HILLCREST MIDDLE SCHOOL

HEAT MITIGATION STUDY

Prepared for Gravenstein Union School District

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AGENDA & GOAL

- Introductions & Roles
- Overview Of Issue
- Recommendations
- Covid-19 Impacts
- Conclusions
- Next Steps

GOAL:

Get District and Staff feedback on recommendations for final report and implementation

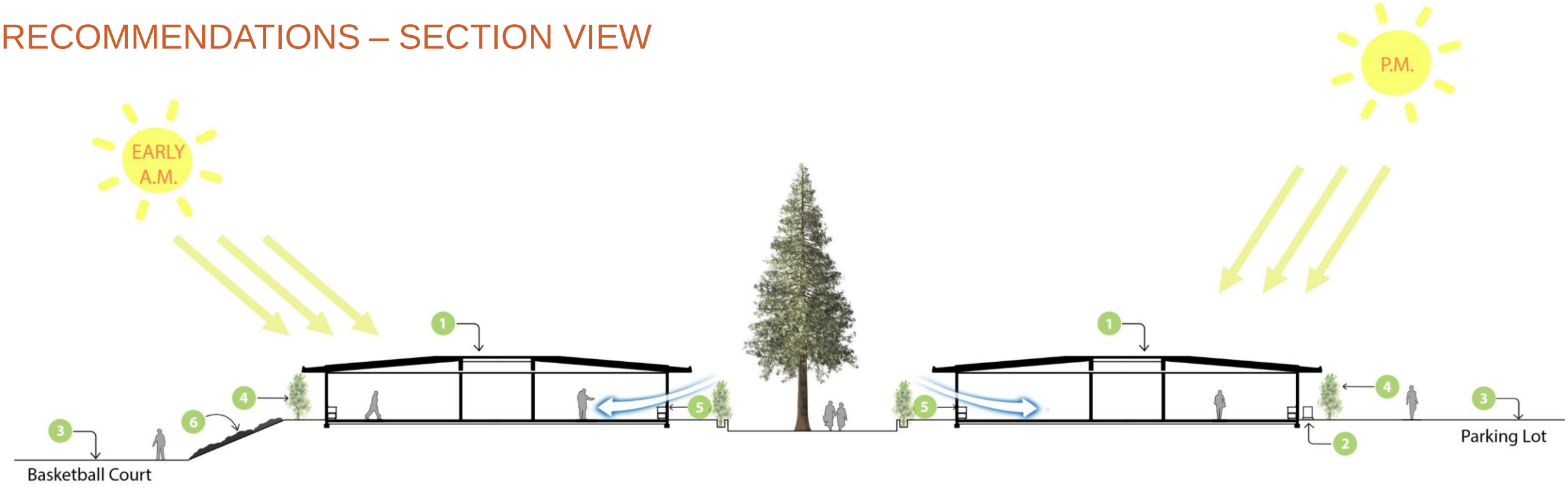
Overview

RECOMMENDATIONS – AERIAL VIEW

1. NEW HIGH REFLECTIVE ROOF AND INSULATION
2. MECHANICAL IMPROVEMENTS (3 LEVELS)
3. HEAT REFLECTIVE COATINGS FOR THE AC PAVING AREAS
4. PLANTING ALONG THE EAST AND WEST WALKWAY
5. ENVELOPE IMPROVEMENTS (2 LEVELS)
6. IRRIGATION FOR WEST SIDE HILL

NORTH

RECOMMENDATIONS – SECTION VIEW



1 **NEW HIGH REFLECTIVE ROOF AND INSULATION.**
- DETAILED IN THE RAMP REPORT FROM GARLAND
- ROOF IS LIKLEY IN NEED OF REPLACEMENT REGARDLESS OF HEAT MITIGATION EFFORT

2 **MECHANICAL IMPROVEMENTS (3 LEVELS)**
- LEVEL 1
  - TEST AND REPROGRAM EXISTING HVAC SYSTEM, NIGHT FLUSH AND REPAIR AS NEEDED
- LEVEL 2
  - VRF OR PACKAGE UNITS (MAY HAVE ELECTRICAL IMPACT) ★
- LEVEL 3
  - ADDITIONAL FILTRATION FOR IMPROVED IAQ

