STANDARDS RESEARCH

Workplaces and COVID-19:
Occupational Health and Safety Considerations for Reopening and Operating During the Pandemic

September 2020

Authors

Victoria H. Arrandale, Ph.D., ROH, Dalla Lana School of Public Health, University of Toronto
Mishika Ahuja, B.Tech., Dalla Lana School of Public Health, University of Toronto
Serena Mo, H.B.Sc, Dalla Lana School of Public Health, University of Toronto
Harshi Dama, B.P.T., Dalla Lana School of Public Health, University of Toronto
Luka Delic, B.Sc. (Hons), Dalla Lana School of Public Health, University of Toronto
Fatemeh Gol-Rasan, B.H.S. (Hons), B.Eng., Dalla Lana School of Public Health, University of Toronto
Peiqi Meng, H.B.Sc., Dalla Lana School of Public Health, University of Toronto

Project Advisory Panel

James Scott, Ph.D., ARMCCM, Dalla Lana School of Public Health, University of Toronto
France Gagnon, R.N., Ph.D., Dalla Lana School of Public Health, University of Toronto
Ramin Farnood, P.Eng., Ph.D., Faculty of Applied Science and Engineering, University of Toronto
Hélène Vaillancourt, P.Eng., Ph.D., CSA Group
Nicki Islic, M.Sc., CSA Group (Project Manager)

Acknowledgements

This work was supported in part by Mitacs through the Mitacs Accelerate program.

The authors wish to thank ***Michèle Prévost, Ph.D.,*** *Professeur et Titulaire principal, Chaire Industrielle CRSNG en Eau Potable, Génies civil, géologique et des mines, Polytechnique Montréal,* for her contribution to the Domain I: Safer Operation of Building Systems During COVID-19 section of the report and for her time and efforts in reviewing and providing comments to the draft versions of the research report and guidance document.

The authors also wish to thank the following individuals for their time and efforts in reviewing and providing comments on the draft versions of the research report and guidance document.

Denise Allen, *President and CEO, Food Processors of Canada*

Tariq Amlani, *Mechanical Engineer, Buildings, Principal, Stantec*

Craig Arthur, MASc, CRSP, P.Eng., *Manager, Safety & Operations, Dalhousie University*

Arinjay Banerjee, *NSERC and M.G. DeGroote Postdoctoral Fellow, Institute for Infectious Disease Research, McMaster Immunology Research Centre, Department of Pathology and Molecular Medicine, McMaster University*

Karen Bartlett, *Professor, MSc OEH Program Director, School of Population and Public Health, University of British Columbia*

Stephen Beaton, M.Sc., CHO, CRSP, *Chemical Safety Manager, Dalhousie University*

Avril Beaubien, MPH (Epidemiology), *Pandemic Workplace Safety Special Advisory Team, Ministry of Labour, Training and Skills Development, Province of Ontario*

John Beckett, CRSP, CHRP, *Vice President, Operations, BC Maritime Employers Association*

Monica Bienfeld, M.Sc., Ph.D. (Epidemiology), *Pandemic Workplace Safety Special Advisory Team, Ministry of Labour, Training and Skills Development, Province of Ontario*

Bob Belanger, P.Eng., *Consumer Representative, CSA Technical Committee on Health Care Facilities*

Jim Boyden, *Senior Policy Advisor, Regulatory Modernization & Business Relief Division, Business Relief Unit, Small Business and Red Tape Reduction, Province of Ontario*

Paul Bozek, *Associate Professor, Teaching Stream & Program Director, MPH-OEH Field, Division of Occupational & Environmental Health, Dalla Lana School of Public Health, University of Toronto*

Teresa Brooks, *Senior Evaluator, Health Canada*

David Brown, *Medical Director, CIBC*

Paula Campkin, *Vice President & Chief Safety Officer, Energy Safety Canada*

Marie-Josée Caron, *Conseillère experte en prévention-inspection, Direction générale de la gouvernance et du conseil stratégique en prévention, Commission des normes, de l'équité, de la santé et de la sécurité du travail (CNESST), Québec*

Ben Chalmers, *Senior Vice President, Mining Association of Canada*

David Clark, CEng., IntPE(UK), P.Eng., FCIBSE, *Principal, Business Centre Practice Leader – Buildings*

Stewart Cramer, *Chief Manufacturing Officer, Next Generation Manufacturing Canada (NGen)*

Andy Dabydeen, *Product Stewardship, Canadian Tire Corporation, Ltd.*

Hugh Davies, Ph.D., CIH, *Associate Professor, OEH Division, School of Population and Public Health, University of British Columbia*

Alexandre Desjardins, *Conseiller en prévention-inspection, Direction générale de la gouvernance et du conseil stratégique en prévention, Commission des normes, de l'équité, de la santé et de la sécurité du travail (CNESST), Québec*

Mary DeSouza, *Member Services & Events Coordinator, Food Processors of Canada*

Michelle Deveau, M.Sc.(A), ROH, *Senior Scientific Evaluator, Health Canada*

Yves Duchesne, ing., *Direction réglementation et expertise-conseil, Régie du bâtiment du Québec*

Dean Dunn, *Vice President, Stakeholder and Public Relations, Infrastructure Health & Safety Association*

Dion Durdle, *Director, Healthy & Safety, Purolator*

Alec Farquhar, *Coordinator, Asbestos Free Canada*

Bruce G. Fraser, M.A.Sc., P.Eng., *Section Head, Environmental and Climate Change Canada*

Ian Frost, *Business Agent, UA Local 787*

Pam Gallant, M.Sc., *Biological Safety Manager, Dalhousie University*

Ayoob Ghalami, *Senior Biosafety Officer, Environmental Health and Safety, Research Oversight and Compliance Office, University of Toronto*

Joseph Giulione, *Directeur, L'Arrimage*

Teresa Griffin, M.Eng., P.Eng., *Occupational Health and Policy, Workplace Safety and Health, Labour and Regulatory Services, Province of Manitoba*

Maureen Haan, *President and CEO, Canadian Council on Rehabilitation and Work (CCRW)*

Jeffrey Harris, B.Sc., MHSc CIH, *Senior Manager, Safety, Metrolinx*

Anne-Marie Harte, P.Eng., Ph.D., MBA, *Industrial Technology Advisor (ITA), National Research Council (NRC) – Industrial Research Assistance Program (IRAP)*

Dr. Deena Hinshaw, *Chief Medical Officer of Health, Alberta Health, Associate Clinical Professor, Department of Medicine, University of Alberta, Clinical Assistant Professor, Department of Community Health Sciences, Cumming School of Medicine, University of Calgary*

Trevor Hughes, *Deputy Minister, Ministry of Labour, Province of British Columbia*

Gary Jenne, P.Eng., *Industrial Technology Advisor (ITA), National Research Council (NRC) – Industrial Research Assistance Program (IRAP)*

Dr. Arif Jetha, *Scientist, Institute for Work & Health*

Ron Kelusky, *Chief Prevention Officer and Assistant Deputy Minister, Ministry of Labour, Training and Skills Development, Province of Ontario*

Dr. Tracy Kirkham, *Scientist, Occupational Cancer Research Centre, Ontario Health*

Denise Koh, B.Sc., MD, CCFP, MPH, FRCPC, ACBOM, *Chief Occupational Medical Officer, Workplace Safety and Health, Labour and Regulatory Services, Province of Manitoba and Medical Officer of Health, Population and Public Health, Manitoba Health Seniors and Active Living, Province of Manitoba*

Tamara Kononoff, B.Sc., MBA, *Industrial Technology Advisor (ITA), National Research Council (NRC) – Industrial Research Assistance Program (IRAP)*

Charles Labrecque, *Conseiller expert en prévention-inspection, Direction générale de la gouvernance et du conseil stratégique en prévention, Commission des normes, de l'équité, de la santé et de la sécurité du travail (CNESST), Québec*

Craig Lawrie, MSc(A), CIPHI(C), CRSP, CIC, *Senior Manager - Health Care Health and Safety Program, Occupational Health and Safety Branch, Ministry of Labour, Training and Skills Development, Province of Ontario*

France Lemieux, M.Eng., *Head, Materials and Treatment Section, Health Canada*

Tracey Machan, ***MeComm,*** *Senior Director, Workplace Service Strategy and Interior Design, Workplace Solutions, Real Property Services, Public Service and Procurement Canada*

Craig MacDonald, ***B.Ed.,*** *Training Coordinator, Joint Training & Apprenticeship Committee, the HVACR Workers of Ontario – UA Local 787 and the Ontario Refrigeration & Air Conditioning Contractors Association*

Sapna Mahajan, ***MPH, PMP, CHE,*** *Director, Programs and Priorities, Mental Health Commission of Canada*

Brad McCannell, *Vice President, Access & Inclusion, Rick Hansen Foundation*

Stéphanie McFadyen, *Head, Microbiological Assessment Section, Health Canada*

Jason McInnis, *Canadian Director, Health & Safety, International Brotherhood of Boilermakers*

Matt McIntosh, *Agriculture Journalist, Mc Communications*

Tom McKenna, *National Health & Safety Representative, Canadian Union of Public Employees (CUPE)*

Manisha Mistry, ***CRSP, LPEC,*** *Prosci Certified Change Practitioner, Senior Director, Health, Safety, Security & Environment and Change Management, CSA Group*

Jeff Moffat, ***P.Eng., Leed AP,*** *Acting Program Manager, Custodial Health and Safety National Centre of Expertise, Technical Services, Real Property Services, Public Services and Procurement Canada*

Cam Mustard, ***ScD,*** *President and Senior Scientist, Institute for Work & Health*

Nancy Pynch-Worthylake, *Executive Director, Canadian School Boards Association*

Nikhil Rajaram, ***MD, CCFP, MPH, FRCPC,*** *Provincial Physician, Occupational Medicine Unit, Occupational Health and Safety Branch, Ministry of Labour, Training and Skills Development, Province of Ontario*

Yves Richard, ***B.A.Sc.,*** *Industrial Technology Advisor (ITA), National Research Council (NRC) – Industrial Research Assistance Program (IRAP)*

Dr. Richard Rusk, ***DVM, MD, CCFP, MPH, DipABPM,*** *Zoonotic Diseases Medical Officer of Health Lead, Manitoba Public Health*

Sari Sairanen, *Director Health, Safety and Environment, Unifor*

W.H. (Wes) Shoemaker, *Deputy Minister, Aritech Land Use Secretariat, Province of British Columbia*

Jeffrey Siegel, ***Ph.D.,*** *Professor, Department of Civil and Mineral Engineering, University of Toronto*

Mahadeo A. Sukhai, ***Ph.D.,*** *Head of Research and Chief Accessibility Officer, Canadian National Institute for the Blind (CNIB)*

Kathleen Therriault, *Director, Pandemic Workplace Safety Special Advisory Team, Ministry of Labour, Training and Skills Development, Province of Ontario*

Emile Tompa, *Senior Scientist, Institute for Work & Health, Associate Professor, McMaster University*

Ashleigh Tuite, *Assistant Professor, Dalla Lana School of Public Health, University of Toronto*

Donald M. Weekes, *Member, Board of Directors, ACGIH*

Aaron Wilson, *Scientific Evaluator, Health Canada*

Troy Winters, *Senior Health and Safety Officer, Canadian Union of Public Employees (CUPE)*

Dr. Amin Yazdani, *Director, Canadian Institute of Safety, Wellness, and Performance, School of Business, Conestoga College Institute of Technology & Advanced Learning*

Foreword

This document presents two separate but related pieces of work:

Part A presents a detailed research report that provides a summary of existing guidelines, scientific literature, and expert opinion relevant to reopening workplaces and to occupational health and safety at work during the COVID-19 pandemic. This report is **intended for those who want to better understand recommended practices**, the evidence available, and areas where there is a need for more evidence before consensus can be reached.

Part B provides an evidence-informed guidance document that workplaces can use to inform safe work practices during the COVID-19 pandemic. These practices are **intended to support workplace parties in reopening safely and implementing ongoing occupational health and safety practices to protect workers from SARS-CoV-2**.

The work from these documents may be used to initiate the development of a new Canadian standard focused on workplaces during an infectious disease pandemic. This standard would be developed using an accredited standard development process, including the establishment of a dedicated technical committee, consensus-building processes, and a period of public review and comment.

Table of Contents

Executive Summary

On March 11, 2020, the World Health Organization (WHO) declared the novel coronavirus disease (COVID-19) to be a global pandemic. The coronavirus disease, COVID-19, caused by SARS-CoV-2, is a rapidly evolving global risk that has already drastically changed the way we live and work. As restrictions ease and workplaces reopen across Canada, more workers are returning to work and workplaces may become important sites of community transmission. Preventing the transmission of COVID-19 in workplaces will protect the physical and psychological health of workers, as well as the broader community.

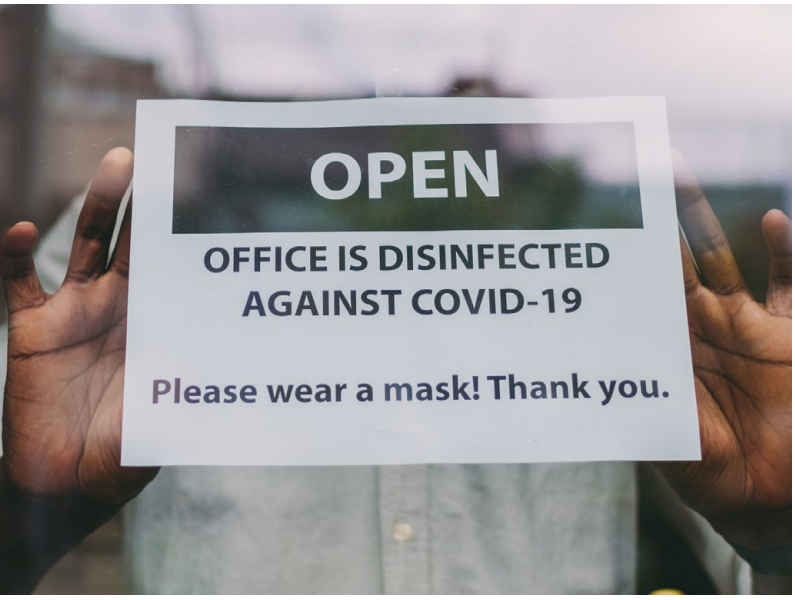
The aim of this research report was to review and summarize occupational health and safety practices that can support safer reopening and ongoing operation of workplaces during the COVID-19 pandemic.

The methodology included a scan of guidelines, technical standards, peer-reviewed scientific literature, and grey literature related to COVID-19 and reopening workplaces or returning to work using Internet search engines, occupational health and safety networks, and an iterative search strategy. A summary of the scan results was compiled into a formal research report (Part A) and the key messages from the research report were then used to develop a guidance document (Part B). The research report and guidance document underwent three rounds of rapid peer review with over 100 experts from across Canada invited to provide comments.

