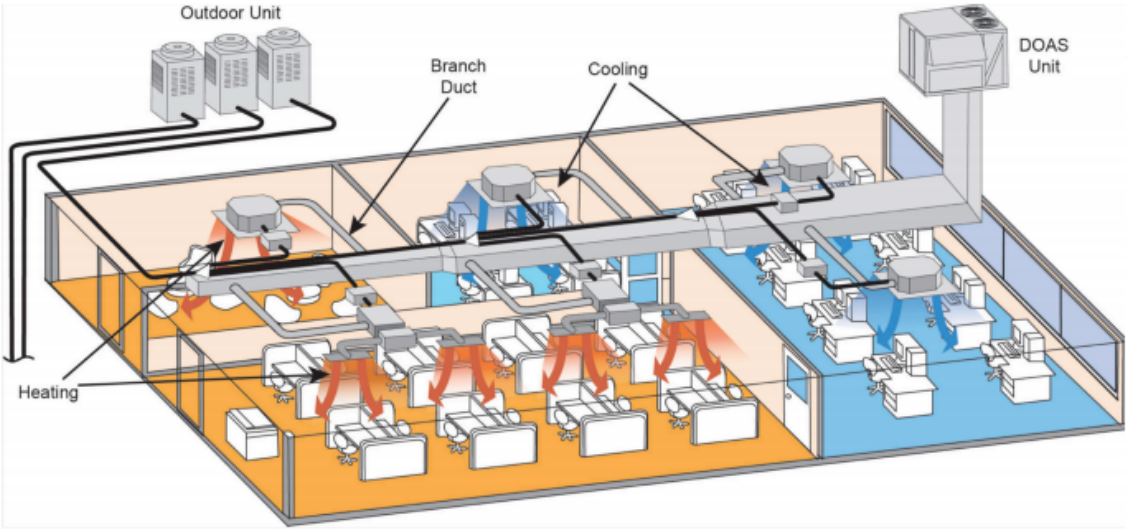
Option 3. VRF (Variable Refrigerant Flow) Heat Pump (All electric)

VRF System provides the ability for multiple indoor units or zones (such as Administration Building in a school environment) to operate on the same (outside condensing unit) system. VRF systems can design as a heat recovery system, which provides simultaneous heating and cooling to different interior zones. Interior unit types allow designer to select the best option for the space.



K-12 school classrooms are primarily conditioned by three different types of indoor units: high wall mounts, ceiling cassettes, and ducted air handlers. Pictured VRF equipment by Samsung, Mitsubishi Electric, and Toshiba Carrier.

This option has a single outdoor unit per building. Multiple indoor units connected to single outdoor unit. Sample indoor units are shown in image above. Units can be ductless (wall mounted or ceiling cassette) or ducted (vertical floor mounted or concealed ceiling suspended). Floor mounted unit can be installed in an enclosure or a closet as well.

Option 3 Advantages:

1. Electric **heating and cooling** costs can be **offset** by addition of solar to site. Equipment aligns with future **net-zero** energy direction.
2. Single outdoor **unit can be located outside building** in landscape or less traveled area. Does not require multiple outdoor units.
3. Heat recovery option allows **simultaneous heating and cooling** at indoor units.
4. One outdoor unit for multiple indoor units, saving space and installation costs while also improving the **building's external appearance**
5. **Better comfort controls for individual offices**. (Recommended to use in **Admin Buildings**)
6. **Less electrical connections** versus split systems
7. **The ability to use long pipe runs**, so the **outdoor units can be located in "out of the way"** places (i.e. places where architects and owners cannot see them)
8. Typically **very quiet outdoor units**
9. **Very quiet indoor fan** coils
10. **Sophisticated control**, offering modulated heating and cooling for better comfort
11. **Very high-efficiency heating**
12. **No requirement for gas piping, flues, and combustion air intakes within units**

