SUMMARY OF PROPOSAL

During the COVID-19 pandemic, most authorities have focused on reducing the contact and droplet transmission of SARS-CoV-2 (coronavirus) by recommending handwashing, surface sanitizing and 2-m physical distancing with little attention to the potential for airborne transmission of SARS-CoV-2. However, recent US Centers for Disease Control (CDC) and ASHRAE statements show the urgency of this RTI grant and our COVID-research to quantify and reduce airborne pathogen transfer in HVAC systems.
ASHRAE: "Transmission of SARS-CoV-2 through the air is sufficiently likely that airborne exposure to the virus should be controlled. Changes to building operations, including the operation of heating, ventilating, and air-conditioning [HVAC] systems, can reduce airborne exposures."
CDC: "There are several well-documented examples in which SARS-CoV-2 appears to have been transmitted over long distances or times."

The proposed optical aerosol spectrometer (OAS) and dry aerosol generator (DAG) will allow us to generate aerosols and measure the key parameters affecting airborne transmission (i.e., the size, concentration and movement of aerosol particles). While the exact viral dose that is required to infect a person with COIVD-19 is unknown, humans infected with influenza generate around 2,000 infectious aerosol droplets per hour and even more during coughing, sneezing and singing. The distance that these aerosols can travel depends on their size and the ambient air velocity. While the coronavirus alone (0.1 µm) may remain airborne for days, exhaled aerosols containing body fluids and the coronavirus are expected to be 1 to 5 µm and may remain airborne for hours (e.g., 3 µm particle will settle at a rate of 1 m/h and natural indoor air currents could transport the aerosol nearly 100 m).

The COVID-19 pandemic has increased public awareness of the importance of indoor air quality (IAQ) in buildings. Canadians spend over 90% of their time indoors and intake 15,000 L (17 kg) of air a day, which is much higher than our daily intake of food (~2 kg) and water (~2 L). Bottled water has mandated labels to indicate contents and purity, while the air we breathe is assumed to be clean. Clearly, the large volumes of air we breathe can impact our health and well-being with or without a pandemic. Therefore, while this RTI grant focuses on research related to the COVID-19 pandemic and pandemic operation of HVAC systems, the research will have long-term impacts for buildings under normal operation.

The 20 HQP trained with the optical aerosol spectrometer (OAS) and dry aerosol generator (DAG) purchased with this RTI grant will develop solutions for HVAC systems that improve IAQ and reduce infectious disease transmission during pandemic and normal operation. During their careers, the HQP trained using the OAS and nebulizers will be well positioned to lead the implementation of these and other solutions in Canadian buildings and thus improve the health and well-being of Canadians.

Team: The team includes the necessary experts in energy exchangers, ventilation, industrial hygiene, aerobiology and microbiology. The team members have a very successful collaborative history, and the expertise and laboratory skills to successfully undertake this work, as indicated in their recent funding success and HQP and publication records. There are likely no other teams in Canada with a comparable combination of expertise in aerosol transfer in ventilation systems, current research in the area, and history of working together. Drs. Simonson and Soltan currently have NSERC COVID Alliance grants on pathogen transfer and sanitation and an ASHRAE research project to study the transfer of gaseous contaminants in energy wheels. Drs. Kirychuk, Schneberger and Simonson currently have funding to test the role of carbon dioxide (CO_2) on virus infectivity and inflammation potential in mice, and they have collaborated on projects related to indoor air quality for many years. The energy exchanger and sanitation systems are being constructed in Drs. Simonson and Soltan's labs and Dr. Kirychuk's laboratory in health sciences is supporting the biological analysis.
Dr. Carey Simonson is a Professor of Mechanical Engineering and a fellow of ASHRAE. (ASHRAE is the premiere HVAC society with over 56,000 members in over 130 countries. Less than 1% of members are fellows.) He has an established research program on energy-efficient ventilation systems for

buildings, with a special focus on heat and moisture transfer in air-to-air energy exchangers. He received the 2015 NSERC Synergy Award for collaborative research with industry and will lead the project. **Dr. Jafar Soltan** is a Professor of Chemical Engineering and has expertise in the area of environmental catalysis, air treatment and advanced oxidation processes. He has worked for more than 15 years on technologies for the removal of air contaminants. Our research team members on our NSERC Alliance and Uof S internal grants includes the following collaborators. **Dr. Shelley Kirychuk** is an Occupational Hygienist and Associate Professor in the Department of Medicine. She heads the National Agricultural Industrial Hygiene Laboratory (NAIHL) **Dr. Caroline Duchaine** is an aerobiologist and professor at the University of Laval. She has extensive experience with aerosol dispersion, measurement, and analysis. **Dr. Schneberger** is a Research Associate at USask Canadian Centre for Health and Safety in Agriculture (CCHSA) and has extensive experience with workplace air issues at the immunological level and is the lead author on the papers on the effects of CO_2 on lung inflammation. CO_2 control is a key element in ventilation strategies. **Dr. Julian Tam** is a respirologist and Assistant Professor in the Department of Medicine at USask with expertise in cystic fibrosis and lung transplantation. He contributes to the knowledge transfer including respiratory disease transfer. **Dr. Yan Zhou** is a Molecular Virologist at VIDO-InterVac at USask, which is one of the leading Canadian organizations seeking a cure for COVID-19. She has experience in virus pathogenesis and microbiology of the Influenza virus. She supports the biological studies and provides technical advice for the laboratory experiments.