There are many occupational health and safety considerations relevant to the physical and psychological health of workers during the COVID-19 pandemic. If a workplace has been closed or operating at reduced capacity, employers must consider the health of the building and building systems before resuming operations. Building heating, ventilation, and air conditioning (HVAC) and water systems can harbour other microbiological and chemical hazards that must be considered and controlled (e.g., *Legionella*). In order to reduce the likelihood of COVID-19 being introduced into the workplace, employers will need to support workers in staying home if they have symptoms or have come into contact with a known or suspected COVID-19 case. Employers may also implement health screening for workers and others entering the workplace. Before workers return to the worksite, a risk assessment should be conducted to identify jobs or tasks where there may be an increased risk of exposure to COVID-19. Efforts to reduce the likelihood of transmission within the workplace should follow the hierarchy of controls. Where potential exposure cannot be eliminated through a shift to isolated or remote work (e.g., work from home), engineering and administrative controls can be implemented. Workspaces can be altered, and the scheduling of workers and work activities can be adjusted, to minimize close contact and maximize physical distance. Improved ventilation rates and improved filtration within HVAC system can also help reduce the probability of transmission. These strategies should be combined with the use of face coverings and good hand hygiene to reduce transmission of COVID-19. Multifaceted interventions are likely to be more effective at controlling workplace hazards. Prevention and control of COVID-19 should be part of a comprehensive occupational health and safety management system (OHSMS), including meaningful worker consultation.

The COVID-19 pandemic is likely to continue for many months, if not years. Employers should consider preparing for subsequent shutdowns of non-essential workplaces. For employers and organizations that would like more support, resources are available from local, provincial/territorial, national, and scientific organizations. The scientific understanding of the virus is improving rapidly; recommendations will change as more is learned. Importantly, knowledge gained during the COVID-19 pandemic will help to better manage subsequent waves of disease and may also be helpful in preparing for future pandemics.

Workplaces are potentially important sites of transmission for COVID-19 and thus play a critical role in controlling the spread of COVID-19. Supporting workers to stay home when they are sick or have had contact with a COVID-19 case will help prevent the introduction of COVID-19 into the workplace. The hierarchy of controls should guide the selection of controls to reduce the risk of transmission in the workplace. Workers and employers need support to minimize the risk of exposure and transmission as we adapt to new work practices during the COVID-19 pandemic.



"The coronavirus disease, COVID-19, caused by the SARS-CoV-2 virus, is a rapidly evolving risk to global health and has quickly changed the way we live and work."

Part A: Workplaces and COVID-19: Occupational Health and Safety Considerations for Reopening and Operating During the Pandemic

1.0 Introduction

The coronavirus disease, COVID-19, caused by the SARS-CoV-2 virus, is a rapidly evolving risk to global health and has quickly changed the way we live and work. In December 2019, cases of an atypical acute respiratory disease were observed in Wuhan, China. It was determined that a novel coronavirus was the causative agent and, on December 31, 2019, this was first officially reported. Almost a month later, on January 25, 2020, the first presumptive Canadian case was reported in Toronto, Ontario. On March 11, 2020, the World Health Organization (WHO) declared the novel coronavirus disease (COVID-19) a global pandemic.

1.1 The Virus: SARS-CoV-2

SARS-CoV-2 is the coronavirus that causes COVID-19. Coronaviruses are large (diameters range from 60 to 140 nm) enveloped RNA viruses that contain a genome of about 30 kilobases, which encodes the envelope, membrane, nucleocapsid, and spike proteins [1]. SARS-CoV-2 belongs to the same genus of betacoronaviruses (β-CoV) as SARS-CoV-1 and MERS-CoV [1]. The spike or S glycoprotein (a transmembrane protein with a molecular weight of 150 kDa and length of about 8 to 12 nm) enables binding of the virus and entry into the host cell [2]–[4]. Due to its presence on the surface of the viral envelope and the mechanism of its action, spike or S glycoprotein is targeted by neutralizing antibodies and is the focus of protein-based vaccines currently under development [4], [5].

1.2 The Disease: COVID-19

Individuals who become infected with the SARS-CoV-2 virus develop COVID-19, a disease typically leading to symptoms that include cough, fever, difficulty breathing, fatigue, and headache, but asymptomatic cases are also possible [6], [7]. Though the most common COVID-19 symptoms arise in the respiratory system, the involvement of other organs has been reported, including neurological, cardiac, kidney, liver, endocrine, skin, and gastrointestinal effects [8]. The disease itself can be severe, leading to hospitalization for approximately 14% of confirmed cases in Canada [9]. Among hospitalized

patients who survived the disease in Wuhan, China, the mean length of hospital stay was 12 days (range 9–15) with a mean of 7 days spent in ICU (range 2–9) [10]. Among mild cases (no hospitalization) in the United States, 35% had not returned to a usual state of health approximately one week (range 5–12 days) following a positive test [11].

1.3 Epidemiology

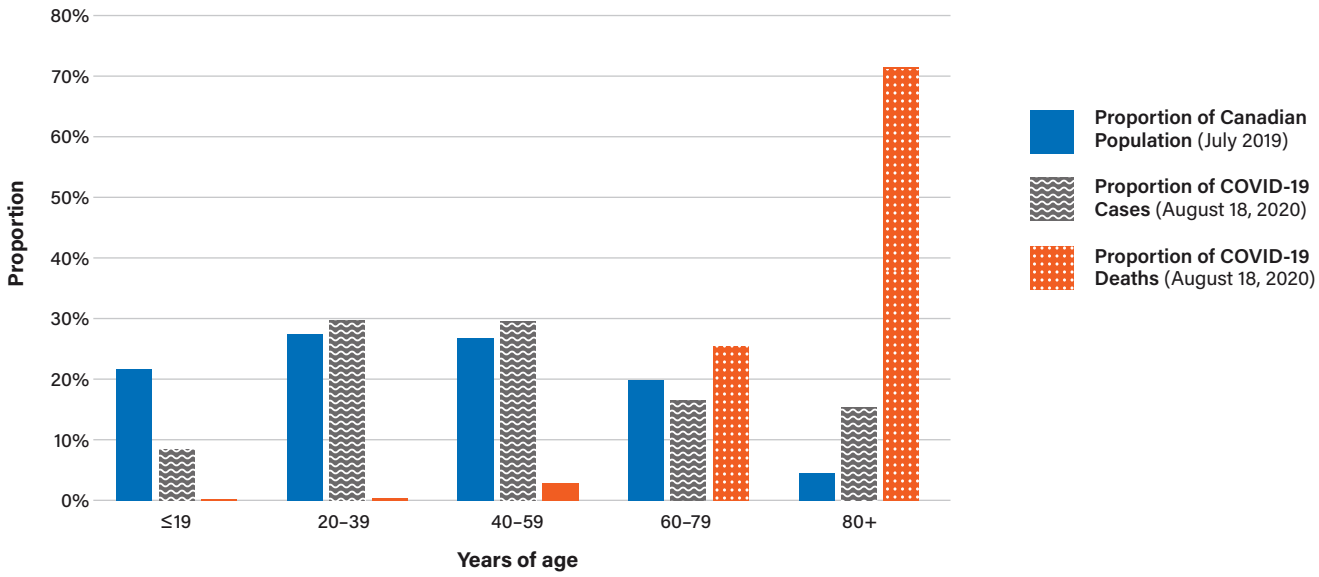
COVID-19 has affected every continent except Antarctica. Globally, cases are expected to continue to rise for the foreseeable future; efforts to mitigate or eliminate COVID-19 vary substantially by nation. In Canada, new daily cases increased rapidly in March 2020 and began to decrease in mid-April 2020. As of August 30, 2020, there have been almost 128,000 confirmed cases in Canada and over 24 million cases worldwide [12], [13].

COVID-19 cases have not been distributed evenly across Canada; incidence varies between places and over time. To date, the majority of cases have been reported in Ontario and Québec, the most populous provinces. The virus has infected individuals across all age and sex groups in Canada, but Canadians over 80 years of age have been disproportionately impacted. Canadians over 80 years of age make up less than 5% of the population but have experienced over 70% of COVID-19 related deaths (Figure 1). Many of the deaths among older adults have been linked to long-term care facilities [14]. Though adults of working age, on average, may be at lower risk of developing severe disease, they can still act as important vectors of transmission, spreading disease to susceptible groups at home and in the community. The higher the incidence of COVID-19 in the local community, the more likely COVID-19 will be present in the workplace.

1.4 Transmission

Initially, it was believed that COVID-19 was spread only by animal-to-human transmission, but quickly it became clear that there was human-to-human transmission [15]. Reports suggest that the incubation period ranges from 2 to 14 days [16], [17]. Several studies have shown that the virus is shed before symptoms begin and that some cases may be entirely asymptomatic [7], [15], [18].

Figure 1: Proportion of Canadian population, COVID-19 cases, and COVID-19 attributed deaths by age category as of August 18, 2020



Source data:
Population: Statistics Canada. Table 17-10-0005-01 Population estimates on July 1, 2019, by age and sex
COVID-19 cases and deaths: https://health-infobase.canada.ca/covid-19/epidemiological-summary-covid-19-cases.html

Infectious disease transmission between humans is conventionally categorized into four routes: direct contact, indirect contact, droplet, and airborne [19]. These are separate and distinct from the routes of exposure described in toxicology and often used in occupational health (inhalation, skin absorption, ingestion, injection).

Direct transmission involves contact with an infected person; indirect contact transmission or fomite transmission does not. Fomites are inanimate objects or surfaces that may be contaminated with the virus. Evidence shows that SARS-CoV-2 can persist on inanimate surfaces in rooms with low humidity and low temperature for up to 9 days under experimental conditions [20]. One study in a laboratory, not under real world conditions, suggested that the virus can stay alive on plastic surfaces for up to 72 hours, stainless steel for up to 48 hours, cardboard for up to 24 hours, and copper for up to 4 hours [21]. Though transmission through contaminated surfaces has not been confirmed, fomites remain a viable route of transmission.

Droplet transmission refers to the transfer of virus containing droplets to the mucous membranes, and can include inhalation of respiratory droplets [15], [22], [23]. Transmission by the droplet route requires close physical proximity, usually considered to be less than 1 to 2 m [24]–[26]. Airborne transmission results from the inhalation of droplet nuclei or aerosols, generally thought to be smaller than 5 µm in diameter and that remain suspended in the air for longer periods of time. Airborne transmission is considered to be particularly important in settings where aerosol-generating medical procedures (AGMP), such as endotracheal intubation and bronchoscopy, are performed [27].

The sharp distinction between droplets and aerosols is misleading as there is a continuum from the droplet-to-droplet nucleus [24]. The process of desiccation, which refers to the removal of moisture, can cause larger droplets to rapidly turn into droplet nuclei that can remain suspended in the air, allowing for transmission over greater distances [24], [28]. A 2011 review by Gralton *et al.* [26] concluded that "particles do not exclusively disperse by airborne transmission or via droplet transmission but rather avail of both methods simultaneously". Recent studies [29], [30] have demonstrated that sneezing, coughing, and exhalation can result in airborne droplets that can travel in the air for up to 10 m from the source [25], [30]–[34]. In hospital wards in Wuhan, China, SARS-CoV-2 containing aerosols were concentrated near patients with a maximum detected transmission distance of 4 m [20], [35]. It has also been found that the virus can be viable in the air for approximately three hours [21].

There was agreement among experts during consultation that inhalation of droplets and/or droplet nuclei during close contact is likely a major contributor to COVID-19 transmission and that direct and indirect contact may also play a role. This conclusion is compatible with the July 9, 2020 announcement from the WHO [36], [37] that aerosol transmission "cannot be ruled out in indoor locations where there are crowded and inadequately ventilated spaces where infected persons spend long periods of time with others".

The infectious dose refers to the number of viral particles required to initiate an infection [38]. The minimum infectious dose for COVID-19 is not known. For SARS-CoV-1, evidence suggests that the infectious dose is approximately 100 to 300 virions [39]–[41]. For Influenza A, the reported infectious dose is approximately 2,000 to 3,000 virions [42]. The more virus-laden droplets that one inhales or comes into contact with, the more likely one is, in theory, to receive a dose that may initiate infection. The potential for larger particles to contain many more virions is one reason why there continues to be concern about contact with larger droplets.

1.5 Prevention: Breaking the Chain of Transmission

Prevention can be defined as keeping something from happening or arising. To slow the spread and reduce the impact of COVID-19, the chain of transmission from person to person must be broken. In the workplace, SARS-CoV-2 represents a new biological hazard that needs to be anticipated, recognized, evaluated, and controlled. The goal is twofold:

1. Prevent SARS-CoV-2 from being introduced into the workplace; and
2. If SARS-CoV-2 is present, reduce worker exposure to SARS-CoV-2 and prevent transmission between people.

"Prevention practices in workplaces will protect not just the workplace but also the larger community."

The current understanding of COVID-19 disease progression, specifically the existence of pre-symptomatic and asymptomatic cases suggests that employers will never definitively know whether SARS-CoV-2 is present in the workplace and will have to work towards both goals simultaneously.

As restrictions ease, businesses are re-opening and more workers are returning to work. Unlike most workplace hazards, SARS-CoV-2 exposure is not limited to the workplace. SARS-CoV-2 is a hazard that workers can bring to work or take home with them, exposing their families, friends, and community members, some of whom may be susceptible to severe disease. Prevention practices in workplaces will protect not just the workplace but also the larger community.

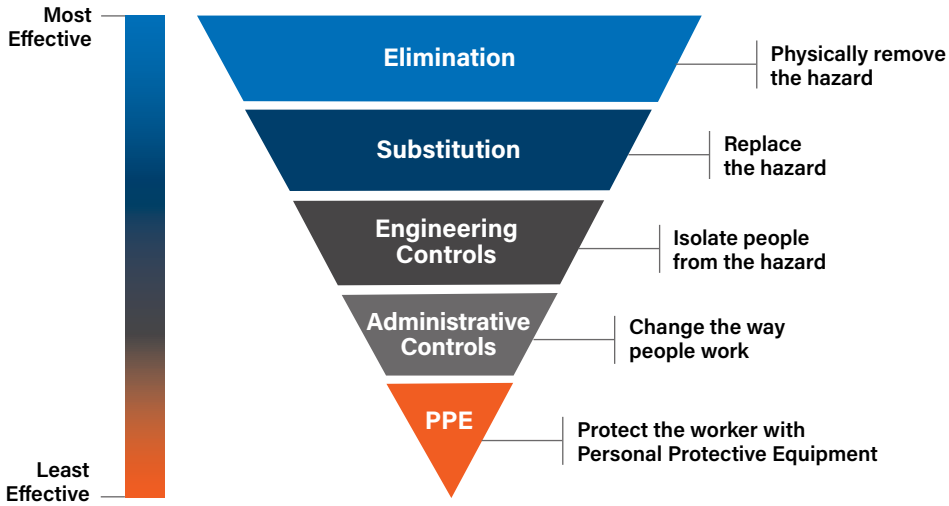
Avoiding close contact through physical distancing is the best way to reduce exposure to droplets and droplet nuclei. Masks are an important control measure to reduce the exposure to viral particles that remain suspended in air, especially in indoor spaces with lower ventilation rates. The importance of close contact in transmission underlies the recommended public health measures for breaking the chain of transmission in the community [43]:

- Staying home if you are experiencing any potential COVID-19 symptoms or have been in contact with someone known to be infected;
- Physical distancing (i.e., maintaining at least 2 m between people);
  - The use of face coverings and masks in indoor environments, and where physical distancing can be difficult to maintain
- Frequent handwashing with soap and water for at least 20 seconds, or the proper use of an alcohol-based hand sanitizer when handwashing facilities are not readily available;
- Avoid touching mouth and eyes with hands;
- Good respiratory etiquette (e.g., covering unexpected coughs with your arm and leaving or avoiding the workplace if they persist);
- Wearing disposable gloves, when practical.