3 **HEAT REFLECTIVE COATINGS FOR THE AC PAVING AREAS**
- INCLUDES THE PARKING AREA THE EAST AND THE BASKETBALL COURTS TO THE WEST
- THIS WILL REDUCE THE AMOUNT OF HEAT COMING INTO THE BUILDINGS FROM ADJACENT PAVING AREAS

4 **PLANTING ALONG THE EAST AND WEST WALKWAY**
- WOULD HELP REDUCE THE HEAT GAIN FROM THE EARLY MORNING OR AFTERNOON SUN
- NEED TO BE MINDFUL OF SEPTIC SYSTEM ON WEST SIDE
- CONSIDER MAINTENANCE OF THE PLANT SPECIES
- LIKELY NEED TO BE POTTED

5 **ENVELOPE IMPROVEMENTS**
- LEVEL 1
  - RETROFIT SOLUTIONS (CAN BE DONE IN STAGES)
    - EXTERIOR PAINTING
      - LIGHT COLORS REFLECT MORE HEAT
    - RETROFIT INSULATION
    - CONFIRM EXISTING BUILDINGS HAVE NO INSULATION
    - A RETROFIT FOAM INJECTION SOLUTION
- LEVEL 2
  - COMPREHENSIVE RECLADDING
    - REMOVE/REPLACE EXISTING STONE/STUCCO CLADDING
    - INSULATE WALLS
      - CAVITY AND/OR EXTERIOR INSULATION SYSTEMS
    - THERMALLY IMPROVED WINDOWS & LOW-E GLAZING
      - REDUCE HEAT GAIN THROUGH FRAME AND GLAZAING

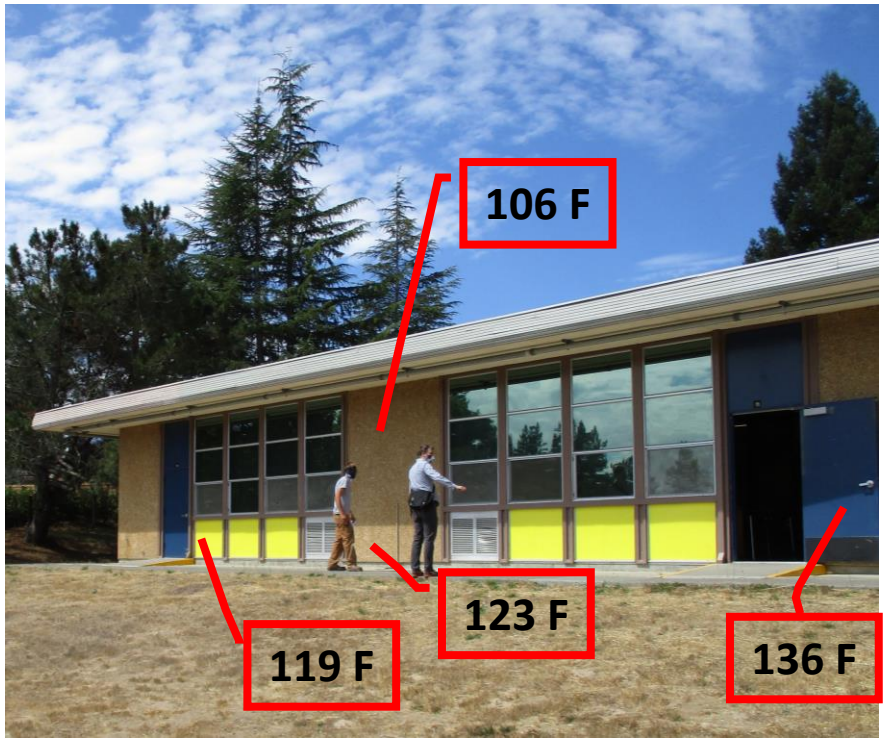
6 **IRRIGATION FOR WEST SIDE HILL**
- HELP REDUCE HEAT GAIN FROM SOIL

