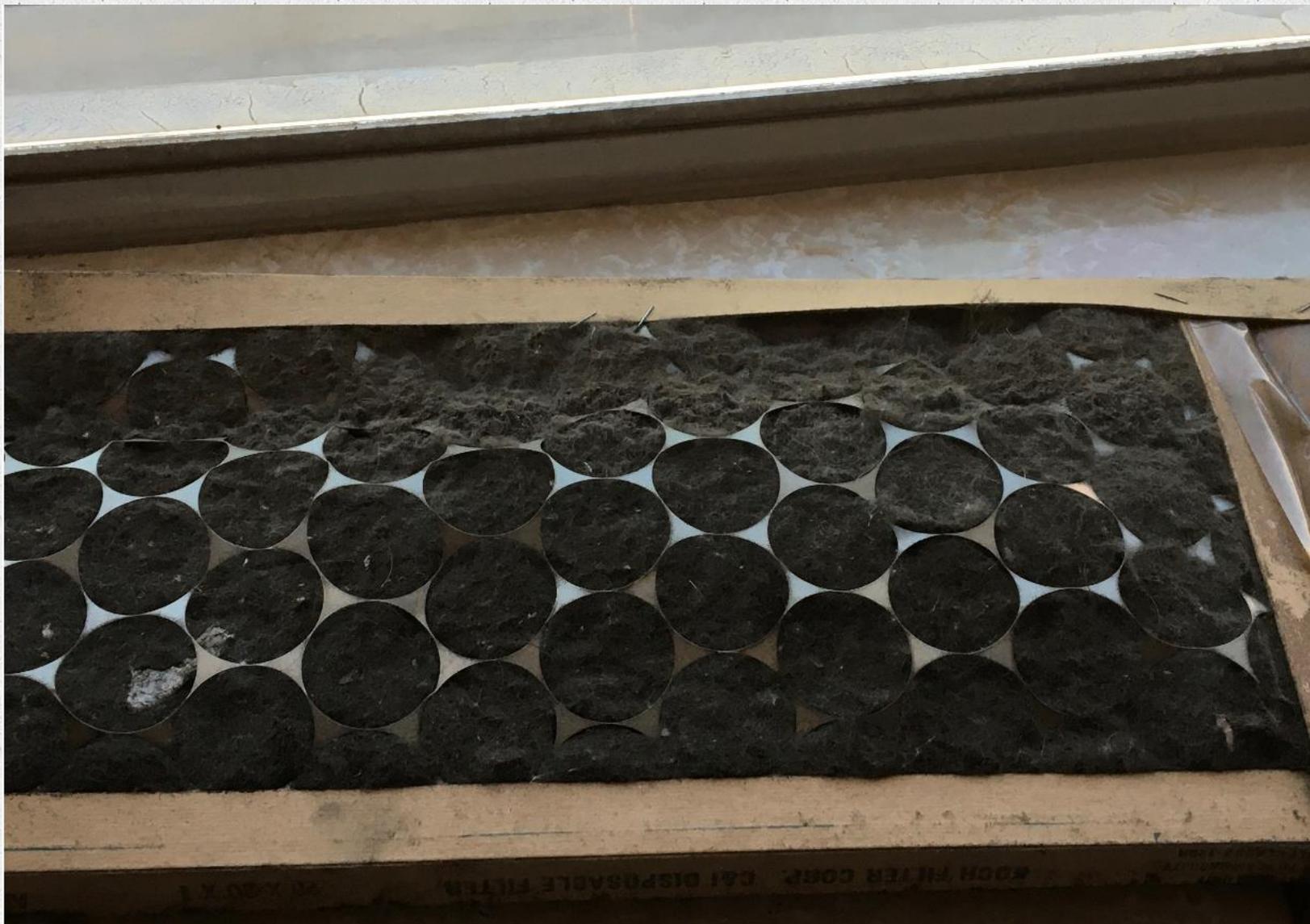
Repair HVAC Systems

- Start Repairing!
- Funding Constrained
 - \$\$\$\$
- Resource Constrained
 - Mechanical Contractors
 - Controls Contractors
 - In-House Technicians
- Prioritization Method
 - Elementary Schools First
 - Back Full Time
 - Full Student Load
 - Mask Compliance is Lower
 - Less Maturity (nose wipers)
 - Highest Occupancy per Square Foot

