(M) Airdale Units (All electric packaged heat pump)

Sunnybrae ES

Inside view of Airdale Units

(N) Airdale Units with Gas Heating

Turnbull Children Center

(O) Bard Units (Wall Heat Pumps)

Exterior Bard Units

All portable buildings are served by wall-mounted (interior or exterior) heat pumps (Bard Units)

Most of the Bard units are aged and use outdated R-22 refrigerant.

Interior Bard Units (A/C) Model Qtec

All portable buildings are served by wall-mounted (interior or exterior) heat pumps (Bard Units)

Laurel ES

Sunnybrae ES

Modular classrooms are served by wall-mounted (interior or exterior) heat pumps (Bard Units)

Exterior Bard Units

Sunnybrae ES

Design Considerations

There are many different types of HVAC systems across the District's sites. The most common systems are: (A) Classroom Furnace Enclosures, (E) Packaged Rooftop Units in permanent buildings and (O) Bard Units (Wall-mounted Heat Pumps) at portable classrooms. Other types of systems are shown with photos in the previous section.

In evaluating the available options for HVAC and air filtration and deciding the most effective solutions, we have taken the following into consideration.

1. The existing predominant arrangement with furnaces inside enclosure in the classrooms is a convenient and economical approach. The drawbacks of this arrangement are that maintenance personnel are required to enter the classrooms to service this equipment. The furnace enclosure also takes up floor space that could be used for instructional purpose.
2. Changing the sheet metal furnace enclosures that are present at most campuses to a site-built, framed and drywalled (such as at Foster City ES) is a superior approach in providing better acoustic separation. Additionally, a conventional door can be equipped with conventional hardware, which can be master keyed to avoid the need for a special key.
3. We recommend adding ductwork to provide better air distribution within the space, improving thermal comfort and reducing noise level. Currently, there is only a single point of supply and return at the enclosure itself.
4. Adding A/C to a furnace requires a cooling coil and an exterior condensing unit. There is usually no convenient place to place the condensers on the ground, as they would impede student traffic and require protection from vandalism. Placing them on the rooftop is the most feasible option.
5. There may not be enough existing electrical power to serve all the new air conditioning equipment and power to the site in many cases will require upgrading.
6. Gas-fired equipment requires a Carbon Monoxide (CO) monitoring system.
7. Adding rooftop units on the existing roof may require structural upgrades and permanent roof access. Existing roofs in wing style buildings do not have permanent roof access. Having HVAC equipment on the roof will not require maintenance personnel to service the units without entering classrooms.
8. Changing the unit location may require Building Management System (BMS) controls wiring to be redone, this may increase the cost.

Options for Adding Air Conditioning and Upgrading Existing HVAC

The best options to meet the District's needs are listed below. Detailed explanations of each option with their associated benefits and disadvantages are on subsequent pages.

Option 1: In classroom, site-built, framed enclosure

A. Gas heating and Electric cooling
B. All Electric Equipment

Option 2: Rooftop Packaged Units

A. Gas heating and Electric Cooling Equipment
B. All Electric

Option 3: VRF (Variable Refrigerant Flow) Unit for Admin Buildings

Option 1: In-classroom, site-built, framed enclosure

The following photo on the left is from a non-SMFCSD school site. It shows a site-built framed enclosure with a full height conventional door and conventional hardware. The return register from the classroom is at the top of the door, which reduces chances of items being placed in front of it and blocking airflow, which is a possibility with return registers at the bottom.

The photo on the right shows a site-built framed enclosure at Foster City Elementary School. This configuration has a half door with a return plenum at the bottom.

A. Mixed-fuel (gas heating, electric cooling)

This option includes a gas-fired furnace with a cooling coil on top of the furnace and condensing unit outside. Refrigerant piping is connected between the outdoor condensing unit and the cooling coil. A high efficiency furnace can be selected and would need additional condensate neutralizer.

This option would allow existing furnaces to be replaced in kind with cooling coils and condensing units added to provide air conditioning.

B. All Electric Equipment

This option includes a fan coil that is connected to an outdoor heat pump with refrigerant piping. Both heating and cooling are provided by the electric compressor.