Japan has adopted the message of stressing that people avoid the three "Cs": closed spaces, crowded spaces, and close contact. In British Columbia, the message of "fewer faces, bigger spaces" has also resonated with the public. Limiting the amount of time spent in close contact with any one person is also recommended, as prolonged close contact may increase the probability of transmission from an infected person [44], [45]. The Public Health Agency of Canada defines prolonged close interactions as contacts that last for more than 15 minutes [46] and notes that the effects may be cumulative [45].

The hierarchy of controls should guide the primary prevention of exposure in the workplace [47], [48] (see Figure 2 below and Appendix 1). Ideally, a hazard is eliminated or substituted, such that it is no longer present;

Figure 2: Hierarchy of Controls from the National Institute for Occupational Safety and Health in the United States (adapted from reference [48]). More information also in Appendix 1.



this is a challenge in the context of COVID-19 where workers are not able to work remotely. Engineering and administrative controls can be implemented to support physical distancing between and amongst workers and clients/customers. Engineering controls include barriers between the hazard and personnel, as well as changes to building systems (e.g., ventilation). Administrative controls include adjustments to shift schedules, cleaning and disinfection practices, and additional training. Employers will have to work to create and/or maintain a workplace culture that encourages workers to stay home when they are experiencing COVID-19 symptoms and to effectively implement other exposure-prevention strategies in the workplace.

Results from a recent review of occupational disease prevention strategies suggests that multifaceted interventions are likely to be more effective [49]. In the face of pre- or asymptomatic transmission, implementing multiple prevention strategies against SARS-CoV-2 seems prudent. Each control may be imperfect in isolation, but when implemented together a layering of prevention strategies (controls) should increase the likelihood of a favourable outcome.

1.6 Impact of COVID-19 Pandemic in Canada

As a result of the COVID-19 pandemic, states of emergency were declared across Canadian provinces and territories between March 13, 2020 (Québec) and March 27, 2020 (Yukon) [50]. All provinces and territories in Canada enforced shutdowns to varying extents, reducing the potential for workplace transmission. While most provinces closed non-essential businesses and enforced public health orders, provinces such as New Brunswick and Prince Edward Island and the territories additionally enacted border closures [51]–[55]. In British Columbia, many non-essential businesses were still permitted to remain open if safety measures were in place [56]. These actions resulted in many non-essential Canadian workplaces suspending operations or shifting to virtual operations, with significant economic impacts. Essential workplaces made significant changes to the way they worked but continued to serve the public in the face of a rapidly evolving understanding of the virus.

Following these emergency orders, there was a sharp decrease in mobility around workplaces [57]. This suggests a drastically reduced occupancy in many buildings over several months. Many workers have been working at home out of necessity, rather than by choice.

Many Canadians have lost their jobs [58]. According to Statistics Canada, there were approximately three million jobs lost between March 2020, the beginning of the shutdown, and April 2020 [58]. The unemployment rate in April 2020 was 13%, attributed in large part to the COVID-19 economic shutdown. This translates into a significant portion of the labour force (36.7%) that was either temporarily laid off or working reduced hours.

Aside from the direct effects of COVID-19 among affected individuals, the COVID-19 pandemic is leading to significant psychological stress. In May and June 2020, the Centre for Addictions and Mental Health (CAMH) conducted four surveys of English-speaking Canadian adults from May to July 2020 [59]. They found that 20% of respondents reported moderate to severe anxiety and 18% of respondents reported feeling depressed. Both symptoms were more common among younger Canadians, women, and those with children at home [59].

1.7 COVID-19 and Workplaces

Though the pandemic continues, restrictions are easing. If they have not already, workplaces are considering how they can safely reopen. Buildings are, or will soon be, reoccupied, but likely not to pre-pandemic levels. Building systems will need to be adjusted and monitored to ensure the occupants' physical and psychological health and comfort, while reducing the likelihood of transmission of COVID-19. Organizations and employers will also need to adapt how work is done in order to reduce transmission in the workplace and prioritize the safety of workers while the pandemic continues. Individuals in the workplace need to be prepared for these changes and supported in adopting new work and prevention practices.

Workplace transmission has already been documented; particularly where physical distancing is challenging. For example, an outbreak in a meat processing facility in Alberta led to over 1,500 cases in total, many in the community [60]. Outbreaks in Ontario have occurred among agricultural workers where workers live in congregate settings [61]. Data on workplace outbreaks are also not consistently reported, nor is information on work regularly included in health records, complicating our understanding of the role of workplaces in the spread of COVID-19.

2.0 Knowledge Gap

COVID-19 presents a new challenge for workers and workplaces. The scientific understanding of the virus improves almost daily, resulting in new peer-reviewed literature, recommendations, and guidelines. This is a challenge for researchers, policymakers, and the public. Guidance is needed on how to best reduce exposure and prevent transmission of COVID-19 in Canadian workplaces.

3.0 Aim of Report

The aim of this research report is to review and summarize the occupational health and safety prevention practices that will support the safer reopening and ongoing operation of workplaces during the COVID-19 pandemic.

This research report considers actions that could be taken in Canadian workplaces. The review was limited to occupational health and safety prevention practices that could be taken at the workplace level; regulatory or policy changes were not considered to be within its scope. Prevention practices are likely to be implemented differently across workplaces, but the underlying principles are the same.

Patient-facing health care settings and activities of first responders were explicitly excluded as exposure occurs under different circumstances, and higher levels of protection are needed. However, there are patient-adjacent roles within the health care and emergency services sectors for whom the contents of this report may be applicable.

Though there is insufficient scientific evidence specific to COVID-19 to fully inform the design and implementation of prevention measures, there is a need to act in the face of uncertainty. Existing knowledge in the areas of occupational health and safety, epidemiology, and infection control and prevention can be utilized to

"Existing knowledge in the areas of occupational health and safety, epidemiology, and infection control and prevention can be utilized to implement prevention strategies."

implement prevention strategies. This report reviewed evidence and opinion from industry experts specific to COVID-19 but many of the ideas and principles described may be useful in controlling other infectious diseases and future pandemic situations.

This report was written for the Canadian context. Readers of this report should consult the applicable federal, provincial, and local bodies in their jurisdiction to ensure that any actions taken are aligned with existing and any new regulations and guidelines.

4.0 Methodology

Beginning in May 2020, a scan of guidelines, technical standards, and grey literature related to COVID-19 and the reopening of workplaces or returning to work was completed using Internet search engines, occupational health and safety networks, and an iterative search strategy. A literature search of the scientific (peer-reviewed) literature was also conducted using PubMed and MEDLINE. Search terms included "COVID" and "SARS-CoV-2" in combination with terms such as "personal protective equipment", "occupational hygiene", "disinfection", and "workplace".

Following the document scan and literature review, a summary of the existing guidelines and the related scientific evidence was drafted. The draft report underwent three rounds of rapid peer review. In Round 1, an early draft was circulated to 31 subject area experts for review and comments; 24 (77%) experts provided feedback. In Round 2, a broader group of 68 industry and subject area experts were invited to provide comments on a subsequent draft; 22 (32%) provided feedback. In Round 3, we solicited comments from 33 senior leaders in occupational and public health across Canada; 16 (48%) provided feedback. During the review process, some invited experts distributed the draft to contacts in their personal networks (with permission), and additional comments were received from those individuals.

After each round of feedback, the draft research report was edited and refined in response to the received feedback. Differences of opinion or interpretation have been noted in specific sections of the report. Following the completion of the research report (Part A), the key messages from the research report were simplified and formatted into a guidance document (Part B). The research report and guidance document may be used as the starting point for developing a new Canadian standard for workplaces to use during an infectious disease pandemic.

5.0 Main Findings

COVID-19 is a new infectious, biological hazard facing all workplaces where people congregate and share space. There are very few workplaces whose operations will be unaffected by COVID-19. The risk of transmission in a workplace will depend on many factors, including the incidence and prevalence of COVID-19 infection in

the local community. At a basic level, the more cases there are in the community, the higher the likelihood that workers may introduce the virus into the workplace, increasing the likelihood of transmission to and from workplaces.

COVID-19 differs from most workplace hazards because workers are the source of exposure. Rather than eliminating or isolating a machine or chemical process, workplaces must minimize close contact and avoid sustained interactions between people to reduce the probability of exposure and transmission. This presents a new and unique challenge for most workplaces. Further, COVID-19 can be contracted both inside and outside of the workplace. When contracted at work, COVID-19 has the potential to impact many people outside of work, including individuals who may be elderly, immunocompromised, or otherwise high risk, including the worker's immediate family and broader community. COVID-19 demonstrates the close connection between occupational health and public health.

As businesses reopen and workers return to work, organizations will have to carefully consider how COVID-19 impacts their operations. The first question every organization needs to answer is, *"For our operations to resume or continue as safely as possible, who must be working on-site?"* The only approach that can fully eliminate possible COVID-19 exposure is for workers to move entirely to remote or isolated workplaces where they do not interact with other workers, clients, or other personnel. This will be unrealistic for many organizations. For workers who need to be on-site, the risk of exposure must be minimized to the extent reasonably possible.

5.1 Risk Assessment

Assessing the risks faced by workers returning to the workplace is critical. This assessment should be tailored to each job, and not using a one-size-fits-all approach [62]. For example, before reopening, WorkSafeBC requires all businesses to conduct an assessment regarding the risks and hazards for COVID-19 transmission in the workplace, as well as other workplace hazards [63]. This should include, where applicable, a walkthrough survey to identify the tasks or conditions that may increase the transmission of COVID-19. Jobs that are likely to have high exposure are those where there is close contact with other people and lower ventilation rates. Risk is substantially increased if there is contact with suspected or confirmed cases of COVID-19, especially in enclosed spaces and as the duration of exposure increases. Risk for workers with permanent disabilities and the impact of any accommodations on risk should be considered as part of this process. Risk assessment of COVID-19 should be incorporated with risk assessments for other workplace hazards to ensure such control strategies implemented do not increase the risk of existing hazards, creating new hazards, or conflicting with other control measures already in place.

Frameworks for assessing risks have been developed by several groups [62], [64]. The WHO's approach is simple and straightforward (see Table 1), categorizing jobs into three risk levels (low, medium, high), based on whether the job requires close contact with other people and whether those other people include known or suspected cases of COVID-19 [62].

Table 1: Risk Categories, modified from the World Health Organization (WHO) [62]

Close Contact with People	Contact with Known or Suspected COVID-19 Cases?	WHO Risk Category
No	No	LOW
Yes	No	MEDIUM
Yes	Yes and/or contact with contaminated surfaces	HIGH

5.2 Cross-cutting Themes

5.2.1 Health and Safety Culture

According to the WHO, the promotion of health and safety is a collective effort of employers, supervisors, and workers. This is aligned with occupational health and safety in Canada, which emphasizes the importance of the internal responsibility system (IRS). The IRS philosophy is that every person within the workplace is responsible for health and safety, and the degree of responsibility depends on their position within the workplace [65], [66].

Culture is the environment embedded with individual and collective attitudes, values, and perceptions that influence workers' behaviour and determine their commitment to safety management [67]. Culture has been shown to be an important indicator of health and safety performance [66], [68]. Good safety culture also leads to greater compliance with workplace safety policies and procedures. Poor safety culture creates obstacles to meeting the recommendations set by the employer in the workplace [69]. Work and workplaces are changing rapidly as a result of COVID-19. A strong health and safety culture is likely to help workplaces adapt quickly to ensure the health and safety of their workers and the success of their business. Strong safety culture is inclusive and considers workers with permanent disabilities and aging adults in all aspects of occupational health and safety.

During the expert review and consultation process, many occupational health and safety management approaches were suggested as possible tools for supporting or developing stronger safety culture, and for managing COVID-19 risk (e.g., the "plan, do, check, act" cycle). ISO 45001:2018 *Occupational Health and Safety Management Systems* provides detailed guidance on developing an occupational health and safety management and the required elements. Worker involvement is a critical component of an effective occupational health and safety management system (OHSMS) and a contributor to a good health and safety culture. Workers have valuable insights into their job tasks and how they could be modified to improve safety; this knowledge should be sought during the risk assessment process to help tackle the workplace challenges of COVID-19.

5.2.2 Communication

There will need to be an ongoing dialogue between workers, supervisors, and employers during the COVID-19 pandemic. Communication should be honest, consistent, and provide specific information, while acknowledging emotional states, as uncertainty related to the COVID-19 pandemic can be associated with anxiety, depression, and distress [70].

Due to the uncertainty related to the COVID-19 pandemic, modifications of guidelines will occur repeatedly as new information becomes available; therefore, frequent communication with management, supervisors, employees, contractors, and vendors is recommended [71]. Written communication should be translated into the majority workplace languages and made available in accessible formats (e.g., audio, American Sign Language, large print). Employees should be informed about any changes in policy, administration, and workforce patterns through various methods [72]. Clear communication will help employees understand the steps taken by organizations and building owners and the role workers play in the new systems and approaches. Onsite communication in the form of signage at all points of entry and key locations is recommended, as it reinforces public and occupational health measures that are in place [73].

5.2.2.1 Worker Consultation

Communication should not flow only from employer to employees. Worker consultation supports workers in voicing their concerns relating to health and safety at the workplace and helps in determining their needs and expectations. This aligns with the employers' legal responsibility to protect workers [74]. Worker participation is also an important aspect in joint decision-making; Joint Health and Safety Committees (JHSC) are one formal structure for supporting worker involvement, but many others are possible [75]. In unionized workplaces, there should be consultation with labour groups and union officials.

"The operation of heating, ventilation, and air conditioning (HVAC) systems also has the potential to influence COVID-19 transmission."