★ ROOFTOP PACKAGE UNITS PENDING STRUCTURAL FEASIBILITY REVIEW

RECOMMENDATIONS – ENVELOPE

Envelope Review

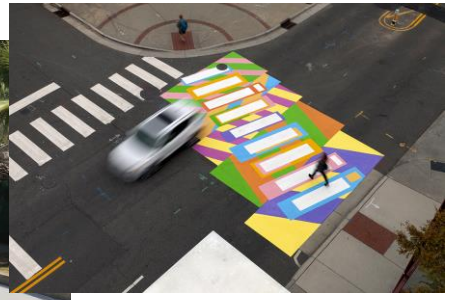
Existing heat gain from surfaces are impacted by the orientation, East & West, having the majority of heat gains in the morning and afternoon. The paint colors, added rock mass walls, and paving surfaces around the building all exacerbate the heat gain and heat transfer to the conditioned space. Site visits occurred on a sunny summer day with an outside air temperature of 86F but the surfaces of the building were exceptionally higher based on the type of material and the paint color. The mass wall surfaces was measured with a thermal temperature gun at 123F in the sun and 106F in the shade under the overhangs. The yellow painted uninsulated wall panels were measured at 119F and the warmest of all surfaces, the blue painted doors, were measured at 136F. All of these surfaces are absorbing and radiating heat into the interior space. The blacktop on the West side of the campus right next to the classrooms was measured at 130F, nearly 50F higher than the air around the building.

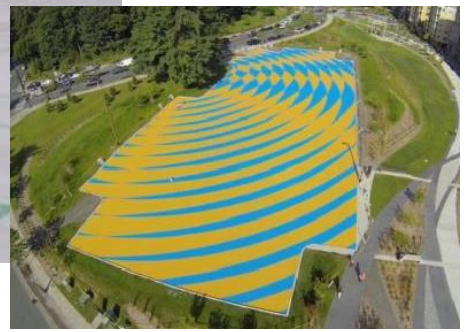


Recommendations:

1. Paint surfaces a light color with high reflectivity, avoid dark surfaces or limit them to areas that are well shaded.
2. Paint asphalt surfaces near the building with high albedo pavement surface paint to reduce heat gain. Sample products: https://neyra.com/products/sealers/sunshield/
3. Plant trees or vines in planter boxes to shade the structure on the East & West facades. Since the area to the East is part of the septic leach field and to the West is paved surface tree planting is limited. Climbing summer vines such as string beans, hops, or other seasonal vine can easily be managed in planter boxes and allowed to climb on trellis or shade structure.

RECOMMENDATIONS – ENVELOPE





Examples of Cool Pavement Coatings

Hops

Bamboo

Bougainnvillea

Black-Eyed Susan

Examples of Cool Planting Screens

RECOMMENDATIONS – ENVELOPE

Typical Existing Façade

Envelope Review

Existing Glazing is single paned glass in a non thermally broken metal framed window system of unknown manufacturer. While in good repair the large window areas with single glazing is allowing a large amount of heat gain into the space and the main point of thermal gain in the existing envelope. The majority of the glass is either West or East facing with limited overhangs. Due to the orientation the gains are early morning or late afternoon with little ability to shade the façade. The roof insulation is minimal, R-19 batt below the deck is estimated based on visual inspection. The wall systems are wood framed and based on the age of the building we're assuming uninsulated. The smaller metal panels within the window systems (Painted yellow in photo below) were uninsulated but normally behind counter and storage pace on the interior wall Inspection of the wall systems were limited.