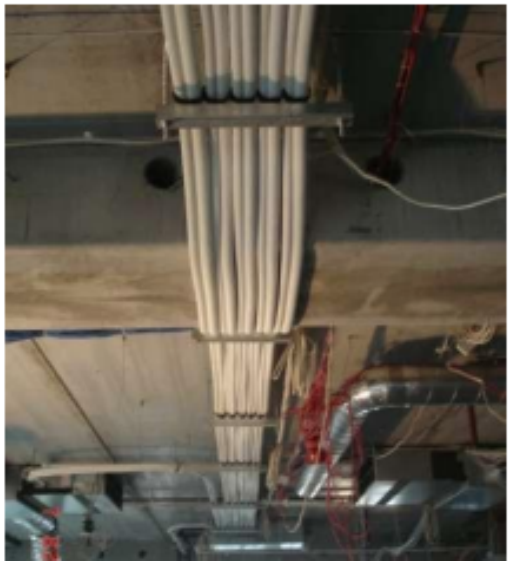
13. **No** requirement for outdoor **wall-mounted grille** as Airdale-type system
14. **Metering/usage capabilities** within the software so that individual rooms can be monitored their particular usage
15. Can be **controlled with BMS (Delta) or Pelican Controls**

Option 3 Disadvantages:

1. Units require **additional electrical power** and may require upgrades to electrical distribution in building.
2. **Units can be located on roofs**, but will require structural modifications to support weight.
3. **Large footprint**, requires more unobstructed area for installation.
4. Requires **branch selection box** to be installed inside building for refrigerant piping to indoor units.
5. **Not a good application** with systems that **require high outside air requirements in general**.
6. Recirculates air in room with minimum filtration. **Cannot accommodate MERV 13 filters**.
7. **Quality of installation.** The nature of VRF pipework, and specific installation requirements (which can vary between different manufacturers), makes the standard of the initial installation a crucial factor in the life expectancy of a VRF system. These are complex refrigeration systems that may have thousands of feet of pipework, hundreds of brazed joints, and hundreds of connecting joints, creating many opportunities for leakage. Linesets/Pipework must be supplied to the site cleaned and capped and must remain capped as long as possible. As soon as the installation of a section of pipe has been completed, it should be sealed again to minimize the entry of moisture.
8. **Special tools and techniques** are needed to tighten flare joints to correctly minimize the risk of leakage. Isolation valves with service ports should be fitted to the branch lines for each indoor unit, so that the unit may be repaired or moved without having to decommission and re-evacuate the whole system.
9. Figures below show a very poor standard of installation.

10. Cannot have economizer for free cooling or **CO2** ventilation control.

11. **Requires additional unit to provide outside air.** This also results in additional ductwork and roof/wall openings with the associated challenges of routing ductwork in building.
12. There will be many refrigerant lines between indoor units and branch controller



13. **Quality of Commissioning**. Completed systems must be thoroughly pressure tested, preferably before joints are insulated, to identify leaks
14. **Troubleshooting and Maintenance.** Location and detection of refrigerant leaks can be very difficult with VRF systems. Some factors contributing to this are that the systems tend to be quite large, so it can take weeks or months for a slow refrigerant leak to become apparent
15. **Physical leak detection is difficult** as the refrigerant pipes are insulated and is even harder where they are run in inaccessible or difficult to access spaces. Also, leaks on internal parts of equipment, such as indoor units, can be difficult to locate without disassembly

HVAC Filtration Options

The following filtration options are summarized in this report:

1. Mechanical Air Filters (MERV 13).
2. MERV 14-16 and HEPA Filters.
3. UV-C Air Disinfection.
4. Needlepoint Bipolar Ionization.
5. In-room portable scrubbers.

Option 1 – Mechanical Air Filters (MERV 13)

This option is the standard filter that is provided with HVAC units. The filter media is rated with MERV ratings which stands for Minimum Efficiency Reporting Value. Higher MERV ratings means increased filter efficiency in removing smaller particles.

The MERV rating is an efficiency rating and indicates the size of particles the filter can remove from the air passing through it. The higher the rating, the smaller the particle size it can filter. Ratings range from MERV 1 to MERV 16. As we observed during our site visits, the District upgraded all the filters in HVAC equipment to MERV-11.