5.2.2.2 Risk Perception

Response to risk is impacted by risk perception. The perception of risk can vary substantially between individuals who face similar levels of risk. Workers who perceive the risk of COVID-19 to be high are more likely to comply with new policies and procedures to protect against COVID-19 than those who perceive the risk to be low. In March 2020, a survey conducted in Germany reported that people were mainly worried about acquiring COVID-19 in places with high public traffic, such as public transportation, shops, and restaurants [76]. During the same time, Wise *et al.* [77] characterized risk perception in the United States and reported that individuals were likely to underestimate their personal risk to COVID-19 relative to the average person. Employers will have to provide clear and ongoing communication about local risk, regularly seeking out up-to-date information from local public health officials.

5.3 Prevention in the Workplace

As restrictions ease and workplaces reopen, practices for preventing the introduction and transmission of COVID-19 in the workplace will need to be implemented. Practices that should be considered for reducing the risk of COVID-19 in workplaces can be organized into three domains:

1. ***Building Systems*** (Domain I) that are critical to the safe and healthy operation of a building, including engineering controls;
2. ***Workplace Organization*** (Domain II) that focuses on the physical design of the workplace, including engineering, administrative, and personal protective equipment (PPE) controls; and
3. ***Supports for Individual Workers*** (Domain III) that focus on efforts to improve or maintain an occupational health and safety culture that can support positive physical and psychological health in the workplace, including elimination and administrative controls.

5.3.1 Domain I: Safer Operation of Building Systems During COVID-19

Since the restrictions were placed on non-essential businesses, many buildings have been closed to the public or have had reduced occupancy. This decrease in building system usage raises concerns that microbiological or chemical hazards may be present upon return to normal operations; *Legionella* is of particular concern. The operation of heating, ventilation, and air conditioning (HVAC) systems also has the potential to influence COVID-19 transmission [78], [79].

When reopening after complete shutdowns or after periods of operation at reduced occupancy, the employer or building manager should conduct a review of all building systems. There is no specific definition of reduced occupancy, or clear guidance on what length of shutdown should trigger specific actions prior to reopening. For agents such as *Legionella* and mould, a

period of reduced operations may be of concern after days, weeks, or months, depending on building and plumbing-specific factors [80]. Periods of low or no use can occur routinely in some types of buildings (e.g., seasonal buildings like schools and hotels, or during renovations); procedures used in these situations may be helpful.

Domain I provides a description of some aspects of the operation and maintenance of building systems that will be useful during the COVID-19 pandemic. It is suggested that comprehensive referenced guidance documents be consulted for more details on the procedures. The impact of any action or change to the building system on occupants and the building itself should be reviewed by a qualified person beforehand. The preparation of buildings for reopening may expose the workers involved to many hazards; this work should be done in compliance with all local occupational health and safety regulations.

5.3.1.1 Legionella

Microbial growth in buildings is a common and serious problem. *Legionella,* a gram-negative bacterium that causes legionellosis, is of particular concern [80], [81]. There are two clinical forms of legionellosis: Legionnaire's disease, which is a type of pneumonia, and Pontiac fever, which is milder and resembles the flu with no indication of pneumonia [81], [82]. Data from the United States indicate that *Legionella* is the most common cause of water-borne illness, despite significant underreporting [82].

In 2018, Spiegelman *et al.* [83] conducted a small study in Toronto, Ontario, among patients with pneumonia and found that 28% of pneumonia cases were actually Legionnaire's disease, demonstrating the underdiagnosis of this disease. In the same year, Public Health Ontario reported 333 confirmed cases of legionellosis [84]. Though outbreaks of diseases caused by *Legionella* are not uncommon, most are sporadic and community acquired with no link to a known source [82].

Exposure to *Legionella* occurs through aerosols generated at points of discharge in domestic piping, such as showers, sinks with aerators, and open water systems like spas and whirlpools. Domestic hot water systems may be particularly vulnerable to *Legionella* growth where thermostatic mixing valves (tempering valves) are installed at the outlets of water heaters to prevent scalding at point-of-use. HVAC systems are also common culprits. Cooling towers and evaporative condensers within HVAC systems provide an ideal ecological niche for *Legionella,* which can proliferate in these reservoirs, especially in biofilms [85]. A review of Legionnaires' disease and Pontiac fever outbreaks that occurred between 2006 and 2017 revealed a notable association with cooling towers [86]. Guidance specific to *Legionella* is available from several organizations, including ASHRAE [87] and the CDC [80]; this guidance overlaps with the recommendations for HVAC (Section 5.3.1.2) and water systems (Section 5.3.1.3).

5.3.1.2 HVAC Systems

Reduction of inhalation exposure to COVID-19 can be achieved by reconfiguring HVAC systems to increase the air exchange rates, minimize recirculation, and improve filtration (engineering controls) [88]. In principle, interpersonal exposures to virus-laden aerosols are more likely to occur in poorly ventilated spaces where employees have prolonged close contact with one another. Lunch, break, and meeting rooms that lack adequate ventilation may therefore be settings where risks of transmission are elevated. Given this possibility, consideration should be given to optimizing mechanical and natural ventilation in the workplace, and particularly in locations where prolonged close contact occurs.

5.3.1.2.1 HVAC Operation Before Reopening

Before reopening a building, it is important to verify that outdoor air delivery rates to individual occupied spaces are, at minimum, conformant to the recommendations proposed in ASHRAE 62.1-2019 *Ventilation for Acceptable Indoor Air Quality* in mechanically ventilated facilities. This will limit the accumulation of air contaminants, including airborne SARS-CoV-2. For older buildings that may be unable to meet the current ASHRAE 62.1 Standard, it is recommended to recommission the HVAC system as per the CAN/CSA Standard Z320-11 *Building Commissioning* (CSA Z320). Where possible, air

"Filtration, either through stand-alone air cleaners or via improving or upgrading the HVAC system filtration, can be used to reduce viral particle concentrations in recirculated air."

handling units should be adjusted to maximize outdoor air intake and indoor air exhaust to outdoors, again with a view to minimizing air contaminant accumulation.

The National Institute of Occupational Safety and Health (NIOSH) has written a guide for reopening after flood contamination, but some aspects are relevant for reopening after any shutdown. NIOSH recommends that a qualified professional, such as an HVAC expert, visually inspects all air distribution systems for dust and dirt accumulation, damaged insulation, or possible fungal growth on coils, drain pans, ducts, and inside casings [89]. Additionally, outdoor air intakes and bird/insect screens should be cleaned of any debris and/or obstructions. ASHRAE *Standard 180-2018 Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems* provides guidance on the maintenance of commercial HVAC systems broadly, and notes that control dampers and actuators should be assessed across their full functional range, which could include cleaning, lubricating, repairing, or adjusting to ensure proper operation. NIOSH also suggests that an HVAC system that has not been active during a prolonged shutdown should be operated between 48 and 72 hours at a comfortable temperature and with outdoor air dampers opened maximally prior to reoccupancy [89]. This has no effect on the potential for subsequent COVID-19 transmission but will reduce air concentrations of contaminants emitted from building finishings and contents before reoccupancy.

5.3.1.2.2 HVAC Operation During Reoccupancy

Once the building's HVAC system is up and running again, the continued operation of the HVAC system at a reduced capacity during the pandemic will also require careful consideration. Ideally, HVAC intakes and returns will be cleaned before reopening and any high touch points in the system (e.g., thermostats) will require regular cleaning and disinfecting (see Domain II).

To improve occupant wellness during COVID-19, the air exchange rate should be optimized to maximize the effective ventilation per person [88], [90], [91]. This could be achieved by disabling demand-controlled ventilation (DCV), upgrading fans to handle higher air flows or filter pressure drops, and opening outdoor air dampers to reduce recirculation of air. Li *et al.* [92] reviewed studies that looked at the association between infectious diseases (SARS, influenza, tuberculosis) and ventilation. They concluded that there is strong evidence that increasing ventilation rates reduces transmission [92]. However, the air exchange rate should be modified on a building-by-building basis with careful evaluation of the ventilation system because ventilation adjustments can lead to thermal comfort issues, poor humidity control, and changes to air circulation that could influence viral exposure unpredictably. ASHRAE Standard 62.1-2019 *Ventilation for Acceptable Indoor Air Quality* can be referred to for space-specific air delivery rates in a building. Increasing the outdoor air intake rate on poor air quality days might also result in poorer indoor air quality; this could be mitigated by improving filtration.

Filtration, either through stand-alone air cleaners or via improving or upgrading the HVAC system filtration, can be used to reduce viral particle concentrations in recirculated air. In buildings with mechanical air supply, the filtration of the air handling unit (AHU) should be increased to the Minimum Efficiency Reporting Value-13 (MERV-13) or higher as suggested by ASHRAE [93]. Azimi and Stephens [94] modelled the risk of infectious disease transmission (influenza) in a hypothetical office space. They showed that using higher efficiency filtration (MERV-13 or higher) resulted in a decrease of the airborne load of infectious particles, and thus, reduced risk of infection. When a central HVAC is employed, the transport of infectious agents from one area to another is greatly reduced with improved filtration of recirculated air. Depending on the fan and the system, this may be possible but should only be considered when airflow is not significantly reduced and when minimum air supply rates as specified in ASHRAE Standard 62.1-2019 *Ventilation for Acceptable Indoor Air Quality* can be maintained.

A systemic approach is required when increasing filtration as it may influence the effective ventilation and pressurization inside the building. It is important that the fan has sufficient capacity to support airflow through the filtration media. In addition, filter installation and maintenance are important to a filter's performance. When installing, ensure the filter is properly gasketed and tightly fitted to minimize leakage. For smaller rooms, high-traffic areas, or if ventilation cannot be improved, portable air purifiers (with HEPA filters) situated close to the workers' breathing zones may also be used. This can be used in addition to physical distancing and not as a replacement [88], [90], [95]. Portable air purifiers should be properly sized according to the space that they are being used in to ensure adequate airflow through the filter.

Where air is being recirculated, natural ventilation can be utilized to the extent tolerated by the building's mechanical systems. Gilkeson *et al.* [96] demonstrated the value of natural ventilation in a study looking at naturally ventilated hospital wards where closure of windows and doors led to a higher risk of infection. Given this reduction in risk, it is important to utilize natural ventilation where possible, such as opening windows for three to four hours during the work shift and opening loading dock doors, to reduce concentration of airborne pathogens. However, the proximity of opened windows and doors to outdoor emission sources, such as idling delivery vehicles, can introduce additional hazards (e.g., diesel exhaust) and can adversely affect building pressurization. Additionally, it is important to be cautious of air current directions generated by open windows to prevent movement of air past one person to another, particularly within breathing zones.

There is a growing interest in air disinfection devices. Morawska *et al.* [97] noted the potential usefulness of local air disinfection devices in situations where improving ventilation is difficult. Ultraviolet germicidal irradiation (UVGI) has been used for air sterilization within an HVAC system or in smaller areas using wall mounted units [98]. As per the Illuminating Engineering Society (IES) Photobiology Committee [99], UV fixtures are mounted in an occupied space at a height of approximately 2.1 metres (7 feet) or higher. Walker and Ko [100] tested the effects of UVGI on three viral aerosols, including a coronavirus that is a surrogate of SARS-CoV-1, and found it was effective. However, it is important to note that the effectiveness of UVGI depends on the specific pathogen as well as the intensity and duration of UV exposure. UV exposure can also lead to adverse skin and eye effects; the potential for exposure to occupants, customers, clients, and maintenance personnel should be considered when selecting and implementing these tools [101]. UVC is germicidal at wavelengths of approximately 254 nm; at shorter wavelengths (approximately 185 nm), ozone can be generated [102]. Some devices have a wide wavelength distribution and may generate ozone unintentionally. Environmental considerations with respect to the disposal of UV lamps would also need to be addressed.

Once the building has been reoccupied, normal operating temperatures and relative humidity should be maintained in accordance with the ranges recommended in ASHRAE Standard 55-2013 *Thermal Environmental Conditions for Human Occupancy.* An appropriate balance will need to be found between maximizing the outdoor air ventilation and meeting this ASHRAE standard. It will be important to operate buildings in accordance with the ASHRAE standard to

"Complete shutdown or reduced operation of buildings may lead to hazardous chemical and microbiological exposures as well as poor water quality."

reduce potential condensation issues on cooler building envelope components due to higher indoor relative humidity, which could lead to mould growth. This balance will change depending on factors such as the season, outdoor weather conditions, indoor heat load, occupant density, cooling and heating capacity of the equipment, pressure drop/fan capacity of the system, and exhaust capacity for the building. For example, to prevent condensation, mould, and damage to interior finishes during the winter season, the temperature setting should be above the dew point, particularly for the interior elevations of exterior walls near windows and mechanical penetrations. Whereas, in the summer, the temperature setting should prevent excessive heat, and relative humidity should be below 60%.

Depending on the system design, heat recovery systems may need to be bypassed or shut down if there is the potential that they could contaminate the air flowing into the outdoor air supply [91]. For example, rotary heat exchangers should be turned off during this time as resuspension of deposited particles on the return air side may occur when the heat exchanger turns to the supply air side [95]. If they cannot be bypassed, regular inspections should be performed to ensure leakage is minimized and appropriately managed to prevent potential cross-contamination issues. When workplaces are occupied during the COVID-19 pandemic, the HVAC systems should be running for longer hours to help flush out contaminants (particularly before and after working hours, even if at a reduced rate) [90].

5.3.1.2.3 Cooling Towers and Evaporative Systems

All building owners and managers should ensure evaporative systems, including cooling towers, are cleaned and well-maintained as per municipal, provincial, and federal regulations and guidance following industry best practices [80], [87], [103]–[105]. Special attention should be given to periods of shutdown and start-ups. If the cooling tower was off for the season, follow the appropriate start-up procedures. If the cooling tower is no longer required, complete a complete shutdown procedure. If the cooling tower remained in operation, building managers should verify if water treatment target levels are being maintained [106].

During reduced building occupancy, cooling towers may be idle more frequently. It is important to avoid non-continuous operations to ensure that water circulates regularly through all components, water treatment systems are functioning, and validation testing (chemical and bacterial) is completed [106], [107]. The PSPC Standard MD 15161-2013 *Control of Legionella in Mechanical Systems* requires a system that does not operate for three days to be shut down and drained. Unless already required by regulations, water quality and *Legionella* testing should be considered for high-risk buildings, including those with vulnerable occupants, a history of positive *Legionella* tests, a history of water-associated legionellosis, or those with substandard maintenance and operations.

