AIR QUALITY IN TRANSIT BUSES A TCRP VIRTUAL INSIGHT EVENT June 21 & 22, 2022

EVENT AGENDA

Date	Time	Session	Topics	Speakers
	1:00 PM (EST)	Opening remarks/kickoff		
June 21, 2022	1:10 PM (EST)	Keynote	The Transit Industry and the COVID-19 Pandemic - Actions/Responses and Challenges	Herold Humphreys, <i>MARTA</i> Rick Gonzalez, <i>DART</i>
	1:30 PM (EST)	Session 1 - Air Quality inside Transit Vehicles	Microbe Emission and Dispersion in Confined Volumes	Donald Milton, Univ. of Maryland
			Transmission of Infectious Disease via Aerosols	William Lindsley, NIOSH/CDC
			Biothreats in Transportation	Meghan Ramsey, MIT Lincoln Laboratory
			Q&A	
	2:30 PM (EST)		Break	
	2:35 PM (EST)	Session 2 - Optimal Airflow Patterns & Measurement Methods	Airflow Verification Studies	Nathan Edwards, The MITRE Corporation
			Ventilation: Guidance and Approaches	Jason DeGraw, Oak Ridge National Laboratory
			Q&A	
	3:25 PM (EST)		Break	
	3:30 PM (EST)	Session 3 - Updating	Transit Organization Pandemic Response	Charles Franz, BART
		and Improving Filtration	Examples on Improving Airflow	Daniel Cheng, BART
			Upgrading HVAC Filtration on an Existing Bus	Ariel Piedmont, Sound Transit
			Fleet	Tim Wagner, Sound Transit
			QAA	
	4.50 PIVI (EST)	wrap up		
June 22, 2022	1:00 PM (EST)	Session 1 - Existing and Emerging Technologies	Use of UV Technology in Mitigation of	Ashley Shipley, EvergreenUV
			Transmission Risks	· · · · · · · · · · · · · · · · · · ·
			Bolt-on HVAC Technologies for Reducing the Risks of Airborne Disease Transmission	John Gasparine, WSP
			Evaluating the efficacy of aerosol treatment technologies in occupied spaces	Katherine Ratcliff, U.S. EPA
			Q&A	
	1:55 PIVI (EST)		Break	
	2:00 PM (EST)	Session 2 - Modeling and Simulations for Transmission Risk Decision Making	Computational Fluid Dynamics (CFD) Simulation	Varghese Mathai, Univ. of Massachusetts, Amherst
			Other Approaches to Modeling and Simulation for Transmission Risk Decision Making	Jose-Luis Jimenez, Univ. of Colorado
			Q&A	
	2:55 PM (EST)		Break	
	3:00 PM (EST)	3:00 PM (EST) Session 3 – Other Strategies for Mitigating Transmission Risks	Moving Toward System Design for Air Quality	TCRP Planning Panel
			Q&A	
	4:00 PM (EST)	Session 4 - Next Steps/Wrap up	Identifying Areas of Research and Topics for Further Discussion	Mariela Garcia-Colberg, NAS/TRB Nathan Edwards, The MITRE Corporation

DAY 1

OPENING REMARKS

NEIL PEDERSEN has been Executive Director of the Transportation Research Board (TRB) since 2015. In that role, he provides executive direction and leadership to TRB's technical activities, including its annual meeting of over 14,000 transportation professionals, its 180 technical committees, its conferences, and its publications; its peer reviewed policy consensus studies; and its multimodal cooperative research programs. Prior to joining TRB, Mr. Pedersen spent 29 years at the Maryland Department of Transportation, where he served the last eight years as State Highway Administrator and Governor's Highway Safety Representative.

KEYNOTE

HEROLD HUMPHREY began his transit career in 1985 while attending high school in Jackson Mississippi. He has remained in transit since then and is currently serving as the Deputy Chief of Bus Operations for the Metro Atlanta Regional Transit Authority (MARTA) in Atlanta. At MARTA, Mr. Humphrey is responsible for the development and implementation of strategies to facilitate seamless bus operations in line with MARTA's strategic direction and coordination of daily operations of bus transportation, maintenance, and mobility offices. He has worked most of his career on the private side of the transit industry and in the past five years has worked in the public sector. His experience includes providing services in multiple modes of transit services. During the pandemic he served as the co-chairman of the APTA bus operations committee where he was able to learn from peers on the impacts of covid to various transit systems.

RICHARD GONZALEZ has been in transit close to 20 years, starting his career at Palm Tran, Inc. in Palm Beach County Florida. Starting in paratransit, he has experience in mobility management, charter, and fixed route services. With experience in both the public and private sector, Mr. Gonzalez understands the multiple challenges faced the industry faces as it experiences many rapid transitions. Currently, he is the Director of Operations, Bus at Dallas Area Rapid Transit (DART). He has worked most of his career on the private side of the transit industry and in the past five years has worked in the public sector. As COVID peaked in the Dallas, Fort Worth area, Mr. Gonzalez worked with transit engineers and risk management to address safety and operational concerns.