ASHRAE recommendation is MERV 13 filters for K-12 schools.

Advantages:

1. Does not require any modification or power. MERV 13 filters can fit in existing filter racks in most units.
2. New units (e.g. Carrier 48JC) are planning to accommodate higher MERV rated filters and thicker filters to reduce pressure drop.
3. Meets code requirements and ASHRAE recommendations for filtration.

Disadvantages:

1. Commercial rooftop units cannot typically accept filters higher than MERV 13 (some equipment maybe able to be modified to accept MERV 14).

2. Most classroom furnaces can only handle MERV 8 filters. MERV 13 maybe possible but would push the limits of fan performance.
3. Higher MERV rated filters cause larger pressure drop and result in more fan energy being used by equipment if the equipment supplies the same amount of air.
4. Higher MERV rated filters get dirty faster and require more frequent replacement.

Option 2 – MERV 14-16 and HEPA Filters

Filters with higher MERV ratings can filter out finer particles from the air stream. Filters higher than MERV 13 are typically thicker than standard filter sizes. For example, pleated MERV 16 filters are commonly found in 12" thickness whereas standard equipment filters are 2" thick.

MERV 15 and MERV 16 filters are able to filter large numbers of smoke particles, which can be helpful in events of wildfire smoke. Bag filters can be used instead of pleated filters to help reduce the pressure drop.

HEPA filters are at least 99.97% efficient at filtering 0.3μm particles. Their efficiencies are better than MERV 16.

Due to the larger filter thickness for these filters, they cannot be installed in existing systems, and may not be feasible in retrofit applications in unitary systems (furnaces or packaged rooftop units). Typical packaged units or furnaces found in classrooms are not designed to accommodate these filters.

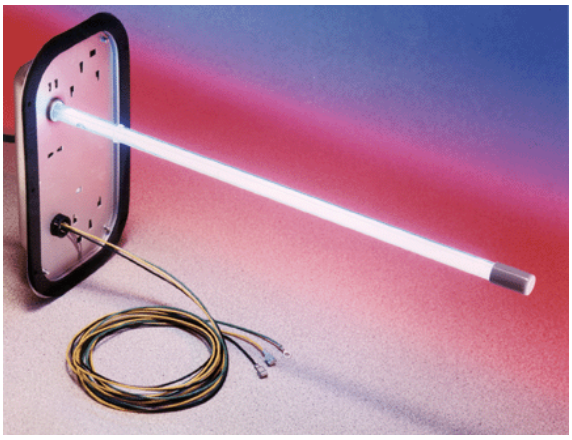
Advantages:

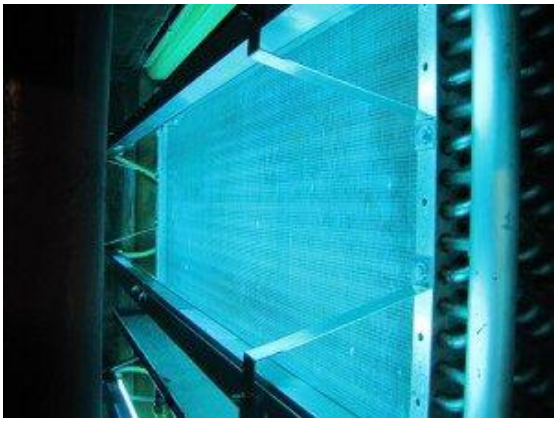
1. Most efficient filters.
2. Can capture bacteria and fluid droplets.
3. Does not require additional power.

Disadvantages:

1. Have very high pressure drops.
2. Are often delicate and require careful handling to prevent damage.
3. Cannot fit in standard commercial equipment, will require modifications to the system to allow them to be used in the HVAC system.

Option 3 – UV-C Air Disinfection





This option uses ultraviolet light to disinfect the coils and can be used to inactivate viral, bacterial, and fungal organisms.