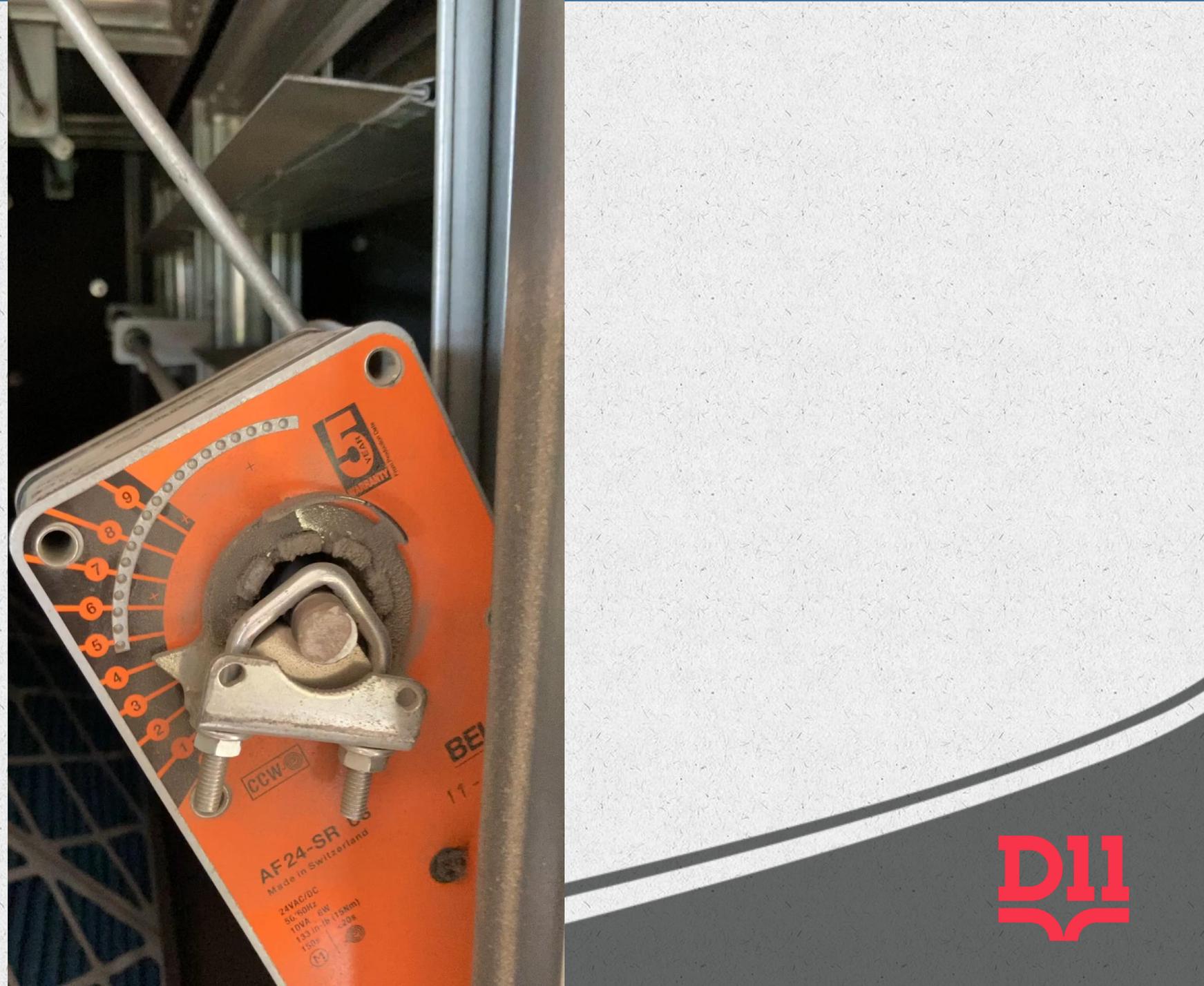
Repair HVAC Systems



Repair HVAC Systems



Don't be deceived

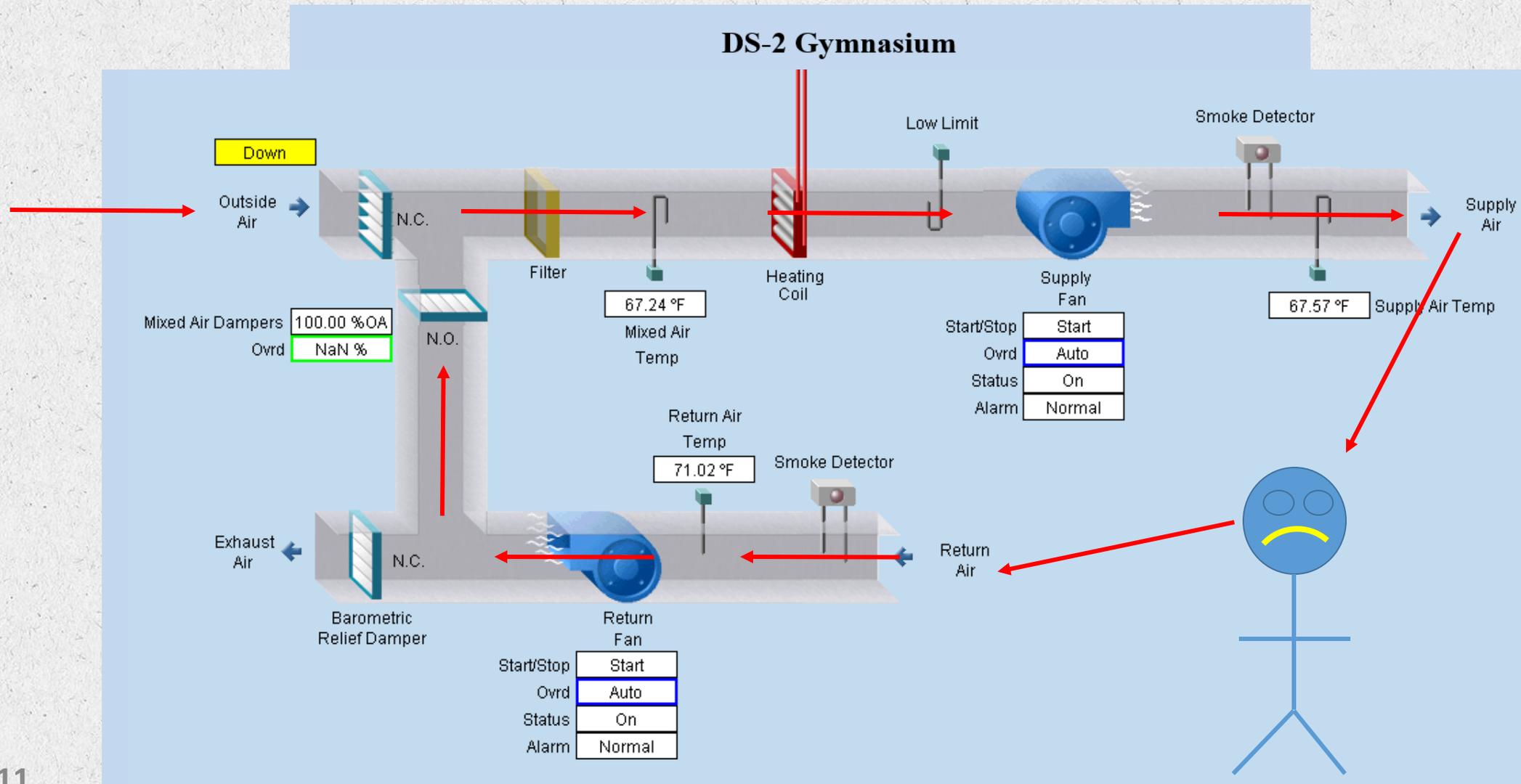


Increase Outside Air

Existing Functionality

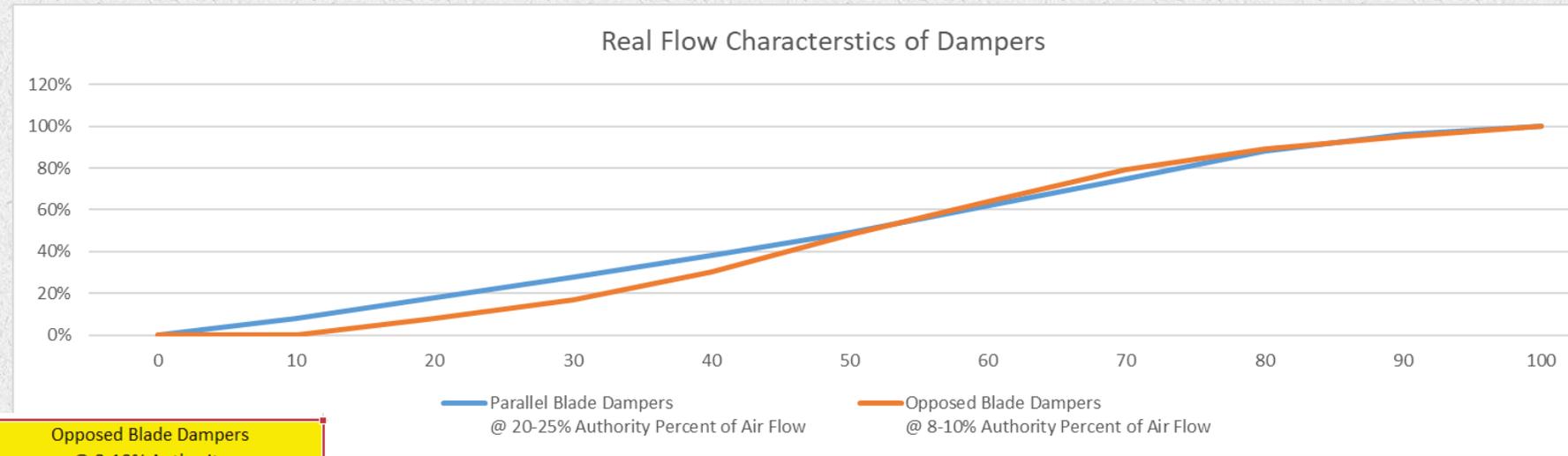
- This is a VERY generalized statement:
 - Our HVAC Systems provide a minimum 20% OSA while occupied.
 - Therefore, 80% of the air in a classroom is being recirculated.

Increase Outside Air



Increase Outside Air

- Question: How much more OSA will we get by increasing damper position?
- Damper Position vs Air Flow is not a linear equation (10% to 20% \neq x2)



	Parallel Blade Dampers @ 20-25% Authority	Opposed Blade Dampers @ 8-10% Authority
Percent of Damper Shaft Rotation	Percent of Air Flow	Percent of Air Flow
0	0%	0%
10	8%	0%
20	18%	8%
30	28%	17%
40	38%	30%
50	49%	48%
60	62%	64%
70	75%	79%
80	88%	89%
90	96%	95%
100	100%	100%

Increase Outside Air

Average Classroom	
900	Square Feet
10	Feet Tall Ceiling
9000	Volume (Ft ³)
31	Students + Teacher
10	CFM/Person
310	Minimum OA (CFM)
0.034	Air Changes / Min
2.067	Air Changes / Hour (ACH)

Assuming 20% open.