The heat pump stand can be an economizer assembly as shown in image (free cooling when the outside air conditions are cooler than inside conditions).

Option 1 Advantages:

1. Condensing units that provide A/C for the interior HVAC equipment can be located **in any outside locations.**
   a. Concrete slab
   b. Landscape area
   c. Roof
2. **Ductwork** can be exposed, above ceiling, or in soffit space as appropriate for the space.
3. Can accommodate **MERV 13** filters
4. **Multiple condensing units can be located in the same area**.
5. **High efficiency heating and cooling** units can be selected.
6. **Outside air opening required is fairly small** for the minimum required ventilation rates.
7. An **Economizer** can be field-installed for free cooling when weather conditions permit (would require larger outside air opening and an opening for relief air).
8. Economizer can be used for **CO_2** ventilation control.

Indoor Unit (Gas heating/Electric cooling)	**All Electric**
1. Existing gas piping for furnaces can be used. 2. Furnaces provide **higher heating capacities** without having to increase the size of cooling units. 3. **High-efficiency** condensing furnaces can be chosen. 4. **Simple system**; most contractors and maintenance staff are familiar with equipment.	1. Does **not require** combustion air or flue penetrations. Condensate neutralizer is **not required**. 2. Electric **heating** and cooling costs **can be offset by addition of solar to site**. Equipment aligns with future **net-zero energy** direction. 3. Systems typically allow longer refrigerant pipe lengths compared to furnace/cooling coils, opening up more possibilities for outdoor unit locations.

Option 1 Disadvantages:

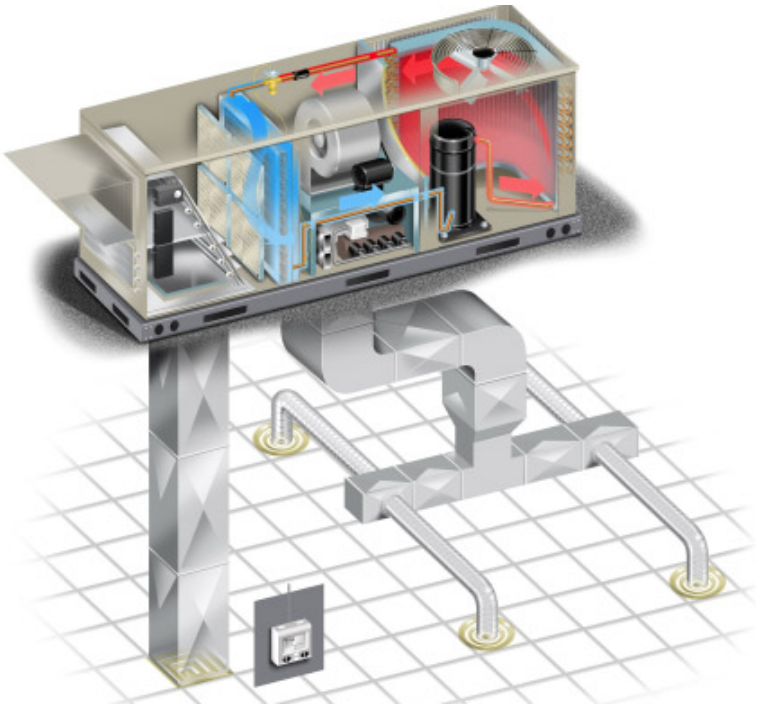
1. Condensing units require **additional electrical power** and may require upgrades to electrical distribution in buildings.
2. Maintenance to the equipment requires **maintenance personnel to be in the classrooms**. School schedule and maintenance personnel work times overlap most of the day.
3. Units take up **floor space** in the classroom, which is currently the case.
4. There may not be a good **place to add condensing units outside on either side of the classrooms** as there are walkways under the overhangs. There may not be landscape areas around the classroom wings on some sites. However, condensing units can be placed on the roof.
5. If multiple condensing units are located away from the classrooms, **farther classrooms require longer refrigerant runs.**

Mixed-fuel Indoor Unit (Gas Fired Heat / Electric Cool)	All Electric
1. Classrooms require **Carbon Monoxide (CO) monitoring**. 2. Furnace would require **combustion air and flue vent piping penetrations** through roof. Most of the SMFCSD cases existing penetrations can be used. 3. High-efficiency furnace would require **condensate neutralizer kit** that would have to be maintained. 4. Use of gas for heating does not align with future **net-zero all electric equipment**. Addition of solar to site would be unable to offset gas costs for heating.	1. Larger capacity units would have to be selected to account for heating loads (**heating capacities derate in colder conditions**) 2. Additional **supplementary electric heat** may be required. Further **increasing the electrical load**.