5.3.1.3 Building Water Systems

Though water systems are generally not part of an occupational health and safety program, complete shutdown or reduced operation of buildings may lead to hazardous chemical and microbiological (e.g., *Legionella*) exposures as well as poor water quality. Water systems can introduce hazards into the building environment that affect all occupants. These systems must be actively managed to maintain water quality while unoccupied or partially occupied. Building owners and operators will need to implement recommissioning procedures to ensure the health of building occupants when reopening their buildings. The proper maintenance and management of water systems also carries the risk of exposure for the workers undertaking this work. Building owners and operators are advised to develop a water management program to manage all their water systems and to involve qualified professionals in this process [80].

Decreased water use will increase water stagnation in the hot and cold water systems. Stagnation occurs when water is not being used and remains standing within the plumbing network. Identified hazards include high concentrations of toxic metals, loss of disinfectant residual, and the development of pathogens such as *Legionella* and non-tuberculous mycobacteria. Water applications such as decorative fountains, pools, humidifiers, misters, hot tubs, etc. can also pose a significant exposure risk and have been shown to cause outbreaks. Building managers should proceed to clean, maintain, and verify the proper operations of these applications before reopening. Appropriate cleaning and disinfection procedures should be completed according to manufacturers' or other relevant guidelines and regulations. Some bodies recommend not operating decorative features and drinking water fountains that require close contact during the COVID-19 pandemic [107]. Building owners and managers should also ensure evaporative systems, including cooling towers, are clean and well-maintained as per municipal, provincial, and federal regulations. More information on these systems can be found in Section 5.3.1.2.3.

Flushing of the building water systems and fixtures is recommended as a minimum procedure to manage and recommission water systems. Detailed guidance on the management of water systems during or following a period of low or no occupancy, during normal operations or caused by emergency shutdowns, can be obtained from several sources, including the US Centers for Disease Control and Prevention (CDC), the Environmental Protection Agency (EPA) [108], the American Water Works Association (AWWA) [82], and ASHRAE [87], [103]. The guidance from the AWWA, "Water System Flushing and Disinfection in Buildings with Reduced or No Water Use. A Framework for Building Managers," will be available in the fall of 2020 [82]. Federal guidance include Public Services and Procurement Canada's (PSPC) water requirements [107] and MD 15161 – 2013 *Control of Legionella in Mechanical Systems* [104].

5.3.1.3.1 Water System Operation Before Re-Opening

After a period of low or no occupancy, and before reopening the building, building managers should conduct remedial flushing to replace all water in the system with fresh cold and hot water to minimize the risk of exposure to contaminants such as *Legionella* and metals. Flushing can cause worker exposure to microbiological, physical (heat), and chemical exposures; it is important that worker health and safety be prioritized. Building managers and employers are advised to seek the opinion of a qualified person before undertaking flushing.

Progressive replacement of all water in the building can be achieved by (1) flushing the service line to bring fresh water from the distribution system to the entry point; (2) flushing the primary hot and cold piping (risers and branches) by operating devices on the pipe farthest from the point of entry to renew water in large piping; (3) flushing all fixtures for a minimum of five minutes each for cold water then hot water at a high flow rate, and activating toilets and urinals. Recent COVID-19 flushing guidance specifies time-based recommendations ranging from two to five minutes for reasons of practicality [91], [109], [110]. However, the frequency, length, flow, and time to conduct flushing may vary between buildings and within zones of the building and adjusting the duration of flushing based on temperature or residual disinfectant can be considered (see guidance from PSPC, RBQ, AWWA, etc.). Aerators and shower heads restrict flow and can be colonized by

Legionella and other disease-causing microorganisms. Where possible, remove, clean/descale, and disinfect aerators and shower heads prior to flushing. To conduct cold and hot water flushing, it is necessary to deactivate electronically activated faucets and thermostatic mixing valves.

Building managers and operators should also verify that the hot water heater system is operated at temperatures that limit the growth of *Legionella* (greater than 49°C throughout the system and greater than or equal to 60°C in the hot water heater) [87]. Onsite disinfection systems to prevent *Legionella* (if present) should be checked to ensure they are operating as intended and adjusted as necessary [103], [111], [112]. Plumbing traps should be inspected and refilled if they have dried out, with attention to floor drains.

5.3.1.3.2 Water System Operation During Reoccupancy

During a period of low or no occupancy, it is recommended to also conduct preventative flushing to minimize the loss of water quality until normal occupancy to the building is re-established. Periodic preventative flushing aims to bring fresh water into the water systems during periods of no or low occupancy. As is the case for remedial flushing, this consists of three steps: (1) flush the service line, (2) flush the primary piping, and (3) flush all fixtures. The optimal frequency of preventative flushing at each point should be determined by considering the building water use, vulnerability of occupants, and resources available. Flushing frequencies recommended in recognized guidance documents range from every three days to monthly [103], [107], [110], [111]; CAN/CSA Z317.1 *Special Requirements for Plumbing Installations in Health Care Facilities* (CSA Z317.1) recommends flushing twice a week for health care facilities.

Building managers and operators should also continue to ensure that the hot water heater system is operated at temperatures that limit the growth of *Legionella* (greater than 49°C throughout the system and greater than or equal to 60°C in the hot water heater) [87]. Onsite disinfection systems to prevent *Legionella* (if present) should be checked to ensure they are operating as intended and adjusted as necessary [103], [111], [112].

5.3.1.3.3 Water Testing and Remediation

Testing water quality can play a valuable role when conducted during recommissioning or within a water management program framework [78], [103], [104]. Proctor *et al.* [78] reviewed how building water systems may be affected by building closures during the COVID-19 pandemic and provide a comparison of testing recommendations. It is recommended to test for water quality parameters, such as temperature and disinfectant residual, to assist commissioning [109], [110], [113]. While not typically required for occupied buildings, more extensive water quality monitoring is required when commissioning new buildings. Testing is the most definitive way to ensure that water in a building is ready for use [78].

If a building owner or manager chooses to perform water quality testing to confirm if water is safe and/or meets regulations/guidelines, it should be conducted once flushing or other recommissioning interventions have been completed, disinfection levels and temperature have stabilized, and prior to reoccupancy. Federal, provincial, and territorial sampling and analytical requirements should be followed. Testing for lead and copper is recommended unless there is evidence of low levels of metals before the shutdown or if a certified filter to remove lead and copper is in place [82], [114], [115].

Testing for *Legionella* should be considered and is often recommended for high-risk buildings (e.g., those with poor temperature and disinfectant control, history of positive *Legionella,* a history of water-associated legionellosis, vulnerable occupants, or the presence of aerosol-producing devices) or to confirm if interventions were successful [80], [82], [87], [107], [111], [116]. *Legionella* testing in water should be conducted using an approved culture method by a laboratory with demonstrated proficiency. The presence of *Legionella* can be detected more quickly by using polymerase chain reaction (PCR) tests, but PCR based results are not indicative of the risk of infection and should be followed with culture [81], [82], [104].

Shock disinfection is typically required when commissioning a new building and could be considered for recommissioning after extended shutdowns,

"When implementing flushing or disinfection procedures, the occupational health and safety of workers must be protected."

particularly for high-risk buildings, those with pre-existing *Legionella* contamination, and in buildings with a positive *Legionella* test result. Where high levels of *Legionella* are found after system clean-up, remediate using methods such as repeat flushing, shock chlorination or thermal disinfection, and conduct follow-up testing [103], [107]. Shock disinfection must be performed if water systems are drained [82].

Disinfection will require the development of a site-specific procedure by a qualified professional in order to meet all federal, provincial/territorial, and municipal regulatory requirements and take into consideration the material of piping fixtures and fittings, the age and condition of the system, and the disinfectant present in the municipal water.

5.3.1.3.4 Health and Safety

When implementing flushing or disinfection procedures, the occupational health and safety of workers must be protected [78]. Exposure to high water temperatures of greater than 50°C poses a scald risk that can be managed by precautions during flushing. When flushing water systems by turning on faucets, showers, and other fixtures for a few minutes, aerosols will form. These could potentially be contaminated with *Legionella*. Exposure to contaminated aerosols poses an infection risk and prevention measures should be implemented using the hierarchy of controls, including the use of respirators and other personal protection equipment (PPE) [80], [82], [107], [110], [117].

5.3.1.4 Washrooms

The current evidence suggests that the probability of oral-fecal COVID-19 transmission is likely low and not a significant route of exposure; however, there is evidence that oral-fecal transmission may be possible [118]. Zhang *et al.* [119] and Chen *et al.* [120] found RNA fragments of the SARS-CoV-2 virus in stool samples. Based on the evidence, precautions for the maintenance and use of washrooms are recommended.

Room pressure differentials are important for controlling airflow between areas in a building, which is of relevance for washrooms. Air flows from the areas with positive-pressure to the areas with negative pressure. In health care settings, engineering controls such as negative-pressure rooms are used extensively for airborne hazards [121]. In non-health care workplaces, and according to building codes and standards (ASHRAE Standard 62.1), there should be negative pressure in the restroom facilities to prevent odours from migrating into other spaces. This has the benefit of reducing the spread of any aerosolized fecal SARS CoV-2 contamination from the washroom. However, this may not prevent exposure of occupants using washrooms, especially as exhaust fans are typically in the ceilings and may draw air from toilets up through the breathing space of washroom users.

Faucets with aerators that generate excessive spray should be replaced or restricted from use as this might cause aerosolization and spread of *Legionella,* if present. Moreover, adjacent stalls, sinks, and urinals should be

closed to maintain physical distancing in the washroom facility. Occupants should be directed to flush toilets with the lid closed, where possible, to reduce exposure to droplets and droplet residue [95]. Best et al. [122] showed that flushing of lidless toilets led to airborne and surface contamination of *Clostridium difficile* as a result of aerosolization.

Though opening windows and doors in work areas is generally recommended, this should be avoided in washrooms where negative pressurization is maintained; an open window may unintentionally reverse the direction of air flow leading to contamination of other rooms [95]. Generally, hand dryers should be avoided. Hand dryers have been shown to lead to bacterial contamination of the dryer itself, as well as other surfaces within restrooms [123]. Disposable paper towels are recommended instead of hand dryers. Further, it is advised to keep the washroom doors closed. Ideally occupants would use a paper towel to open/close the door and dispose of the paper towels in an adjacent bin. High-touch surfaces such as doors, handles, and faucets should be regularly cleaned and disinfected.

5.3.1.5 Other Building System Considerations

After a prolonged shutdown and before occupants return to work, buildings should also be assessed for mould and excess moisture [80]. Excess moisture and mould growth can arise in poorly maintained buildings, causing respiratory and allergic effects among occupants [124]. If mould is present, clean-up and remediation should be conducted before the building is reoccupied [125]. Prior to reoccupancy, it is also important to inspect and maintain life and personnel safety equipment such as fire sprinkler systems, safety showers, fire alarms/smoke detectors, and eye wash systems. In addition, inspection of natural gas lines and other specialized equipment for damage is important.

5.3.2 Domain II: Workplace Organization During COVID-19

Workspaces will need to be altered to help employees, customers/clients, and other people on-site maintain physical distance of at least 2 metres between individuals [126], [127]. Engineering and administrative controls in the workplace can help maintain physical distance [71]. Personal protective equipment (PPE) can also be used to reduce the possibility of transmission [71]. Multifaceted interventions are likely to be more effective at reducing transmission where SARS-CoV-2 is present [49]. Tasks and processes conducted in the workplace need to be examined to determine how they are impacted by COVID-19 considerations. For example, physical distancing, barriers, and PPE requirements will alter the way many tasks are performed. Safe work procedures (SWP) will need to be developed that describe updated work practices.

5.3.2.1 Physical Distancing to Reduce Close Contact

In many settings, physical distance can be safely maintained by reducing the number of workers on-site. Organizations will have to review their operations to identify the workers who need to be present on-site, and at what times they are needed. For other workers, options such as working in isolation (e.g., alone in a shop or in the field) or working remotely (e.g., at home) should be considered wherever feasible. Visits by contractors, visitors, and non-essential service providers to the workplace should be minimized.

For workers who are required to be on-site, many options to promote physical distancing can be explored, including rotating schedules, flexible work hours, staggered start times, shiftwork, or the addition of extra shifts so that workers are not simultaneously on-site. These adjustments could also likely lead to some workers avoiding rush-hour traffic and crowded commuting environments. Workers could also be organized into groups or pods, or cohorts, to minimize the number of contacts between workers [128]. Of note, adding a night shift, for example, would introduce hazards that may not have been present in the workplace previously, including low-light conditions, shift work, and fatigue; any new hazards introduced should be considered when making adjustments to the workplace [129].

5.3.2.1.1 Workplace Design

Physical distancing between employees can be supported by modifying the workspace. As an administrative control, signage pertaining to physical

distancing should be placed at multiple, relevant locations in the entry sequence and by reception counters or greeting areas of the workplace to inform and guide employees, customers, and other visitors. If feasible, public announcement systems can be used to broadcast physical distancing reminders to all people on-site [130]. This may be useful in industries such as transportation, retail, food services and processing, and manufacturing. Peak traffic times may require additional measures to maintain physical distancing at the entrances [131]. Employers should consider implementing a one-way traffic circulation pattern in the workplace (including all the entrances and exits), especially in areas where physical distancing cannot be maintained between individuals moving in different directions. This can be accomplished as a combination of engineering and administrative controls. When implementing one-way traffic patterns, employers should ensure that the walkways are accessible for all workers. Changes to workplace design can affect accessibility for workers with disabilities; new layouts, traffic flow systems, and other changes should be evaluated before implementation to ensure that all workers will be able to work safely in the updated workspace.

The space between occupied workstations should be at least 2 m. The Canadian Centre for Occupational Health and Safety (CCOHS) suggests that on constructions sites employers should keep large job shacks to 5 people, and small shacks to 3. Additionally, 3 to 4 workers should be allowed per 1,000 square feet or 10 workers per 10,000 square feet at construction sites [132]. Where this is not possible, in offices for example, other controls can be implemented, including the use of masks/face coverings and installation of barriers (such as a Plexiglas, curtains, cubicles, partitions, or windows) between desks or workstations [133]. If physical barriers are installed, employers should ensure the barriers neither adversely affect airflow distribution by creating dead zones nor introduce other physical hazards, such as trip hazards or increased risk of collisions. Additionally, the barriers should not violate fire codes.

Workstations and related equipment (such as laptops, keyboards, and mice for office settings; hand and power tools for industrial settings) should be assigned to one individual and not shared whenever possible [133]. If equipment must be shared, the number of people sharing should be minimized and sanitation should occur between each user [133]. The 6 Feet Office developed by Cushman and Wakefield is an example of a conceptual idea to help workers return to office settings [72].