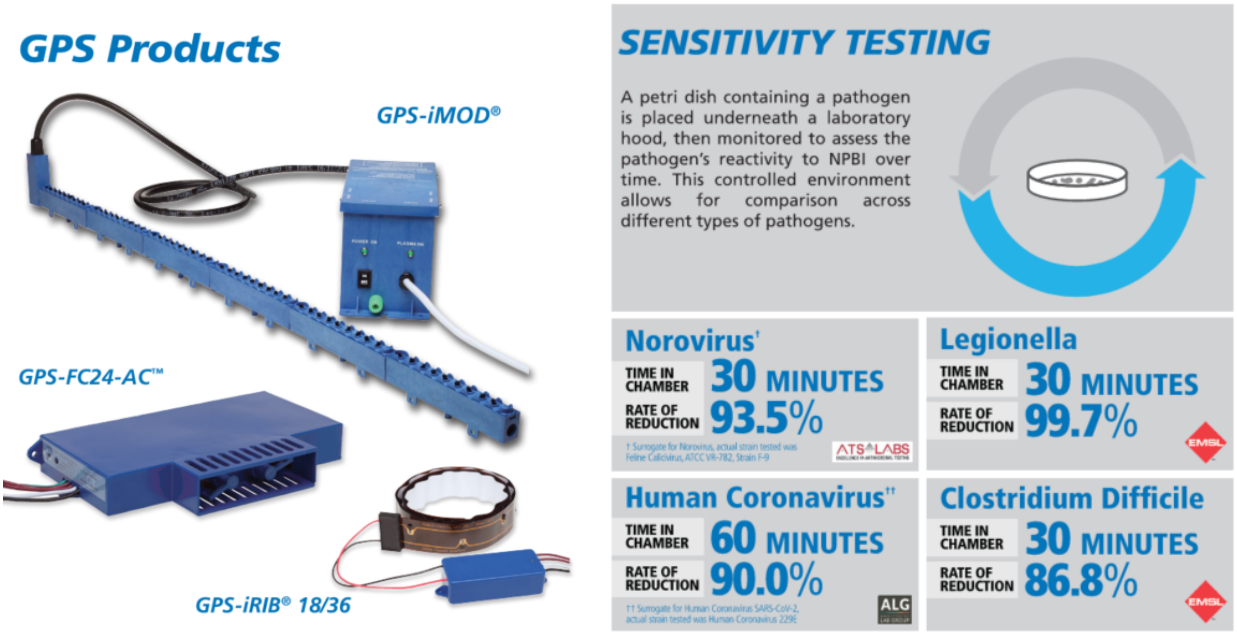
Advantages:

1. Minimal pressure drop on coil.
2. Maintains cleanliness and keeps coil disinfected and minimizes organic growth on coil.
3. Does not require excessive modification to system. Can be installed near evaporator coil.

Disadvantages:

1. Unable to provide enough exposure in moving air to effectively deactivate viruses. This would require large banks of UV light in the ductwork and extensive modification in ductwork to allow for installation.
2. Requires power for UV lights (in some cases, may be possible to get power from unit control board).

Option 4 – Needlepoint Bipolar Ionization



This option uses and electronic charge to create reactive ions which travel through the airstream. The ions help agglomerate (mix all the tiny particles stick together to form a bigger particle) fine particles, making them filterable. The ions also kill pathogens by robbing them of life sustaining hydrogen.

Note that above claims are made by equipment manufacturers and limited third party testing. Some of these technologies are relatively new and may not be time tested.

Advantages:

1. Does not require long exposure times like the UV lights. Ions travel in the airstream.
2. Minimal pressure drop added to system.
3. Does not require excessive system modification. Can be installed inside unit or return air duct.

Disadvantages:

1. Requires power. In some cases, it may be possible to get power from unit control board.
2. May require additional maintenance and replacement. With newer technology, life expectancy and frequency of maintenance and replacements is not yet fully understood.