Existing Conditions

Where we landed
30% OSA
150% Increase
2 ACH -> 3 ACH

Increasing OA by x% Changes ACH to ->		
Percent of Damper Shaft Rotation	Parallel Blade Dampers @ 20-25% Authority	Opposed Blade Dampers @ 8-10% Authority
0	N/A	N/A
10	N/A	N/A
20	N/A	N/A
30	3.2	4.4
40	4.4	7.8
50	5.6	12.4
60	7.1	16.5
70	8.6	20.4
80	10.1	23.0
90	11.0	24.5
100	11.5	25.8

1.5x the design OSA

2.1x the design OSA

30% vs 40% Justification

Increase in OSA is still 1.5x

More likely to maintain space temp setpoint.

Schools without AC will be cooler.

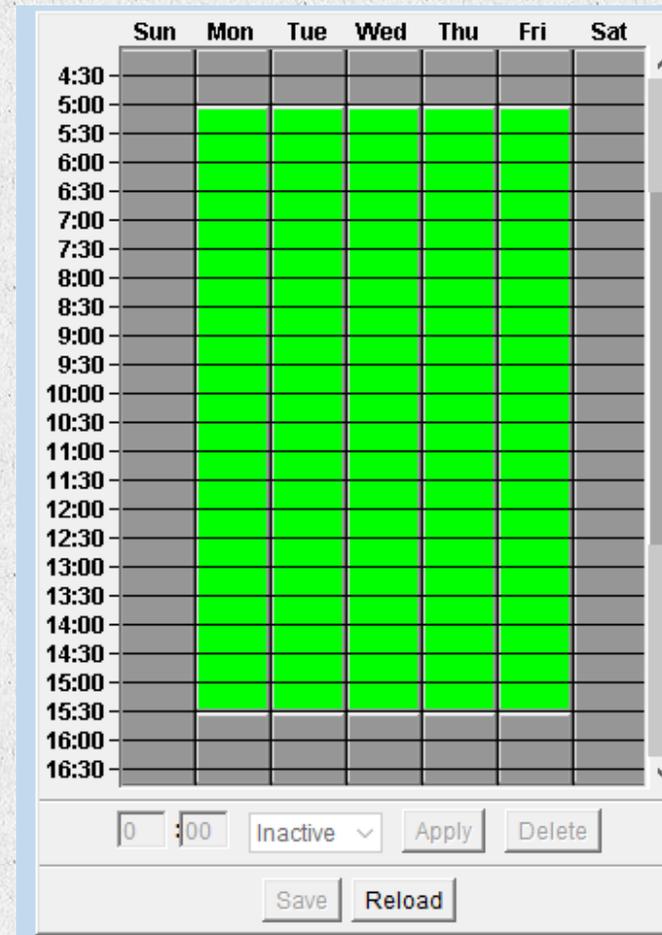
Equipment strain is lower: (1) extends the life of our equipment (2) lower outages (3) lower maintenance resource requirements.

Increase Outside Air

- How much is too much?
- Sacrifices of bringing in too much OSA:
 - Comfort level in the spaces
 - Design Day
 - Longevity of Equipment
 - Running it Harder
 - Reliability of Equipment
 - Outages = Zero Ventilation
 - Utility Bills
 - More electricity and natural gas
 - Building Damage Potential
 - Freeze Protection is Key
- Advantages
 - Decrease likelihood of viral transmission through respiratory droplets
 - Save lives?