Visual cues such as signs and floor markings should be used to warn and remind employees where to stand when physical barriers are impractical. Floor markings help direct pedestrian flow especially in high-traffic areas [72]. Tactile ground surface indicators should be installed for those who are visually impaired; this will help to maintain physical distancing and direct traffic flow [134]. Employers should reduce the number of meetings and people on-site by implementing flexible meetings and travel options, such as having meetings outside or in a large space to ensure that individuals stay at least 2 m apart from one another, or utilizing video/teleconferencing [135]. Non-essential travel should be postponed or other options (e.g., virtual participation) should be considered. After employees return from any travel, they may have to self-isolate/quarantine in compliance with local and provincial/territorial public health guidelines [136].

For workplaces where workers interact with customers, physical space between employees and customers will also need to be increased. Employers can adjust business practices using administrative controls to reduce close contact with customers, such as providing curbside pickup, delivery, or drive-through services, where feasible [127], [137]. Electronic payment should be encouraged [138]. Prohibiting cash payments disadvantages customers and clients who lack access to electronic payment methods; instead, workers should wash or sanitize hands after handling cash [139].

Some companies may consider investing in contactless technologies to reduce COVID-19 transmission (e.g., automatic doors or facial recognition attendance as engineering controls) [140]. The technology could also be used to remind people of physical distancing, such as providing real-time meters or dashboards at entries to display the number of people on-site [72]. Though these technologies are new and exciting, they might not be accessible to all organizations and the transmission of COVID-19 can be reduced through more simple measures.

"Physical distancing also needs to be maintained in common areas where employees are likely to interact and congregate, including kitchens, lunchrooms, and cafeterias."

5.3.2.1.2 Common Areas

Physical distancing also needs to be maintained in common areas where employees are likely to interact and congregate, including kitchens, lunchrooms, and cafeterias. Communal items in common areas that cannot be easily and thoroughly cleaned should be removed. If physical distancing cannot be maintained easily, then additional controls may be needed such as barriers between seats, rotating access to these spaces, or the provision of an alternate space for breaks. For example, if the facility is too small to maintain physical distancing, one option could be to use alternate spaces as lunchrooms. Workers should not be required to remain at their desks all day, particularly during unpaid breaks. Parry et al. [141] demonstrated that workplace sitting is the largest contributor to daily sitting time for office workers. Prolonged sedentary behaviour in the workplace can increase the risk of developing cardiovascular diseases, low back pain, and diabetes [142], [143].

Businesses may want to consider whether any outdoor space can be made available for workers to use during breaks. Staff should also be encouraged to bring their own food for meals and breaks. If there is a cafeteria on-site, operations should be minimal and support physical distancing for occupants in these areas (e.g., fewer items cooked, prepackaged options) [133]. Minimizing the handling of utensils should also be considered by providing individually wrapped or single-use utensils.

5.3.2.1.3 Elevators

Elevators are critical for moving people in multistorey buildings and they are a necessity for ensuring equitable access to the workplace, providing access for those with physical disabilities. Despite the short time people spend in elevators, physical distancing should be maintained as best as possible [144] and face coverings/masks should be worn. Posters or signage on the floor can also be used to remind people to maintain physical distance. The number of people travelling at a time can be limited; exact numbers will depend on the size of the elevator and the ventilation rate. The Government of Alberta suggests limiting the number to two to three people [145]. The Middlesex-London Health Unit recommends there should not be more than three people in any elevator car [146]. Vancouver Island Strata Owners Association (VISOA) only allows a maximum of one person or one family per elevator [147].

During expert reviews and consultations, there were different opinions on how to use elevators during the COVID-19 pandemic. There was general agreement that occupant loads should be reduced to promote physical distancing (greater than 2 metres). Some experts felt that the duration of exposure in an elevator would be short and that no other controls were necessary, while others felt that low air-exchange rates and the use of these spaces by many people in a short period of time meant that elevators were higher-risk spaces and workers should be instructed to face the elevators' walls or even reduce occupancy to a single person at a time.

If employees are able, stairwells can be used as an alternative to elevators. Concerns have been raised about the low ventilation rates in stairwells, with suggestions to increase ventilation where possible. However, stairwells in high rises, particularly, are pressurized for fire suppression during emergency situations. Changes to the stairwell ventilation may affect the building ventilation more broadly and caution should be exercised in making any adjustments. Building managers are advised to confirm that any steps taken are compliant with all applicable ventilation and fire codes.

5.3.2.2 Workplace Cleaning and Disinfectant Practices

Though fomite transmission has not been confirmed for COVID-19, it remains a possible route of transmission. Health Canada recommends that application of diluted bleach solutions (sodium hypochlorite-containing disinfectants, 0.1–0.5%), ethanol (62–71%), and hydrogen peroxide (0.5%) to effectively inactivate SARS-CoV-2 [45]. According to the Centers for Disease Control and Prevention (CDC), diluted bleach should be applied according to the manufacturer's instructions and the solution remain on the surface for at least one minute [148]. Workplaces can find a list of hard-surface disinfectants suitable for use against SARS-CoV-2 on the Health Canada website [149].

During expert consultation, there was some discussion about the need for surface testing to identify contamination and to guide cleaning and disinfecting practices. There was agreement that this was not necessary and instead that it is preferable to clean and disinfect all accessible surfaces, particularly high-touch surfaces. High-touch areas include door and sink handles, paper towel dispensers, counter tops, access buttons, turnstiles, elevator buttons, vending machines, and printers/photocopiers. Caretaking staff should maintain records of cleaning and disinfection and use checklists of areas/surfaces to ensure key areas are not missed. The employer should also provide a safe place to dispose of used tissues, wipes, PPE, and other potentially contaminated materials in lined, no-touch waste receptacles.

During expert review and consultation, germicidal UVC was also raised as a possible tool for surface disinfection. However, the general opinion was that safer and effective alternatives for cleaning and disinfecting surfaces exist. Any use of UVC for disinfecting should be done after careful assessment of the potential for occupant exposure during the cleaning cycle.

Caution should also be taken with cleaning agents and disinfectants as mixing of these products can lead to the production of toxic gases (e.g., mixing bleach with ammonia or amines produces chloramine gas). Personnel working with cleaning agents and disinfectants should complete Workplace Hazardous Materials Information System (WHMIS) training to prevent unsafe use. The use of cleaning products has been associated with occupational diseases; working as a cleaner, janitor, or caretaker is associated with increased risk of respiratory diseases, including asthma, chronic bronchitis, and reactive airway dysfunction syndrome [150]. Resuspension of dust, allergens, and other particles from floors, carpets, and surfaces during cleaning activities is also a concern [151]. Proper exposure controls should also be in place, including ventilation and PPE appropriate for the tasks and products being used [152].

5.3.2.3 Personal Protective Equipment

Personal protective equipment, commonly referred to as "PPE", is equipment worn to minimize exposure to hazards that can cause serious workplace injuries and illnesses. PPE can refer to many things, including respirators, surgical masks, gloves, protective clothing, eye protection, and face protection. If PPE is used, employers need to provide training sessions on how to use PPE, including fit, use, donning and doffing, maintenance, cleaning, and disposal, as well as the limitations of different types of PPE. These requirements may differ by jurisdiction and the employer must ensure they follow applicable occupational health and safety regulations [153]–[155].

Generally, when following the hierarchy of controls, protective equipment is used only as the last resort when hazards cannot be controlled using higher level controls

such as engineering and administrative controls. However, during the pandemic, particularly in the face of evolving scientific understanding of transmission, PPE offers another layer of protection and can be utilized as part of a multifaceted prevention strategy. Employers should evaluate their workplace to determine if PPE is an appropriate and helpful tool and consult local public health guidelines for requirements pertaining to public spaces.

Employers should also be aware that the use of respirators, and other PPE, can introduce or increase exposure to heat stress [156]–[158]. Any use of heat stress exposure tools, including Humidex or the American Conference of Governmental Industrial Hygienists (ACGIH) Screening Criteria for Heat Stress Exposure needs to account for the additional burden of PPE [159]. The use of PPE can also lead to the development of occupational diseases among users, including hand and facial dermatitis [160], [161]. Workers experiencing these symptoms should be advised to seek medical advice and alternative PPE should be provided where possible.

5.3.2.3.1 Respirators

Respirators are specialized PPE that meet strict testing standards related to contaminant reduction and fit. Respirators are worn to reduce the exposure of the person who wears the respirator. There are many types of respirators. Disposable filtering facepiece respirators (e.g., N-95) are most often referred to in relation to COVID-19. Other types of respirators include full and half face elastomeric respirators, powered air purifying respirators (PAPRs), and self-contained breathing apparatuses (SCBA). Although N-95 respirators provide less protection than many other respirators, in general they provide a sufficiently high degree of protection for biological hazards such as SARS-CoV-2. Most, not all, respirators require fit testing, often on an annual basis as part of a respiratory protection program. As part of a respiratory protection program, workers are required to be medically fit to wear a respirator; there are a variety of physical and psychological conditions that may preclude a worker from wearing a respirator [162]. Employers should consult the regulations and guidelines in their jurisdiction.

During the COVID-19 pandemic, the use of N-95 respirators has only been advised for health care workers who are at greater risk of exposure, or in other industries where workers are already fit-tested and are using them to protect against other hazards [6]. Employers who use respirators for COVID-19 or other hazards can refer to CAN/CSA Standard Z94.4-18 *Selection, Use and Care of Respirators* (CSA Z94.4) for further guidance.

5.3.2.3.2 Surgical Masks

Surgical or medical masks are not respirators; they are fluid resistant masks and act as a barrier to prevent splashes, sprays, and spit. They can also help prevent the wearer from spreading aerosols into the environment (source control). However, they do not protect the wearer from breathing in gases, chemicals, or small particles in the air. Neither fit testing nor a seal check is required; surgical masks are not included as part of respiratory protection programs [163], [164].

5.3.2.3.3 Face Coverings

Face coverings or non-medical masks are neither respirators nor surgical masks. Face coverings are highly variable and often homemade. They are not tested to recognized standards and are not designed to form a proper seal around the mouth and nose; fit testing is not required, and face coverings are not included as part of respiratory protection programs. However, where the use of face coverings is mandated in public spaces, exemptions have been granted for people with physical and psychological conditions preventing mask use, as is the case for respirators as part of a respiratory protection program [162].

Face coverings may act to reduce the transmission of COVID-19 in two possible ways:

1. As a protective device that reduces the mask wearer's exposure; and
2. As a source control device that reduces aerosols released into the environment by the wearer.

Current public health guidelines in Canada are to wear a cloth face covering when physical distancing cannot be maintained [43]. There has been a more recent shift towards the mandated use of face coverings when in

indoor public spaces in some jurisdictions. When using a face covering, the mouth and nose should be fully covered, there should be no gaps between the face and the face covering, and the face covering should be kept clean with regular washing in warm soapy water. Face coverings should not be shared. Employees should wash hands with soap and water or alcohol-based hand sanitizer before putting on, after touching or adjusting, and after removing the face covering [43].

Potential risks associated with face coverings have been raised and include increased contact with the virus due to contact with a contaminated mask, relaxing of other prevention measures (e.g., physical distancing), and concerns about a lack of evidence for efficacy against SARS-CoV-2 [165]. However, cloth face coverings appear to provide some protection both as a protective device and as a source control device. The magnitude of this protection varies considerably across studies and is likely to be even more variable in practice as mask designs, materials, and fit will vary.

5.3.2.3.4 Face Coverings to Protect the Wearer

In studies evaluating the ability of cloth masks to filter particles and protect the mask wearer, results vary depending on the fabric. Davies *et al.* [166] tested fabrics alone under experimental conditions and found that many fabrics could filter more than 50% of *Bacillus atrophaeus* (range 58–83% vs. surgical mask 95%) and bacteriophage MS2 (range 48–72% vs. surgical mask 89%). Notably, the minimum aerosol size of *Bacillus atrophaeus* is tenfold greater than that of SARS-CoV-2. Rengasamy *et al.* [167] found much lower levels of filtration among most fabrics using sodium chloride aerosols whose size is more approximate to the smallest aerosols capable of propagating SARS-CoV-2. T-shirt material filtered more than 20%; thicker fabrics like sweat pant material fared slightly better (20–60%).

Van der Sande *et al.* [168] reported protection factors among adults using homemade masks. Protection factors are used to describe the level of protection a mask offers and describe the ratio of the concentration outside a mask over the concentration inside the mask. A higher protection factor means the mask filters out more contaminants. Homemade masks of tea cloth material had protection factors ranging from 2.2 to 3.2, depending on activity [168]. For the same activities, the protection factor for surgical masks was 4.1 to 5.3, and for N-95 respirators, it was 66 to 113 [168]. Similar results were seen for children, but with consistently lower protection factors, especially for the N-95 respirators [168]. Interestingly, when worn for three hours, the cloth face coverings and surgical masks saw relatively small declines, if any, in protection factors, while the N-95 respirators protection factors dropped substantially [168].

5.3.2.3.5 Face Coverings as Source Control

If face coverings act as source control and prevent an infected person from spreading respiratory droplets when talking, sneezing, or coughing, the use of face coverings would help protect co-workers and members of the general public [169]. This could be particularly useful in the context of asymptomatic spread [170]–[173]. Davies *et al.* [166] tested homemade masks as source control, finding that they did reduce the detectable colony forming units of *Bacillus atrophaeus* and bacteriophage MS2 during coughing as compared to wearing no mask, but did not perform as well as surgical mask. Van der Sande *et al.* [168] also tested cloth face coverings as source control, finding that they did provide some protection, but only marginally. In these source control experiments, the surgical mask and N-95 respirator performed similarly (protection factors were in the approximate range of 1.6 to 3.1) [168].

5.3.2.3.6 Face Shields as an Alternative to Face Coverings

There has been recent discussion about the use of face shields as an alternative to face coverings because the lips and face are visible to those who rely on lip reading for communication, and because they provide a barrier that prevents the wearer from touching their own face. An experimental study from NIOSH used mannequins and a cough simulator to assess the effectiveness of face shields at reducing inhalation exposure of influenza virus in cough particles [174]. Results suggested that face shields do decrease inhalation of large particles when the distance between the cough and the shield wearer is less than 0.5 m, but this was not the case for smaller particles that remained suspended and were able to travel around the shield. Lindsley *et al.* [174] concluded that face shields are not a replacement for

respiratory protection such as face coverings/masks. Similarly, consulted experts suggested that while face shields may protect the eyes from splashes and large droplets/particles, they likely offer insufficient protection against droplets or droplet nuclei when worn either to protect the wearer or as source control.

5.3.2.3.7 Evidence of Mask Effectiveness Against COVID-19

During the initial months of the pandemic, there was conflicting guidance on the use of masks and face coverings [175]. Community-level data from Hong Kong suggest universal masking may reduce COVID-19 transmission [176]. Similarly, a meta-analysis funded by the WHO suggests a decrease in transmission of SARS, MERS, and COVID-19 when masks are worn, though much of the data included are from health care settings and cloth face coverings are analyzed together with surgical masks [177]. A research letter from a hospital setting in the United States also suggests masking was correlated with a decrease in transmission among health care workers [178]. Two review articles posted as preprints also conclude that mask use is a positive prevention strategy [179], [180].