Option 5 – In-room Portable Air Cleaning Devices

A portable air cleaning device recirculates filtered air in the room. These devices are equipped with HEPA filters for removal of particles as small as 0.3 microns, activated carbon filters for odor removal, and washable pre-filter to remove larger particles and prevent clogging of the HEPA filters.

Advantages:

1. Portable unit can be easily moved to any classroom.
2. Runs on 120V power, readily available in all rooms.
3. Unit configured with HEPA filters (most efficient).
4. Does not require any modifications to the existing HVAC system.

Disadvantages:

1. Takes up additional floor space in the rooms. Some classrooms may require multiple units.
2. Can be loud at a higher speed.

Demand Control Ventilation (CO2 Sensors)

Demand Control Ventilation (DCV) refers to the control of fresh air ventilation based on CO2 levels within the conditioned space. It is an attempt to supply higher levels of ventilation when there are more people in the space triggering greater demand for fresh air, while lowering ventilation when the level of occupancy drops. The benefit of this approach is to save energy by not having to condition larger amounts of outside air when there are fewer people in the space. In such instances, more air that has already been conditioned is recirculated, reducing the load on HVAC equipment and thus reduces the amount of energy consumed.

California code requires DCV controls in large rooms, especially areas that experience frequent changes in occupancy level. Examples of such areas include conference rooms, assembly areas, gymnasiums, etc. With the most recent change in the energy code (2019), DCV is also required for all classrooms when the HVAC system is equipped with an economizer. An economizer is an optional component that uses cool outside air to cool the building instead of operating the air conditioning compressor.

Due to COVID-19, current ASHRAE recommendations call for disabling DCV, because the DCV response time to adjust outside airflow is slow. The room must be occupied with many people before the CO2 levels rise and only then does the rate of ventilation increase to reduce the CO2 levels below setpoint. Because of this lag in response, ASHRAE recommends always running systems at higher ventilation rates during this pandemic, causing equipment to use more energy.

It should be noted that California Energy Code still has DCV (CO2) requirement and any new design must comply with this provision even if current recommendations are to disable the system temporarily.

Monitoring the amount of Carbon Dioxide (CO2) that accumulates from human respiration can be a reliable way to ensure that adequate fresh air is provided in classrooms. Newer HVAC systems can monitor the amount of CO2 concentration continuously and via economizers adjust the amount of fresh air to maintain the volume required by the building code. The majority of the SMFCSD's classroom mechanical systems currently do have CO2 monitoring capability through the Energy Management System (EMS) but lack the automatic capability to adjust the amount of fresh air. If it is programmed to do so, EMS systems can send an alarm to maintenance personnel but building users cannot hear this alarm.

There are short-term option of using stand-alone CO2 monitors that have an audible alarm, alerting both the teaching and maintenance staff so that they could carry out corrective measures. Teachers could simply open windows and doors to provide more natural cross ventilation. If the problem is chronic, maintenance staff could manually adjust the fresh air dampers further. We recommend installing stand-alone CO2 monitors with alarms set to maintain a maximum concentration of 1,100 parts per million (PPM) of CO2.

See attached specification for the stand-alone CO2 monitoring systems.

Home / Autopilot Desktop CO2 Monitor & Data Logger

Autopilot Desktop CO2 Monitor & Data Logger

SKU: [HF-APCEM2]

OUR PRICE: $119.99

- or - As low as $20/month PayPal CREDIT Get 6 months to pay on $99+

List Price: $139.99

Email to a Friend

In Stock

Delivers in 2-7 Business Days

100% Discreet Shipping

Best Price Guarantee

Availability: In Stock

Qty: 1 Add to Cart

Add to Wishlist Add to Compare

Frequently bought together

Customers who bought this product also commonly purchased the following combination of items.

This Item: Autopilot Desktop CO2 Monitor & Data Logger

Product Description | Customer Reviews | Questions | Best Price Guarantee

Accuracy, innovative features, and unbeatable affordability in one small, user-friendly CO2 monitor. To deliver its measurements, the Autopilot APCEM2 Desktop CO2 Monitor features a clear display system that boasts a digital chart of memory-logged CO2, relative humidity, and temperature readings over an adjustable 24-hour or 7-day period. With the industry-new feature Trend Chart, the device is able to trace the above quantities through past minutes, hours, or up to 7 days.