Recommendations

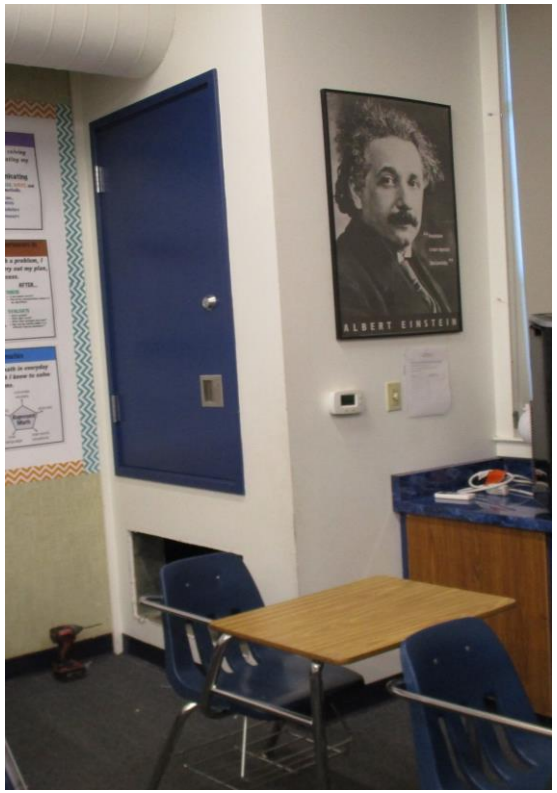
1. Replace the window systems with new insulated low-e glazing in thermally broken framing systems with a U-factor no more than 0.45 and SHGC of 0.25. Casement or other operable windows are recommended for controlling natural ventilation path on days with mild temperatures and good air quality.
2. When Re-roofing add 4 inches of rigid insulation to the roof deck adding approximately R-20 to the roof deck with Cool Roof coating with minimum aged solar reflectance of 0.63 and thermal emittance of 0.75
3. When replacing wall surfaces insulate wall systems with minimum R-13 Batt insulation.

Example of New Low-E Casement Windows

RECOMMENDATIONS – MECHANICAL

Existing Conditions

The existing gas fired condensing furnace units are in good working order and are equipped with motorized outside air dampers scheduled to provide between 450 to 550CFM minimum of outside air to each classroom space with economizer capability. Each unit observed appeared to have newly installed 2" MERV 13 filters in place. Digital programmable thermostats were installed in each classroom observed but since most classrooms were un-occupied due to COVID-19 most thermostats were set to run in "Auto" mode and not continuous operation. When set in "auto" mode once space temperatures are met the unit simply shuts off and no ventilation air is provided. Since no air conditioning is installed there is no opportunity to provide fresh air when in "cooling" mode mechanically. Fresh air would only be supplied during these times from open windows or doors with no filtration.



Typical Gas Fired Furnace Closet & MERV-13 Fresh Filter

Level 1 Recommendations:

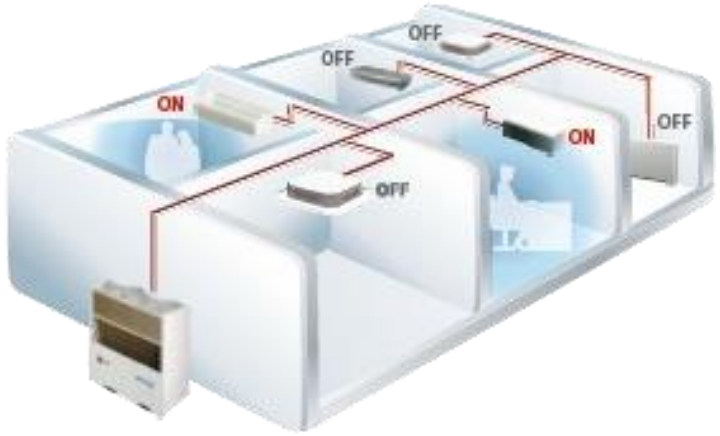
Recommission all existing classroom furnaces, furnace controls and economizing air dampers/actuators in the mechanical closets to ensure proper operation. There are no air pressure relief measures in the classrooms; therefore, add a barometric relief grille, duct, damper and exhaust cap on roof in each classroom.

Perform an air test and balance by a certified TAB contractor to ensure the appropriate outside, exhaust, return and supply air quantities are met. The contractor should also test the air economizing sequence to ensure for proper operation.