During the expert reviews, there were differing opinions on the usefulness or effectiveness of mask policies in relation to COVID-19. Some experts believe that there is no way of safely occupying a building without a mandatory mask policy. Other experts are not fully convinced by the current evidence of mask effectiveness, which is largely from health care, where the intensity and duration of exposure differ, and where surgical masks are worn as opposed to cloth face coverings. Face coverings likely provide some reduction in exposure and some measure of source control, but the magnitude of these effects is still unknown. Face coverings may, however, serve as a visual reminder of COVID-19 and the need to maintain physical distancing among other prevention behaviours, which would be a positive effect.

5.3.2.3.8 Gloves and Hand Hygiene

Gloves are usually worn in workplaces to protect the hands from injury, prevent skin contact with substances that may damage the skin, or prevent skin absorption of chemicals. In the case of COVID-19, none of these situations apply. Further, gloves do not prevent hand contact with the face and mucous membranes. Gloves are not a replacement for proper and frequent hand hygiene; they may create a false sense of security and may increase exposure to risk [181]. In circumstances where proper hand hygiene is not possible or workers have direct contact with persons or high-touch objects, gloves are recommended as a last resort [181]. For workers wearing gloves, single-use (discard after every single interaction), powder-free, and non-latex gloves should be used [181]. Employers should provide an adequate supply of single-use gloves so that they can be changed often to avoid contamination. Workers will need to be educated on the safe use and disposal of gloves with every new interaction.

For workers who must wear gloves to protect against other work-related hazards, such as cold and heat stress, chemical agents, cuts, vibration, or allergens, they should clean the gloves at least once per day based on manufacturers' instructions and have a designated space to store their gloves when not in use. Hands should be sanitized or washed prior to donning or doffing reusable protective gloves [181]. Where employees are required to wear reusable gloves, employers can provide posters to encourage safe practices [181].

Hands should be washed frequently with soap and water or alcohol-based hand sanitizer. The lipid bilayer of viral envelopes is susceptible to disruption by the means of surfactants, the main constituents of hand soaps [182]. Rabenau *et al.* [183] demonstrated the effectiveness of hand rubs and disinfectants against SARS-CoV-2. Employers should make soap and water or alcohol-based hand sanitizers accessible throughout the site (especially at entrances, exits, and in vehicles where applicable [184]). A list of approved hand sanitizers is published by Health Canada [185]. Employers should encourage good hand hygiene but also remember that frequent hand washing and use of alcohol sanitizers can cause dryness, skin irritation, and dermatitis [186]. Good skin care practices, including pat-drying hands after washing and the use of moisturizers, can promote healthy skin, even with frequent hand washing [186].

"To support public health authorities and contact tracing in the event of a COVID-19 case, organizations should keep a tracking system of who was on-site each day, including contact information for those who are not employees."

5.3.2.4 Waste Management

Workers and employers should manage waste generated from increased frequency of cleaning and increase use of single-use items (including PPE) as they would any other non-contaminated waste [187]. This would include safe work practices with appropriate exposure controls to prevent contact with infectious materials that can be present in waste [187].

5.3.3 Domain III: Supporting Workers to Increase Adherence to Workplace and Public Health Prevention Practices

Employers are legally obligated to take every reasonable precaution to protect employees from illness and injuries, including infectious diseases. Beyond the building systems and the organization of the workplace, many factors can play an important role in reducing the probability of the virus being introduced and transmitted in the workplace/community. As restrictions ease and more workers return to work, supporting workers in adhering to local public health recommendations and in following new workplace practices will be important.

5.3.3.1 Monitoring Cases in the Workplace

COVID-19 symptoms could be used as a basis for health screening at the workplace, with the goal of identifying sick workers before they begin work. However, as some cases are asymptomatic and many have a pre-symptomatic phase, not all cases will be caught. Evidence from previous outbreaks, such as SARS 2003 and Ebola, suggest that temperature screening may not be a strong prevention tool. In 2003, infrared thermometers were used at airport entry sites in many countries, including Beijing, Australia, Singapore, and Canada. Out of the 12 million people screened for SARS, only 12 probable cases of SARS were found in Beijing [188] and none were detected elsewhere [189]. When infrared thermometers were used for five months in Guinea, Liberia, and Sierra Leone during the Ebola pandemic, four infected passengers were missed because they did not have symptoms [189].

Though some experts think health screening is neither useful nor a good use of resources, many companies are implementing health checks (e.g., temperature screening) [181], [182]. This may be because a visible program provides some reassurance to workers and visitors that the employer is taking steps to prevent COVID-19. If temperature screening is used, it should be combined with messages describing other symptoms of COVID-19 and reminders about the importance of hand hygiene, physical distancing, and face coverings [190].

According to the Government of Canada, employees subject to the Canada Labour Code Part II (federal and private sectors) must report to employers if they have been diagnosed with COVID-19, if they have been potentially exposed to SARS-CoV-2, or if they have had contact with other employees for contact tracing purposes [191]. This may differ by jurisdiction. Any health information collected from employees should be treated in accordance with privacy legislation. Employers should

be sensitive to the stress and anxiety that people may feel if they develop COVID-19 or have been in contact with a known or suspected case [190]. According to the Ontario Human Rights Commission (OHRC), an employer can only ask an individual employee to go home or to not work due to the concerns over COVID-19 in accordance with the most recent advice from the medical and public health officials [192]. If employees have COVID-19 symptoms, they need to go home in the safest and fastest manner possible. If it is expected that there may be delays in a worker being able to leave, plans to support isolation on-site should be in place.

In all circumstances, employers should encourage workers to follow the guidelines provided by local public health authorities, including requirements for testing, reporting, and contact tracing. These may also differ by jurisdiction. Where the guidelines are unclear, the worker and/or employer should contact public health officials directly. Workers who have acquired COVID-19 in the workplace should report their case to their immediate supervisor followed by local workers' compensation boards, or equivalent. To support public health authorities and contact tracing in the event of a COVID-19 case, organizations should keep a tracking system of who was on-site each day, including contact information for those who are not employees.

Part of the workplace response plan for when suspected or confirmed cases of COVID-19 arise in the workplace will include cleaning and disinfection [152]. The US Centers for Disease Control suggests that areas occupied by ill persons should first be closed off, information recorded for contact tracing, occupants directed to self-isolate, and air circulation increased by either opening windows/doors or by increasing the outdoor air intake and using exhaust fans [152]. After a 24-hour period, or as long as practical, all areas used by the ill persons, including frequently touched surfaces, should be cleaned and disinfected [152]. Discussion of suitable cleaning agents can be found in Section 5.3.2.2.

5.3.3.2 Accessibility and COVID-19

According to the 2017 Canadian Survey on Disabilities Report, 22% of Canadians self-identify as having a disability [193]. Almost 59% of the Canadians with disabilities (aged 25 to 64) are employed, representing 12% of the total population in this age group [193]. The OHRC uses a broad definition of disability, covering conditions that were "present at birth, caused by accident, or developed over time" and including physical and mental impairments as well as chronic conditions (e.g., diabetes) [194].

The impact of COVID-19 on people with disabilities will vary, as it does for all workers. Some individuals may be at a higher risk of exposure, as in the case of individuals who are blind or partially sighted and touch objects to obtain information. The COVID-19 pandemic may have exacerbated existing barriers for people with disabilities or uncovered new accessibility needs. For example, the use of masks or face coverings limits communication. Specifically, masks prevent lip reading and reduce speech volume in addition to blocking cues that support non-verbal communication. A clear/transparent mask with full face visibility is one solution [195].

The COVID-19 pandemic may also have led to employers offering more accessible work options (e.g., work from home), including the provision of accessible workstations (i.e., screen readers, magnification, and specialized lighting) [196]. It is important that accessibility be considered in all aspects of workplace design and reorganization, not just individual level controls (e.g., PPE). For example, employers should ensure that workplace prevention measures, such as locations of hand sanitization stations and one-way traffic flow passages, are accessible to all workers [197].

Importantly, COVID-19 is not a short-term hazard for workplaces; workers with disabilities need to be accommodated. To support this, the Government of Canada has established the COVID-19 Disability Advisory Group (CDAG) with a purpose to advise the Minister of Employment on disability-specific issues, challenges, measures, and systemic gaps [198].

5.3.3.3 Training and Education

Workers need information and training related to COVID-19 prevention and associated changes in the workplace. When people understand why safety measures are being taken, they are more likely to support the change [199]. Increasing awareness and education about hazards, as an administrative control, has been

found to be effective in improving workplace safety, but is more common in unionized and larger organizations [200]. Many resources are available to help support education and training in workplaces (Appendix 2). Training can build trust and support employees in adopting a safety measure or tool, likely leading to improved work habits [201]–[205]. Posters can increase awareness and provide information; COVID-19 specific posters are available through many of the provincial public health authorities (Appendix 2). Employers should provide training and education material in accessible formats to accommodate all workers.

Where training is provided it should be straightforward, industry specific, and relevant to the daily tasks. Employers should ensure that the worker is not overwhelmed with the information. Industry and job-specific training is important because jobs will be differentially affected by COVID-19. Some workplaces (e.g., personal services sector) will have close contact with clients due to the nature of their work, as well as frequent use of potentially shared work equipment. Risk assessment can provide information on the potential places where training is needed [206]. It will also be important to provide refresher training, especially as new information becomes available.

5.3.3.4 Transportation

Employers are generally not responsible for health and safety during the commute to and from work. But safer commuting may reduce the probability of SARS-CoV-2 being introduced into the workplace. The best option for reducing commuting would be eliminating the need to commute by shifting to alternative work arrangements (e.g., work from home), but this will not be feasible in all workplaces. Where workers must commute, it is important to consider the different forms of travel used by workers and encourage good practices that will reduce their likelihood of exposure.

Workers may be using public transit, drivers-for-hire services (such as taxis and ride hailing services), private vehicles, walking, or cycling. Regardless of the type of travel, it is important to comply with any public health guidelines for the respective jurisdiction [207]. In a private vehicle (with people outside of one's household) or in a drivers-for-hire vehicle, it is recommended to open the windows and avoid recirculation of air through the air-conditioning system [207], [208]. For those who walk or use a bike, it is encouraged to maintain a distance of 2 m from other cyclists/pedestrians [208]. If workers need to travel between locations while at work, a physical distance of 2 m should be maintained wherever possible. Larger vehicles may be able to accommodate physical distancing by using a seat configuration that maximizes the distance between passengers.

5.3.3.5 Work Refusals

In Canada, employees have the right to refuse unsafe work. In most provinces and territories, a work refusal triggers a formal process involving the regulator that concludes with a determination on the safety of the work practices. COVID-19 may lead to more frequent work refusals arising from safety concerns and fear of returning to work, among other possibilities [209]. This has already been seen in Ontario [210]. *The Toronto Star* reported that since the COVID-19 pandemic started in Canada, more than 200 COVID-19 related work refusals have been filed in Ontario [210].

5.3.3.6 Health and Safety in New Work Environments

In response to the COVID-19 pandemic and the recommendations made by the public health authorities, there has been a shift to alternate work arrangements that include working remotely, working from home, or working alone or in isolated settings. Supporting work in these new environments can prevent SARS-CoV-2 from being introduced into the workplace. Importantly, new work environments may also introduce new hazards. Across Canada, employers have a duty to provide and maintain a safe work environment and are generally required to take every reasonable precaution to protect the physical and psychological health and safety of employees, regardless of work location.

5.3.3.6.1 Working from Home

Working from home may have negative outcomes in terms of reduced productivity and mental health impacts, especially when they are not voluntarily working from home, possibly due to changes in their

physical environment, lack of privacy, lack of choice, and caregiving responsibilities [211]. On the other hand, when employees voluntarily work from home, their productivity can improve [212]. Working from home may also be beneficial for some people with disabilities.

Bloom [212] and CCOHS [213] suggest regular communication and collaboration with colleagues when working from home, as it could mitigate some of the negative effects. Working from home should still be subject to normal risk assessment processes, including, safety, ergonomic, and psychosocial hazards [213]. Training and education should include information on safer remote work and how employers and employees can work together to make the remote workspace safer. If possible, employers should provide work-from-home accommodations for equipment or ergonomic enhancements (chairs, keyboard, extra monitor).

One challenge surrounding working from home (telecommuting) is that it is not always obvious how compensation and occupational health and safety legislation apply. In Canada, most workplaces are regulated by provincial or territorial occupational health and safety laws. During expert consultations, there was general agreement that workers' compensation acts would cover an injury arising from remote work at home, but it was less clear whether the employer had responsibility (or even the ability) to confirm the safety of the remote work location.

To address the lack of clarity on this issue, CCOHS [213] encourages employees and employers to develop a written agreement between themselves that includes responsibilities for health and safety of the worker when working from home, e.g., "Will the employer or the health and safety committee have access to the house for safety inspection? Or, will alternative arrangements be made such as the worker using checklists or submitting photos or videos of the work area? What parts of the house will be considered the 'workplace'? How will incidents be investigated?"

Employers across Canada should follow the relevant workers' compensation and occupational health and safety legislation and consider recommendations from CCOHS. A formal work-from-home policy should clearly outline all the duties and responsibilities of the employer, employee, supervisors, and managers. Any pre-existing work-from-home policies, which were not developed with COVID-19 in mind, may need to be updated for this emerging situation.

5.3.3.6.2 Working Alone or in Isolation

Working alone is defined as conducting job tasks by oneself or in situations where the worker cannot be seen/heard by someone else [214]. Working alone may introduce new hazards such as safety, ergonomics, and violence, depending on the nature of the work, length of time working alone, and location, among other possibilities [214]. Existing policies on working alone should be reviewed and updated as needed. In workplaces where working alone is a new practice, applicable training should be provided, policies developed, and a risk assessment completed, including meaningful worker consultation [214]. It will be important to consider both the physical and psychological health of the workers, take into account any accommodations that may be required, and implement a check-in procedure to keep in contact with the workers when they are working alone [214]. Importantly, the employer should refer to local regulation and guidance documents. General information on working alone is available from CCOHS [214]. WorkSafeBC's *Working Alone: A Handbook for Small Businesses* [215] is also a useful starting point for the safe implementation of working alone practices.

5.3.3.7 Psychological Health

The uncertainty and unpredictability related to the COVID-19 pandemic may have significant psychological effects on workers. These effects may stem from the disease itself, the prospect of financial stress due to loss of employment, additional caregiving burdens, and interactions with the public and clients who are themselves anxious [216], [217]. Health care workers, the elderly, and those with compromised immune systems, as well as individuals with substance abuse issues and pre-existing mental health conditions, are thought to be more susceptible to psychological distress [216], [218], [219]. During COVID-19, younger Canadians, women, and those with children in the home have been more likely to report anxiety and feelings of depression, independent of work status or exposure to COVID-19 [59].