Outdoor unit options

Note that all the manufacturers have similar units.

Option 2: Rooftop Packaged Units



A packaged rooftop unit is fully self-contained and consists of a supply fan, direct expansion cooling coil, filters, compressors, condenser coils and condenser fans. Supply and return air ducts connect at the bottom (vertical discharge) or on the side (horizontal discharge) of the unit. Units are typically mounted on roof curbs but can also be mounted on other types of structural support.

Heating is typically provided by gas fuel and heat exchanger within the unit. An all-electric heat pump configuration is also an option where the compressors, refrigerant, and direct expansion coils are used to provide both cooling and heating.

The most common configuration is to use a separate packaged rooftop unit for each classroom. This design allows individual rooms to have separate temperature control or to be part of a centrally managed EMS system. Common options for these units are economizers, powered exhaust, and corrosion protection for marine climates. Economizers are often a standard, cost-effective option. Powered exhaust fans are often specified for classrooms to avoid excess indoor space pressure.

Option 2 Advantages:

1. **Frees up floor space inside** the room.
2. Maintenance can be performed **without interrupting classrooms**. All access is on the roof.
3. **Higher efficiency** units can be selected.
4. **Economizers** can be factory-provided for free cooling when weather conditions permit..
5. Allows for **CO_2** ventilation control.
6. **Simple system.** Most contractors and maintenance staff are familiar with equipment.

 WeatherExpert® Ultra High-Efficiency Single-Packaged Rooftop Units 48LC	 WeatherMaster® Single-Packaged Rooftop Units with EcoBlue™ Technology 50GCQ
Rooftop Packaged Unit Mixed-fuel (Gas heating/ Electric cooling)	**Rooftop Packaged Unit (All Electric)**
1. Provide **higher heating capacities** without having to increase overall unit size. 2. Gas heating capacities not affected by outdoor temperature.	1. **Electric cooling and heating costs** can be offset **by addition of solar to site**. Equipment aligns with future **net-zero** energy direction. 2. **CO** monitoring will not be required.

Option 2 Disadvantages:

1. May require **structural upgrades** to the roof to support the weight of these units. This option is most suited to replacement applications where there are already rooftop units or new buildings. Rooftop units are heavier than the floor mounted units, since all the parts of the refrigerant system and heating system are in one box. All the piping connections for the mechanical system are inside the box.
2. **Requires access to the roof.**
3. **Sloped roof buildings** require additional curb structure to mount units. **Some cases may not be possible**
4. **Outside Equipment**: With every control, electrical wire, and coil located outside, the packaged system endures harsher conditions than an indoor unit. Corrosion may happen after some years. **Protective coating** shall be used at locations close to the ocean environment.
5. Units require **additional electrical power** and may require upgrades to electrical distribution in building.

 WeatherExpert® Ultra High-Efficiency Single-Packaged Rooftop Units 48LC	 WeatherMaster® Single-Packaged Rooftop Units with EcoBlue™ Technology50GCQ
Rooftop Packaged Unit (Gas heating / Electric cooling)	**Rooftop Packaged Unit (All Electric)**
1. Use of gas for heating does not align with future **net-zero** all electric equipment. Addition of solar to site would be unable to offset gas costs for heating. 2. A packaged system is not as energy efficient when it comes to heating. Heating efficiency if the **gas fired package units are around 80%.** Condensing Furnaces can go up to 98%. 3. Classrooms require **Carbon Monoxide (CO) monitoring**	1. **Larger units would have to be selected** to account for heating loads (**heating capacities** derate in colder conditions). 2. **Additional supplementary electric heat may be required**. Further increasing the electrical load.