TEMPORARY TRANSIT BUS ENGINEERING CONTROLS TO REDUCE COVID-19 EXPOSURE

NEED

Transit buses provide essential transportation service. Transit bus operators may be at risk of exposure to passengers with COVID-19 at close interactions for short periods of time and distant interactions over longer periods of time. Viral exposure risks include lack of physical distance during front door entry; lack of physical distance while supporting passengers (e.g., ADA securement); and potential air exchange hazard.

SHEN, Y., ET AL. (2020) JAMA INTERNAL MEDICINE | CDC (OCTOBER 5, 2020) SCIENTIFIC BRIEF ON AIRBORNE TRANSMISSION

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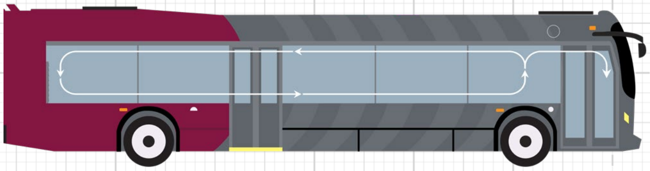
INVESTIGATION PURPOSE

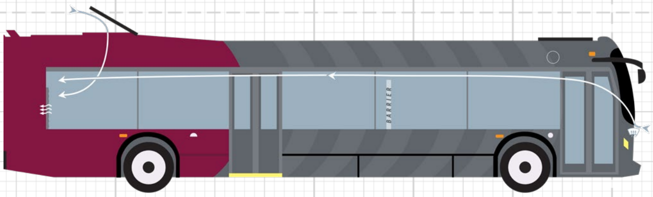
1. Reduce bus operators' exposure to the presence of COVID-19 in airborne droplets and particles.
2. Maximize fresh air for passengers who occupy buses for shorter periods of time than bus operators.
3. Determine feasibility of a temporary barrier to organize air flow and pressure in a transit bus.

ENGINEERING CONTROL SOLUTION

Three barrier designs were considered, including one near the bus operator workstation and two in the passenger compartment. A barrier design was developed prior to testing to meet the air quality objectives: (a) maximize fresh air for dilution, (b) produce a pressure differential inside the bus to organize air flow, (c) identify other methods to reduce exposure for bus operators.



NO VENTILATION CONTROLS



OPTIMAL VENTILATION CONTROLS

HIERARCHY OF CONTROLS

To reduce risks to workers, the range of controls used in workplaces include elimination, engineering, administrative, and personal-protective equipment (PPE).

Other than elimination, engineering controls are the most effective risk reducers. According to OSHA, "In workplaces where appropriate, these types of controls reduce exposure to hazards without relying on worker behavior."
[GUIDANCE ON PREPARING WORKPLACES FOR COVID-19 (2020) OSHA 3990-03]

This investigation, performed by the Virginia Tech Transportation Institute (VTTI), focused on applying a temporary barrier as a physical and ventilation engineering control to reduce bus operator exposure to COVID-19. The study also sought to identify other bus features that may provide ventilation benefits.

AIR FLOW OBSERVATIONS

REAR-MOUNTED HVAC RETURN

Organized flow front-to-rear was achieved with the temporary barrier when the front roof hatch and driver window were closed.

If the bus is equipped with a fresh/recirculate option for the driver heater/defroster, fresh air helps resist rear air flowing toward the bus operator.

A driver HVAC booster fan blows air from the passenger area into the bus operator workstation.

Interior cooling temperatures were largely unaffected by installation of the temporary barrier.

ROOF HATCHES AND DRIVER WINDOW

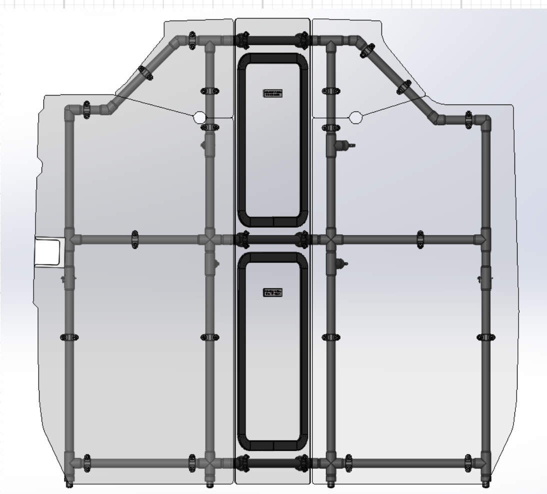
Driver window open drew air out and towards the driver, overcoming all other air flow effects.

Rear roof hatch open drew air into the bus and forward towards the bus operator when the driver window was open.

Rear roof hatch open drew air into the bus and rearward on a rear-mounted HVAC return equipped bus when the driver window was closed and the passenger air was active.

Front roof hatch open near bus operator workstation drew air out and towards the driver, overcoming all other air flow effects of driver HVAC, passenger HVAC, rear hatch, and temporary barrier.

Front roof hatch open rearward of front axle drew air into the bus and away from driver. This configuration was only evaluated without the temporary barrier.



TEMPORARY BARRIER DESIGN FEATURES

Physically limits passenger access near bus operators when combined with rear-door entry, and durable enough to last approximately one year (barring abuse or vandalism).

Supports interior bus ventilation flow from front to back on buses equipped with rear-mounted passenger HVAC air returns, improving safety for operators and passengers by reducing exposure and increasing airborne particle extraction.

Has no moving parts and does not interfere with bus operator workstation access or visibility. Gaps between the barrier and the bus ceiling (1 and 3 inches) provide for organized flow.

Design can be modified to fit many bus make/model configurations that are equipped with rear doors. Considers national APTA and FMVSS standards. Barrier features support emergency egress.

THE FOLLOWING GUIDANCE IS BASED ON THE VIEWS OF VTTI AND NOT THE FEDERAL TRANSIT ADMINISTRATION.

COVID-19 EXPOSURE REDUCTION FOR BUS OPERATORS AND PASSENGERS

Apply principles of gravity (physical distance) and dilution (fresh air) with organized air-flow to reduce exposure.

- Close driver window.
- Open rear roof hatch to increase front to rear flow and fresh air mixing; close front roof hatch if located near bus operator workstation; open front roof hatch if located rearward of front axle.
- When equipped, set driver heater/defroster on max (100%) fresh with the fan on high.
- Filter (HEPA) or close operator workstation air grille connected to the passenger area HVAC system.
- Filtering option allows the bus operator to maintain the heating/cooling benefits.
- For rear-mounted HVAC return equipped buses, consider construction and installation of temporary barrier near ADA area to organize interior air flow from front to back. Best when combined with rear-door entry touchless fare system.

FOR QUESTIONS & AVAILABLE RESOURCES:

3D & 2D CAD Models | Parts & Cut Lists | Assembly Description | Implementation Documents

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U.S. Department of Transportation
Federal Transit Administration

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