The Autopilot APCEM2 Desktop CO2 Monitor is patent pending, featuring a hook-and-loop fastener along the back that can securely affix a rectangular external battery pack. By maximizing mobility, the device can be easily moved to any room—living room, kitchen, office—to monitor IAQ virtually anywhere. The Autopilot APCEM2 Desktop CO2 Monitor can be powered by almost any standard USB port that provides power, such as a laptop, a wall adapter, or an external mobile battery pack (PowerBank). Battery pack not included.

Features:

- CO2/RH/Temperature monitor on a clear display
- Trend Chart: shows variable Min/Hr/Day/Wk for readings of CO2/RH/Temperature
- 2-Channel Low Drift NDIR (non-dispersive infrared) Gas Sensor
- Audible alarm for low/high CO2 levels
- Alarm function for environmental extremes
- 3 Multicolored LEDs for Easy Reading
- Built-in directory of common plant types of their general CO2 requirements; two slots for custom plant inputs
- Replenish CO2 Reminder: calculates time frame based on usage from past 5 days
- "Green" Power Supply that is compatible with a standard smartphone charger
- View charts as weekly, daily, hourly, or per minute
- Additional settings measure air quality for breathing
- PPM settings for tomatoes, cucumbers, and more
- Multiple options for hanging, mounting or desktop display
- Comes with two Micro USB Cables for power
- USB AC adapter

Conclusion and Recommendations

For the predominant existing conditions, which are the wing-style classrooms with in-room furnaces, we recommend replacing them with all-electric split-system heat-pumps in the same locations. We also recommend upgrading the existing sheet-metal enclosures to site built framed enclosures, which improve sound isolation and make maintenance easier by using conventional doors that can be master keyed (Renovation option 1B). Heat-pumps are all-electric equipment and give the District a head start in achieving its Zero-Net-Energy goals. We recommend adding ductwork to provide better air distribution, improve thermal comfort and reduce noise level further. Currently, there is only a supply plenum with register(s).

Where rooftop HVAC units currently exist, we recommend replacing them with newer and more energy-efficient rooftop units in the same locations. This like-for-like replacement is the simplest and least expensive option as the supporting infrastructure is already in place.

We recommend replacing in-kind wall heat-pumps (Bard Units) with updated refrigerants with better filtration for school sites listed in FMP study.

In cases where HVAC units serve multiple offices or classrooms, we recommend a central VRF (Variable Refrigerant Flow) exterior unit with separate interior units with dedicated outside Air Supply (DOAS) system for ventilation. This option will always provide each space with its own comfort controls and code-required ventilation air. These systems are already in use in the Administration Buildings at Foster City ES, Fiesta Gardens International School and Parkside Montessori ES.

We recommend replacing all existing air filters with MERV 13 air filters. This will bring filtration standards to code-required level and in-line with ASHRAE recommendations. This may not be possible at some existing units, because it may degrade the system's performance. Testing these units is advised to determine whether they can accommodate the higher-level filters.

Where Merv-13 is not possible to use in existing equipment, other technologies such as bipolarization are available to improve filtration capabilities of the current MERV-11 filters. Product manufacturers states that with the addition of this system, lower-level filters can perform at a higher level, equivalent to MERV-13. We recommend adding this bipolarization technology (Option 4) when the equipment cannot accommodate MERV-13.

All new equipment should be designed with MERV 13 filters as a minimum requirement. New equipment can also be selected with factory antimicrobial coatings such as Carrier Agion.

We also recommend portable air cleaning devices (option 5) in classrooms that are occupied. This option allows for quick deployment since it does not require modifications to the buildings. These portable units can be easily moved to where they are needed. The District has already purchased these units and they should be implemented in occupied rooms. Some rooms may require multiple units to ensure proper coverage.