SESSION 1 - AIR QUALITY INSIDE TRANSIT VEHICLES

DR. DONALD K. MILTON is Professor of Environmental Health, in the School of Public Health, University of Maryland, College Park, and Professor in the Department of Medicine, School of Medicine, University of Maryland, Baltimore. He earned a BS in Chemistry from UMBC, MD from Johns Hopkins, and an MSOH and a DrPH (Environmental Health) from Harvard. He is board certified in Internal and Occupational and Environmental Medicine and has over 20 years of experience in environmental and occupational medicine referral practice. Milton's work focuses on the interrelated areas of infectious bioaerosols, exhaled breath analysis, mechanisms of transmission of respiratory viruses, and respiratory epidemiology. His insights on aerosol transmission led to an innovative model of airborne infection transmission risk estimated from simple CO2 measurements that has been widely adopted as means of identifying high risk environments for COVID-19 transmission. His work on exhaled breath has contributed to understanding how the lung generates particles and how best to sample these particles while preserving their biological properties for analysis. His research group developed the Gesundheit-II (G-II) human exhaled aerosol collector and used it to show that influenza patients can shed infectious virus into aerosols without coughing. They also demonstrated that surgical mask worn by infected cases can reduce aerosol release of influenza. He is the Principal Investigator of the UMD StopCOVID study (investigating SARS-CoV-2 transmission) and of the Evaluating Modes of Influenza Transmission (EMIT-2) study, a 5-year \$15 million UMD-UMB collaboration to perform randomized controlled trials that will define the modes and mechanisms of influenza transmission.

DR. WILLIAM LINDSLEY received his BS in Mechanical Engineering from the University of Maryland, College Park and his PhD in Bioengineering from the University of California, San Diego. He is currently a research biomedical engineer at the National Institute for Occupational Safety and Health (NIOSH), which is part of the Centers for Disease Control and Prevention (CDC). Dr. Lindsley studies the role of infectious airborne particles (called aerosols) in the transmission of diseases. He designed the NIOSH two-stage cyclone aerosol sampler, which has been used to sample the air for airborne influenza virus, SARS-CoV-2 virus, and other pathogens. His group has collected coughed and exhaled aerosols from influenza patients and examined the amount of virus contained in these samples. Dr. Lindsley also designed the NIOSH respiratory aerosol simulator, which is used to study how well face masks and other face coverings block aerosols produced by coughing and breathing from being expelled into the environment and how well different measures like face masks, room ventilation and portable air cleaners reduce exposure to these aerosols.

DR. MEGHAN RAMSEY is a technical staff member in the Counter-WMD Systems Group at MIT Lincoln Laboratory. She received her B.A. in Biology from Williams College and her Ph.D. in Microbiology from the University of Wisconsin – Madison. Her Ph.D. work focused on characterizing mechanisms of bacterial horizontal gene transfer. She then conducted a postdoctoral fellowship at the Tufts University School of Medicine investigating mechanisms of host adaptation and immune evasion in the Lyme disease bacterium. Her postdoctoral work was funded by a National Research Service Award. Dr. Ramsey joined MIT Lincoln Laboratory in 2017 and has worked on a variety of research topics including the characterization of trace DNA deposits for forensic applications, the design of safe tunable simulant materials to mimic biological threat agents, and the characterization of pathogen dispersion in complex environments such as urban areas, transit systems, and healthcare settings.

SESSION 2 - OPTIMAL AIRFLOW PATTERNS & MEASUREMENT METHODS

NATHAN EDWARDS is a Principal Scientist & Engineer at MITRE Corporation and previously worked at U.S. Dept of Energy Sandia National Laboratories as a Senior Member of Technical Staff. Over the past 2 years, much of his work has been focused on field experiments with COVID-19 related aerosol dispersion and control with improvised masks, indoor environments, and on public transit or school buses. His recent work has been published in peer review journals and he has been asked to participate in national panels with U.S. Dept of Homeland Security and National Association for Pupil Transportation. He has a prior career in public health and safety where he led a local government training organization on chemical, biological, fire, and heavy rescue emergencies and served as a fire officer and mobile intensive care paramedic. Mr. Edwards has over 15 years in science and technology, with research efforts leading to a number of innovations and resulted in several patents and publications. Mr. Edwards has a MS in Electrical and Computer Engineering from University of Illinois, BS in Computer Systems Engineering from Arizona State University, and an AS in Fire Science – Fire Service Administration from University of Alaska Anchorage.