Morning/Evening Purge

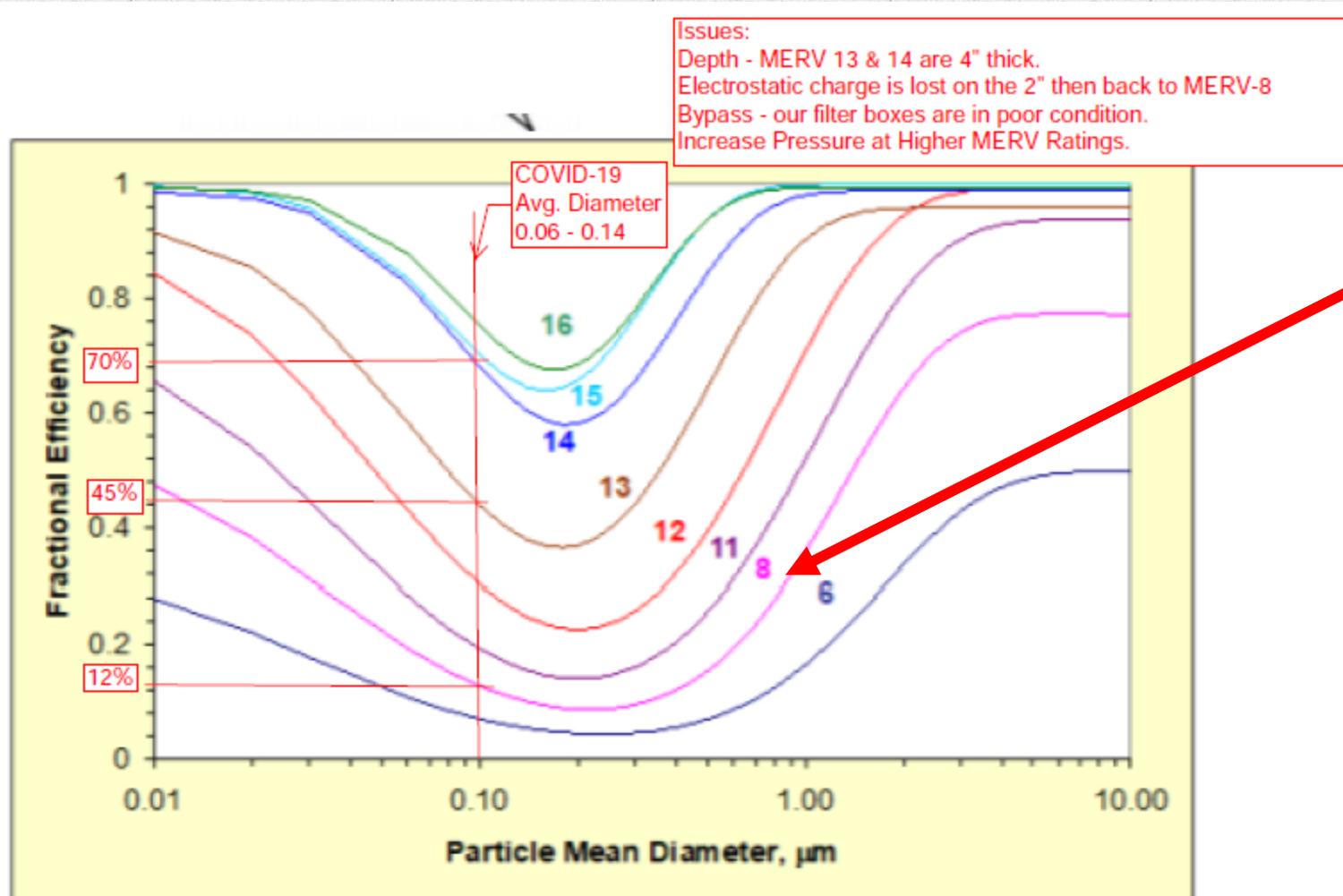
- Running Equipment in “Occupied Mode”
 - 2 Hours Longer at End of Day
 - 2 Hours Earlier at Beginning of Day



Increase Filtration?