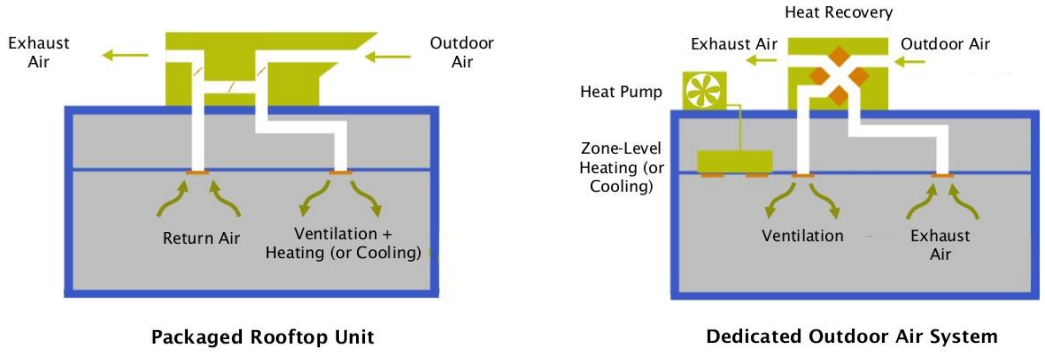
Re-program the existing thermostats to ensure that they continuously operate the furnace supply fans at all times during classroom occupied hours. Currently the fans turn off when temperature setpoints are met or are shut down by local users at the thermostat.

Expand the existing furnace controllers to allow for a night-air-cooling in full economizer mode (classroom air flush) to pre-cool the rooms prior to occupancy for one to two hours and allow a purge sequence at the end of the day to flush out any potential contaminants left in the space for the one to two hour time period.

RECOMMENDATIONS – MECHANICAL



Ground Mounted VRF/VRV Option with Refrigerant Piping to Existing Furnace Closet Typical



Rooftop Dedicated Outside Air Systems

Level 2 Recommendations:

Two reasonable options are available for classroom heat mitigation. The intent is to provide tempered (neutral temperature between 65º F. to 70º F.) outside ventilation air introduced into the classrooms. Size equipment for 30% beyond minimum Title-24 Part-6 ventilation requirements and add CO2 sensor controls within the occupied space.

Option 1: Provide Variable Refrigerant Flow (VRF) systems comprising of centrally located outdoor heat pumps at grade level, retrofit direct expansion (DX) vertical coils directly behind the outside air louvers, pre-heated/pre-cooled air temperature sensors and associated refrigerant piping from the heat pumps to the DX coils. This would utilize the existing fresh air pathways and existing HVAC system to enhance space conditioning and outside air flow to the space. This strategy is intended to temper the outside air but not provide full space conditioning in cooling mode. This concept will serve four (4) classrooms with one outdoor unit. These systems have electrical system impacts and would be classified as a Deferred Maintenance project which probably won't require DSA review.

Option 2: provide packaged Dedicated Outdoor Air Systems (DOAS) units, with or without heat recovery, with MERV-13 or better filters on the roofs centrally located with exposed distribution ductwork to each classroom. These units are designed to heat and cool 100% outside ventilation air to the desired range of neutral air temperatures. This strategy is intended to temper the outside air but not provide full space conditioning in cooling mode. This concept will serve four (4) classrooms with one outdoor unit. These systems will have electrical and structural impacts and will require DSA review and approval. The heat recovery option would be the most efficient option utilizing heat recovery from the exhaust air stream to heat or cool the incoming air. There are no air pressure relief measures in the classrooms; therefore, add a barometric relief grille, duct, damper and exhaust cap on roof or exterior wall in each classroom. This will allow the tempered air quantity introduced into the classrooms from the DOAS units to be relieved to outdoors.

NOTE: Option 2 is pending structural feasibility review for the additional weight on the structure.

RECOMMENDATIONS – MECHANICAL

Examples of Stand Alone HEPA Filtration Systems

UVGI Mitigation Duct Mounted Retrofit Kit
(https://iaqsolutionsinc.net/products)

Room Mounted UVGI System
(https://iaqsolutionsinc.net/products)

Level 3 Recommendations:

Option 1: In addition to the level 2 replacement system, install in room portable HEPA Filtration systems capable of handling the appropriate square footage of the classroom size from 600 SF to 1000 SF. The additional HEPA filtration systems are proven to enhance IAQ in addition to the mitigation measures mentioned in recommendations 1 & 2 on previous pages. This also adds additional comfort level and flexibility of placement within the classrooms near lecture tables and workstations with higher occupant use.