DR. JASON W. DEGRAW is a member of the research and development staff of Oak Ridge National Laboratory. He holds a BS in Mechanical Engineering from the University of Houston and MS and PhD degrees in Mechanical Engineering from the Pennsylvania State University. Dr. DeGraw's research work has focused on the numerical simulation of thermo-fluid flow phenomena at a variety of scales and in several different application areas. His recent work inbuilding performance simulation has applications in indoor air quality and building security and resilience. Dr. DeGraw is currently a member of the development team of Energy Plus, the U.S.DOE's flagship building energy simulation engine. He is an active member of ASHRAE, was the first chair of ASHRAE TC 2.10 Resilience and Security and is a member of the ASHRAE Epidemic Task Force.

SESSION 3 - UPDATING AND IMPROVING FILTRATION

CHARLES FRANZ is a Principal Vehicle Systems Engineer for the Rolling Stock & Shops Department (RS&S) at San Francisco Bay Area Rapid Transit (BART). Mr. Franz oversees the mechanical engineering of the existing as well as new fleet procurement in the areas of trucks, suspension, mechanical propulsion, pneumatics, hydraulics, HVAC, and structural carbody. Mr. Franz began his railroad career in high school as a Locomotive Mechanic, and later as a Conductor and Engineer for various shortline railroads around the San Francisco Bay, and Colorado. During this time, he also gained experience in the niche industry of restoration, maintenance, and operation of steam locomotives and historic rolling stock from the 1880s to 1930s. He went on to work for the Union Pacific Railroad as the Los Angeles Manager of Mechanical Maintenance for three years before returning home to San Francisco and taking a vehicle engineering role at BART. He has been at BART for over six years, progressing into his current position today. Mr. Franz has a BSME degree from Santa Clara University. **DANIEL CHENG** is a Sr. Vehicle Systems Engineer at San Francisco Bay Area Rapid Transit (BART). He started his railroad career with Alstom as a test supervisor in the assembly and test of 150 new C1 cars for BART in the San Francisco Bay Area. When the project was completed, he moved on to work for Morrison Knudsen, BART's contractor for 80 new C2 car project as a test manager. Under these two projects, Mr. Cheng gained vast experience in the rail car assembly and knowledge of the function of various systems on the rail cars. Mr. Cheng also worked on San Francisco Municipal Railways (MUNI) as MUNI's on-site representatives for the acceptance and delivery of 150 new Light Railway Vehicles built by BREDA prior joining BART in 2008 as a Sr. Vehicle Systems Engineer. In addition to supporting the day-to-day maintenance activities in the shops, Mr. Cheng's main focus is the HVAC systems of the railcars. He had instrumented and successfully completed the multi-million-dollar project to upgrade the C1 and C2 car HVAC units. Currently, Mr. Cheng has been working on improving the air quality of the HVAC systems of the BART fleet in response to the COVID pandemic. He has a BSME and MSME from Imperial College, University of London in the UK.

ARIEL PIEDMONT, CIH, CSP, is the Industrial Hygiene Program Manager for Sound Transit, a regional transit authority providing the greater Seattle area with light rail, regional bus, commuter rail and streetcar services. Responding to early emerging information suggesting that airborne transmission was a potential pathway for COVID-19 spread, he used tools such as the CIRES (Cooperative Institute for Research in Environmental Sciences at the University of Colorado Boulder) developed COVID-19 Aerosol Transmission Estimator tool, transit vehicle ventilation system's design criteria, field measurements and ridership information to prioritize potential pandemic mitigations across multiple vehicle classes and build types. Mitigation strategies examined include increasing outside air exchange, incrementally improved filtration with existing HVAC's, auxiliary air cleaning (filtration/electronic air filtration/airborne disinfection products) and airflow changes with an eye towards improving our current fleet where possible and designing the purchase criteria for tomorrow's vehicles. Mr. Piedmont completed his undergraduate studies at the U.S. Coast Guard Academy and an Industrial Hygiene Master of Science from T.H. Chan Harvard School of Public Health.

TIM WAGNER has been the Bus Maintenance Superintendent at Sound Transit for the last twelve years. Mr. Wagner overseas the maintenance contracts and work performed by three partner agencies. Additionally, Mr. Wagner is responsible for inspections, bus procurements, facilitating training, and disposition of equipment. Tim's career experience has also included serving on peer review panels for technical evaluation for the Washington State Department of Transportation, Medium and Heavy Duty Bus Procurement Contract. Mr. Wagner was formerly the local Maintenance Manager for a global transportation firm. Prior experience also includes 20 plus years of military service, in Logistics and Communications, responsible for providing support/ management for all base vehicles and later management of the base computer hardware. Mr. Wagner holds an Associate degree from the Community College of the Air Force in Vehicle Management. He continues his education through courses at the Transportation Safety Institute and the National Transit Institute.