MERV = Minimum Efficiency Reporting Value

- Existing filtration = MERV-8

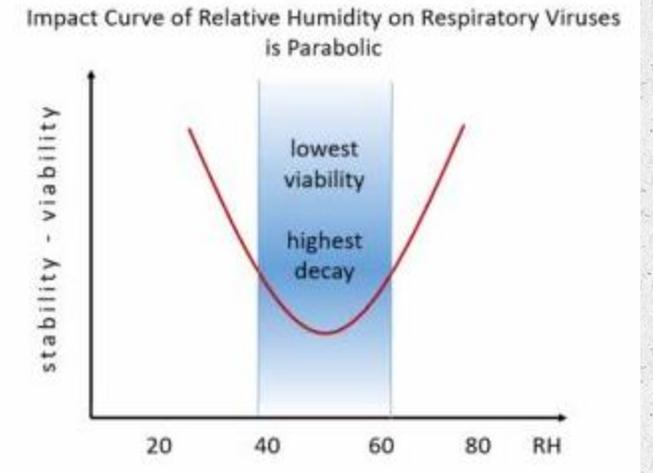
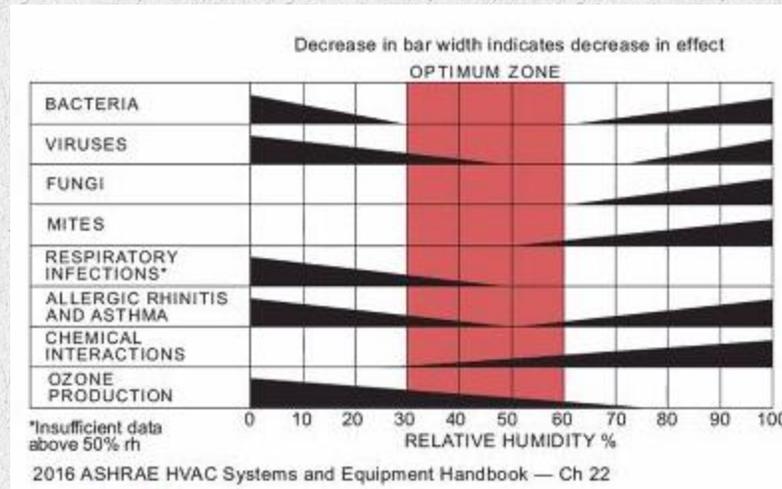


Increase Filtration?

- Decision:
 - Keep MERV-8 Filters
 - Replace filters 3 times this year (versus normal = 2).
- Challenges
 - Size/Fit
 - Filter boxes are not large enough for non-electrostatically charge MERV-13 filters
 - Higher Static Pressures on Fans/Motors
 - Increase failure, outages, financial constraints (maintenance + utilities)
 - Brake horse power on motors not (or barely) designed for 25% increase SP.
 - Bypass (around the filters) is high on our antiquated equipment
 - Increases with static pressure
 - Efficiency of Electrostatically Charged Filters is lost quickly
 - Funding
 - Resources

Other Consideration

- Considered the following, but financial constrained:
 - UV Light
 - In-line
 - Portable units
 - Bipolar Ionization
 - In-line
 - Portable Units
 - Humidification Control
 - Colorado Springs is in an arid climate.
 - In-line



Recap

- **Fix Existing HVAC System Issues**
 - Some ventilation is better than no ventilation...
- **Increase OSA from 20% to 30%**
 - Ensure Freeze Protection has priority to protect equipment and buildings
 - Monitor temperature control
 - Toggle Switch – Pandemic vs Normal Conditions – Pay Once
 - Shut of Demand Control Ventilation
- **Morning/Evening Purge**
 - 2 Hours Each
- **No increase in filtration rating**
 - Stick with MERV-8
- **Yes increase in filtration change frequency**
 - 3x per year versus 2x

For More Information

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Sources

- **Damper Shaft Position versus CFM**

- Johnson Controls, Damper and Actuator Manual 268.1, Damper Design Section, Engineering Report, Issue Date 0991

- **ASHRAE**

- EPIDEMIC TASK FORCE: SCHOOLS & UNIVERSITIES BUILDING READINESS GUIDE | Updated 5-5-2020
- 62.1 VENTILATION STANDARD
- INDOOR AIR QUALITY GUIDE
- FUNDAMENTALS HANDBOOKS