Option 2: Enhanced portable HEPA filters with Ultraviolet light (UVGI) use electromagnetic radiation to destroy bacteria and other pathogens as another means to reduce the risk of virus transmission. Many variations of these products are available on the market currently to further reduce the risk of virus transmission. Examples of these below with either duct mounted systems or room mounted options that use the UVGI. Further testing and balance of the existing systems would be needed to verify if duct mounted options could be implemented with the existing forced air systems but the independent versions could be implemented easily. DO NOT use air cleaning devices that generate harmful pollutants like ionization or ozone generators.

COVID-19 IMPACTS

Technical Review of COVID-19 Mitigation Strategies

While the Science continues on the ways to mitigate COVID-19 in enclosed spaces a handful of tactics are proven facts. Wearing a mask, washing hands, keeping surfaces disinfected all prevent the spread of the Virus. The majority of the spread is from person to person contact and surface, or fomite, transmission. There are various reports linked below with further resources on the topic around airborne transmission and conveyance through the HVAC systems. Throughout these various reports the pattern is similar to these minimum impacts and once established only slight decreases in the rate of transmission are gained going beyond these minimum steps (see Fig.1).

1. Establish current code required minimum outside air rates to each space on a continuous basis.
2. Establish MERV-13 filters at a minimum and replace filters on a regular basis.
3. Either increase outside air to the space or add portable HEPA filtration within the space. DO NOT use air cleaning devices that generate harmful pollutants like ionization or ozone generators.

CA Department of Public Heatlh and COVID-19 Protection
https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/EHLB/IAQ/CDPH%20Document%20Library/IAQ%20paper%20on%20school%20ventilation%20filtration%20viral%20transmission.pdf

ASHRAE: Detailed Guidance for Reopening Schools
https://www.ashrae.org/file%20library/technical%20resources/covid-19/ashrae-reopening-schools-and-universities-c19-guidance.pdf