DAY 2

SESSION 1 - EXISTING AND EMERGING TECHNOLOGIES

ASHLEY SHIPLEY is an 8-year veteran in the UVC and indoor air quality industry. She is currently the UVC Subject Matter Expert for EvergreenUV and Lumalier's UVC upper air, surface, and in-duct/HVAC product lines. Ms. Shipley is a member of ASHREA, the UVA and is a peer reviewer for ASHRAE SPC 185.

JOHN GASPARINE has over 20 years of experience providing policy, planning, performance management, financial management, and program management services. His multidisciplinary background includes a comprehensive understanding of transportation capital, operations, legislative matters, and public health, which lays a solid foundation to develop creative and analytical approaches to transportation management systems. Mr. Gasparine provides direct support to the transportation industry, is knowledgeable in recent legislation, such as the Bipartisan Infrastructure Law (BIL), prevailing US health guidance, and has coordinated projects with many federal transportation agencies, including the USDOT, FTA, FHWA, and FRA.

DR. KATHERINE RATLIFF is a principal investigator at the U.S. Environmental Protection Agency's Office of Research and Development, working under EPA's Homeland Security Research Program in the Center for Environmental Solutions and Emergency Response. She uses modeling, laboratory, and field-scale studies to develop and evaluate sampling and decontamination techniques for environmental contaminants, including leading EPA's research to evaluate the efficacy of different air treatment technologies against airborne pathogens. Dr. Ratliff received her B.A. in Earth and Environmental Sciences from Vanderbilt University and a Ph.D. in Earth and Ocean Sciences from Duke University.

Session 2 - Modeling and Simulations for Transmission Risk Decision Making

DR. VARGHESE MATHAI is a faculty member in the department of physics at the University of Massachusetts, Amherst. He completed his PhD in Applied Physics from the University of Twente, the Netherlands in 2017, and then did a postdoc at Brown university, where his research addressed fluid mechanics and turbulent multiphase flows. His group's current research interests are primarily in particle-laden flows, and on airborne transmission of particles and droplets. Varghese's research was selected for the ERCOFTAC Da Vinci award for top 5 PhD theses in Europe in 2017, and in 2018, he received the European COST prize for Best Researcher in Flowing Matter. His recent research on COVID-19 and airborne transmission risks in passenger cars was featured in the New York times, the Washington Post, and several other media, and appears among the current CDC guidelines for transmission mitigation efforts. **DR. JOSE-LUIS JIMENEZ** joined the University of Colorado at Boulder (CU) in 2002 and is currently a Professor in its Department of Chemistry & Biochemistry (Analytical, Environmental, and Atmospheric Chemistry Division), and is a Fellow of the Cooperative Institute for Research in the Environmental Sciences (CIRES). The Jimenez research group centers on the development and application of advanced instrumentation for real-time, quantitative measurements of the chemical composition of submicron aerosols and gases, which affect radiation balance (climate forcing), have severe short-term and long-term effects on human health, reduced visibility, and deposition of acids, toxics, and nutrients to ecosystems and crops. Dr. Jimenez earned a Double Mechanical Engineer degree at Universidad de Zaragoza, Zaragoza, Spain and at Université de Technologie de Compiègne, Compiègne, France in 1993. He holds a PhD degree in Mechanical Engineering from the Massachusetts Institute of Technology.

SESSION 3 – OTHER STRATEGIES FOR MITIGATING TRANSMISSION RISKS

THE TCRP INSIGHT EVENT PLANNING PANEL supports TCRP in the development of the Insight event including identifying subject-matter experts to attend and present, identifying industry members and groups to be involved, determining what topics to cover during the Insight Event, and other needs to best inform the organization and execution of the Insight Event. The panel is comprised of twelve members, two liaisons, and two liaison representatives, from transit organizations, academia, and private industry. The panel members, liaisons, and liaison representatives have experience and expertise in a variety of areas, including public transportation (buses), epidemiology in public transportation and buses, disease transmission, air quality in public transportation, design and manufacture of air quality systems in public transportation, and national/ regional/local transit planning.

SESSION 4 - NEXT STEPS/WRAP UP

MARIELA GARCIA-COLBERG is a Senior Program Officer at the Transportation Cooperative Research Program. Her portfolio includes the management of TCRP Synthesis Studies, TCRP full studies and now the first TCRP Insight Event. She has worked in the Transportation Research Board since 2016. Ms. Garcia-Colberg has a vast experience in transit management and previously worked at the Northern Virginia Transportation Commission and at the American Public Transportation Association. She has a bachelor's degree from Washington University in St. Louis, a master's degree from Boston College and a Law Degree from University of Puerto Rico Law School. She also has advanced studies in Urban Planning from University of Maryland.