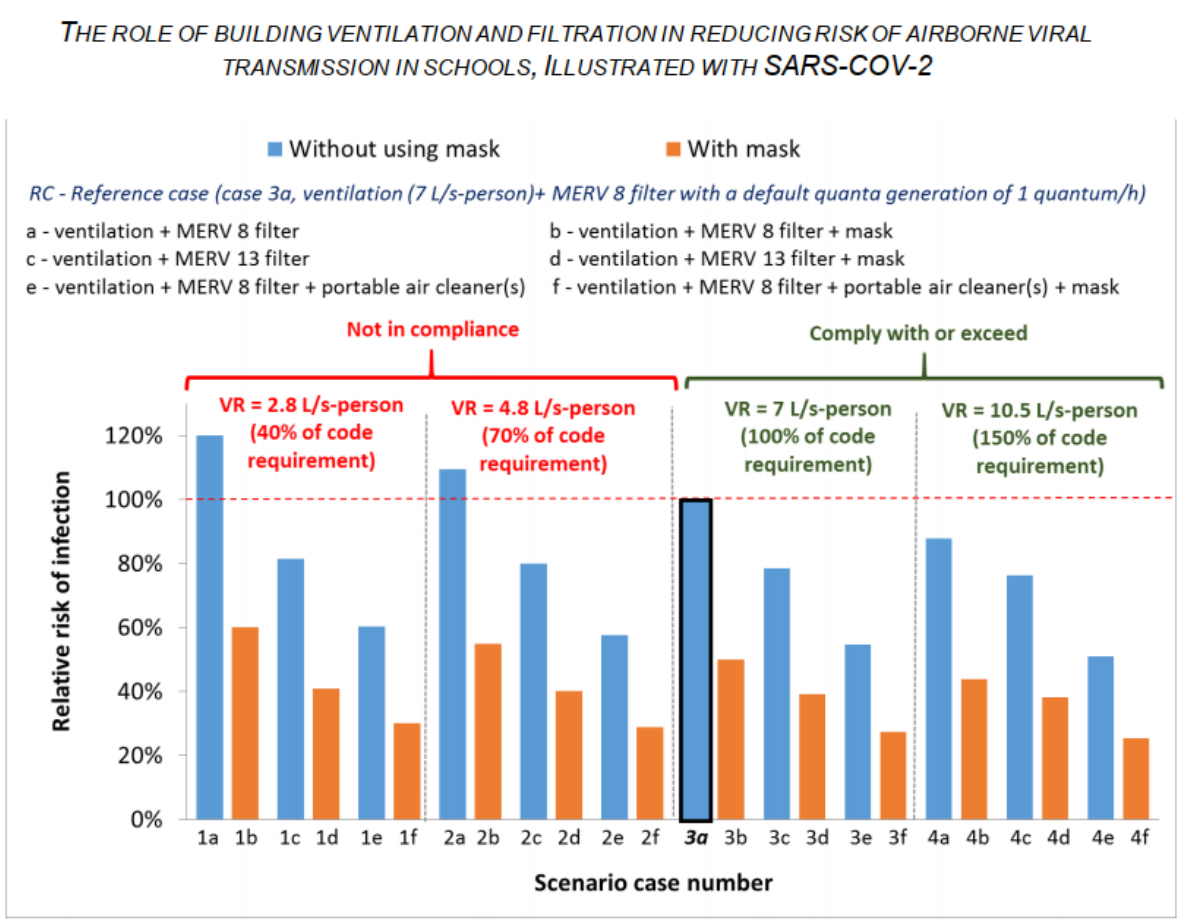


Figure 1: CA Department of Public Health Mitigation Strategies*

*Not outlined in this study but supported by the authors a virus transmission risk reduction of just over 30% for portable HEPA Filters with MERV-13 filters in a room designed with minimum ventilation air provided to the space.

CONCLUSIONS

CONCLUSIONS:

Heat Mitigation: The primary goal of this study was to investigate heat mitigation in the building. The simple measures of painting the surfaces of the building with reflective materials on the roof, walls, and door panels will reduce the collection of heat gain within the spaces. The environmental surfaces of the parking lots, concrete, and even dry grass collect significant amounts of heat that warm the surfaces and exacerbate the microclimate around the building. Painting the play surfaces and parking lots with reflective pavement coatings have proven to drop environmental temperatures by nearly 10 degrees in some climates. Enhancing shading with trees and other vegetation enhances the cooling effect with plant transpiration, passive cooling, as well as adding healthier air with plant CO2 to oxygen transformation.

Adding insulation to the roof and walls as noted when doing capital improvements will further mitigate heat gain into the space. The glazing systems will need to be replaced as they fail at end of life and should be replaced with high performance low-e glass. Retaining the natural ventilation paths will enhance IAQ and flexibility with the climate on mild days.

HVAC Improvements and COVID Mitigation: The three levels of mitigation measures recommended allow for measured improvements in both IAQ and virus risk mitigation strategies. The first is bringing IAQ to current code levels with re-establishing fresh air systems and maintaining constant airflow through the MERV-13 filters. That first step is the most important according to the CA Department of Public Health. Adding cooling to the fresh air stream in either of the proposed options in recommendation level 2 will start to address thermal comfort in the spaces on hot days. Since there is no cooling system attributed to the existing classrooms the recommendations in level 2 will address both fresh air and comfort cooling. The third level of air quality introduces portable HEPA filtration and enhanced UVGI virus mitigation which is the third tier of virus infection risk mitigation. With each of the level tiers of recommendations there are increasing costs with diminishing virus mitigation potential. As with any of these recommendations there is no implied guarantee of complete virus mitigation as the bulk of the research suggests fomite (surface) transmission is more likely than aerosol transmission through room air once minimum outside air and MERV-13 filters are established. Each of these recommendations reduce the likely transmission of viruses but cannot guarantee full protection. It is recommended that each of these measures be evaluated in detail with cost estimation impact and potential for heat gain and virus mitigation.


THE END?