"The uncertainty and unpredictability related to the COVID-19 pandemic may have significant psychological effects on workers."

Managers and supervisors must be trained to recognize cognitive, emotional, and behavioural symptoms of distress and to support workers in seeking appropriate intervention. Research suggests that workers who feel supported and who have undergone training are likely to experience better psychological health outcomes [220]. Managers and supervisors should also practice self-care if they find themselves struggling or in need of support.

Thirteen psychosocial risk factors relating to the workplace have been identified, including organizational culture, psychological demands, workload management, clear leadership, and expectations [221]. Each play an important role within an organization and greatly affect various aspects of work, such as productivity, psychological health, and job performance [221]. The 13 psychosocial risk factors are described in CAN/CSA Z1003-13 (R18) *Psychological Health and Safety in the Workplace – Prevention, Promotion, and Guidance to Staged Implementation* (CSA Z1003), also known as the National Standard for Psychological Health and Safety in the Workplace. This is a voluntary Canadian standard that organizations can adopt in guiding the promotion of mental health and prevention of psychological harm at the workplace [222]. Complementary to this standard is the Mental Health Commission of Canada's "Psychological Health & Safety: An Action Guide for Employers" [223].

Resources from mental health and psychological associations such as the Canadian Mental Health Association, Canadian Psychiatric Association, Canadian Counselling and Psychotherapy Association, Mental Health Crisis Line, and Mental Health Commission of Canada are also available and can be accessed online [224]. For some workers, Employee Assistance Programs (EAPs) may be available. EAPs can include training and provide resources and guidance on psychological health and resiliency at all stages of the pandemic [225], [226]. Employees should be made aware of the available resources.

5.3.3.8 Worker Accommodations during COVID-19 Pandemic

Employers must also equitably address new COVID-19 related accommodation requests. The need for accommodation may arise for several reasons, including being a member of a high-risk COVID-19 group, workers with caregiving responsibilities, and those facing mandatory quarantine or isolation periods. It is also possible that changes to work tasks and the workplace may lead to additional accommodation needs for workers.

Accommodation policies and procedures should be developed, updated periodically and based on objective criteria to avoid the impacts of unconscious bias. According to the OHRC, the employer's duty to accommodate to the point of undue hardship remains unchanged during COVID-19 pandemic. Experts suggest that employers should make it a habit to check in with employees, especially in the early stages

of returning to work to ensure they are comfortable with the new work environment and any changes that have occurred. Challenges in accessing non-urgent medical care during COVID-19 may present barriers to acquiring medical documentation; employers should consider this within their policy and procedures. In some circumstances, workers may be entitled to sick leave or disability leave, including benefits offered by the employer or government benefit programs. Sick leave benefits and the documentation required vary by province.

5.3.3.9 Financial Supports

There is considerable economic stress as a result of COVID-19 [227]. Though not usually an occupational health and safety issue, financial concerns may impact the health and safety of workers, particularly during the COVID-19 pandemic. If people are under financial stress, they may be less likely to stay at home when sick, potentially exposing numerous people at work and during their commute.

Mechanisms are needed to support workers who are experiencing symptoms of COVID-19 to stay home until they are healthy. The federal and provincial governments have put in place many programs to support people through this time. Organizations should ensure that workers are aware of these programs and how to access them if, and when, needed. Canadian employers whose businesses have been affected by COVID-19 may be eligible for the Canada Emergency Wage Subsidy (CEWS). The Canadian Emergency Response Benefit (CERB) program is also available for workers who have been affected by COVID-19. Workers may also be eligible for other Employment Insurance (EI) benefits, such as the EI Caregiving benefits.

6.0 Looking Ahead

There is agreement among experts that COVID-19 is not a short-term challenge; it is expected that the pandemic will persist through the next year, if not longer. Subsequent shutdowns of non-essential workplaces may occur, though these may be targeted to smaller geographic areas, where and when community spread increases. The local context of the pandemic can inform workplace prevention strategies. The higher the rate of cases in the community, the higher the chance that the virus will be introduced into the workplace. It will be important that employers follow local public health guidelines in order to adjust operations as required, for example issuing reminders to workers and offering retraining when epidemiological data indicate local community spread is increasing.

Our understanding of COVID-19 is rapidly evolving. This is a challenge for everyone, including workers, employers, and policymakers. Work has already changed as a result of COVID-19. Some of these changes are welcomed and will likely remain (e.g., expanded work from home policies). Other changes are problematic for the economy and workers, and practices will slowly inch back towards pre-COVID-19 norms (e.g., schools and child care).

Knowledge gained now will help to better manage subsequent waves of the COVID-19 pandemic and may also be applicable to future pandemics. Workplaces should develop a business continuity plan for how they will safely scale back operations, if needed, and transition to alternative models of work; these plans will be valuable now and in the future. Workplaces could also develop a pandemic response plan, including the identification of unique risks they may face, and strategies for supporting the physical and psychological health of their workers as well as the sustainability of their businesses.

7.0 Conclusions

The COVID-19 pandemic is highlighting the importance of occupational health as a critical part of public health. While the spread of COVID-19 has slowed across Canada, the virus is still present in our communities. In places where community spread is higher, the chance of COVID-19 being introduced to the workplace is higher. If proper precautions are not taken, workplaces could become sites of transmission, leading to increased community spread.

"Efforts to reduce the likelihood of transmission within the workplace should follow the hierarchy of controls: elimination, substitution, engineering controls, administrative controls, and personal protective equipment."

After periods of low or no occupancy, and before workers return to a worksite, the building HVAC and water systems need to be inspected to ensure they are operating as designed. These systems can harbour *Legionella* or other chemical or microbiological hazards that must be considered and controlled. In order to reduce the likelihood of COVID-19 infections arising in the workplace, employers will have to support workers in staying home if they have symptoms or have come into contact with a known/suspected COVID-19 case. This may include working from home, accessing financial supports, and supporting employees' psychological health. Employers may also choose to implement health screening for workers and other people coming into the workplace. Though the scientific literature shows little support for the efficacy of health screening, a visible health screening program may reassure workers and visitors that the employer is taking steps to provide a safer working environment. If a case arises in the workplace, employers should have a plan in place for managing the case and communicating with affected workers.

Preventing the transmission of COVID-19 in the workplace depends on preventing close contact between an infected individual and others. There was widespread agreement that efforts to reduce the likelihood of transmission within the workplace should follow the hierarchy of controls: elimination, substitution, engineering controls, administrative controls, and personal protective equipment. The only approach that can fully eliminate possible COVID-19 exposure is for workers to move entirely to remote or isolated work where they do not interact with any other workers, clients, or other personnel. This is unrealistic for many organizations. The best approach is likely to be a multifaceted prevention strategy. Following a workplace risk assessment process, engineering and administrative controls can be used to reduce the likelihood of exposure and transmission. Physical distancing can be achieved through several means, including the redesign of workplaces and adjustments to work and workers schedules. These changes can minimize the number and duration of close contact interactions workers have each day. Improved ventilation rates and improved filtration within HVAC systems can reduce the probability of transmission. These strategies can also be combined with the use of face coverings and good hand hygiene. Measures that seek to prevent the transmission of COVID-19 should be implemented in addition to other occupational health and safety practices in the workplace. The prevention of COVID-19 transmission in the workplace should not reduce workers' protection against other non-COVID-19 hazards and should not introduce new hazards into the workplace that cannot be mitigated.

We are still learning about SARS-CoV-2 and COVID-19; new evidence emerges almost daily. Much of the evidence that underlies the recommended engineering and administrative controls is based on previous, similar, infectious diseases (e.g., SARS-CoV-1). More

work is needed to better understand the effectiveness of engineering controls in workplaces and the factors that may impact their effectiveness in relation to SARS-CoV-2 and whether this differs from other infectious agents. Face coverings are now commonplace across Canada, with their use being mandated in public spaces (including many workplaces) in several cities and regions. Despite this policy change, we continue to know very little about the performance of face coverings as to how this practice relates to both exposure reduction and source control. There is a need to better understand face coverings, including their design, material, performance, and the characteristics that lead to better exposure reduction and source control. This evidence will be helpful not only as we manage the ongoing COVID-19 pandemic but may also be helpful in preparing for future pandemics.

The peer-reviewed literature suggests that multifaceted interventions are likely to be more effective at preventing occupational disease. The implementation of several controls from across the hierarchy will introduce redundancy into the prevention approach, whereby the failure of one control will not automatically result in increased exposure because other controls are in place. This would seem a particularly prudent approach in the current environment of uncertainty that surrounds SARS-CoV-2 and COVID-19. There is also evidence that a strong health and safety culture will lead to more successful prevention initiatives, which will help workplaces adapt quickly to ensure the physical and psychological health and safety of their workers and the success of their businesses. Prevention strategies for COVID-19 should be part of a comprehensive occupational health and safety management system (OHSMS). A strong OHSMS includes meaningful worker consultation and follows the principles of the internal responsibility system (IRS).

Many employers who have not previously dealt with occupational health hazards now find themselves at the forefront of COVID-19. Many of these workplaces are also spaces where members of the public are regularly present (e.g., services, retail, education). In these cases, employers will have to consider the behaviours of non-employees as they implement prevention strategies. For employers who may feel unprepared to navigate the many changes that are needed, numerous organizations are ready and willing to help. Resources are available from local, provincial/territorial, and national organizations, as well as industry-specific guidance for supporting safe work practices (Appendix 2).

This review of the evidence highlights the foundation of understanding that exists to manage building systems, control workplace hazards, and support workers' physical and psychological health during the COVID-19 pandemic. There are, however, several gaps in our understanding of SARS-CoV-2 and COVID-19 in workplaces. Though the simplest public health prevention message may be to avoid the 3Cs of "closed spaces, crowded spaces, and close contact", this is not always easily implemented in a workplace setting. Supporting workers to stay home when they are sick or have had contact with a COVID-19 case will help keep the virus out of the workplace but will be imperfect. The hierarchy of controls should be used to select multifaceted controls to reduce the risk of transmission in the workplace. Specific guidance is needed for workplaces as they adapt to a new and evolving hazard, which – if poorly handled – may have implications for public health more broadly.

Part B: Suggested Practices and Considerations Arising from the Research Report

1.0 Guiding Principles

This guidance document considers the following guiding principles and frameworks:

a. Considerations related to the COVID-19 pandemic and SARS-CoV-2 virus with respect to building systems, workplace design and maintenance, and worker support;

b. Hierarchy of controls;

c. Occupational health and safety management systems (OHSMS);

d. A continuous improvement approach (e.g., plan, do, check, act [PDCA]); and

e. Compliance with applicable laws and regulations.

2.0 Scope

This guidance document considers the following:

a. Actions that could be taken in Canadian workplaces broadly, with the exclusion of patient-facing activities in health care and first responder settings;

b. Occupational health and safety prevention practices that could be taken at the workplace level, not including regulatory changes; and

c. Occupational health and safety prevention practices may be implemented differently in various workplaces, however the underlying principles and intent will remain similar.

3.0 Definitions

Alcohol-based hand sanitizers – gel, liquid, or foam substances used to kill infectious agents on the hands that are approved by Health Canada and typically contain at least 60% alcohol.

Assigned protection factor (APF) – the level of contaminant outside of a respirator relative to the level inside the respirator. It is used to determine the appropriate respirator for the job task in question.

Building systems – includes various aspects within a building, such as the HVAC system, hot and cold water system, life/personnel safety systems, and electrical systems.

Common workplace areas – any area of the workplace that is not an office or work area dedicated to a single worker, including areas such as shared work areas, kitchens, meeting rooms, lunch rooms, break rooms, lounges, and waiting rooms.

COVID-19 pandemic – global outbreak of the novel COVID-19 disease due to the SARS-CoV-2 virus that originated in Wuhan, China, and was declared a pandemic on March 11, 2020 by the World Health Organization (WHO).

Decorative water features – type of open water system that aerosolize water. Some examples include fountains and open pools.

Face coverings – cloth masks that cover the nose and mouth to reduce COVID-19 transmission but that are neither a respirator nor a surgical mask. Some examples include scarves, cloth masks, and non-medical masks. See *Respirator* and *Mask*.

Hazard – a potential source of harm to a worker.

Hierarchy of controls – a system of five types of controls (elimination, substitution, engineering, administration, and personal protective equipment) used to mitigate exposure to health and safety hazards.

High-risk buildings – buildings with poor temperature control, history of water quality issues, vulnerable occupants, or the presence of aerosol producing devices.

HVAC system – heating, ventilation, and air conditioning system used to heat and cool a building.

Isolation – the separation of an individual who tested positive for COVID-19 from those who are not sick.

Mask – general term that is used to refer to any of respirator, surgical mask, or face covering.

Personal protective equipment (PPE) – controls that are used to reduce worker exposure to contaminants at the worksite.

Physical barriers – an engineering control in which materials such as Plexiglas, curtains, and plastic are used to form a barricade between individuals to reduce COVID-19 transmission.

Physical distancing – a distance of at least 2 m between two or more individuals to minimize COVID-19 transmission.

Points of use – system installed in an individual source line ahead of building taps, faucets, or other dedicated outlets used to dispense water. Some examples include faucets and showers.

Psychological health – a state of well-being in which individuals realize their own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and are able to make a contribution towards their community. Synonym: mental health.

Quarantine – limiting the contact with individuals (typically for 14 days) who may have been exposed to COVID-19 such as those travelling from abroad.

Respirator – a type of personal protective equipment (PPE) worn on the face that either removes contaminants from the air before being inhaled by the user or provides an external source of air.

Water system – a private water supply system, a water service pipe, and a water distribution system, or parts thereof.

Working alone – conducting job tasks by oneself or in circumstances where the worker cannot be seen/heard by someone else.

Workplace – any location in which work-related activities under the control of the organization are performed.

4.0 Workplace Programs

4.1 General

Workplace reopening policies, processes, and procedures should be designed to protect employees and others entering a workspace that is operating at a full or reduced occupancy during the COVID-19 pandemic.

Note: *Others entering a workspace may include contractors, clients, customers, visitors, etc.*

4.2 Employer Responsibilities

The employer shall ensure that the controls implemented to mitigate COVID-19 exposure and transmission:

a. Do not introduce new hazards into the workplace that cannot be mitigated;

b. Do not decrease the effectiveness of controls in place to reduce exposure to other workplace hazards;

c. Adhere to relevant legislation and consider industry best practices;

d. Do not contradict public health directives and guidance related to COVID-19; and

e. Are accessible or can be adjusted to accommodate employees with disabilities.

4.3 Employee Responsibilities

The employee shall:

a. Comply with workplace reopening policies, processes, and procedures implemented by the employer to mitigate COVID-19 exposure and transmission.

5.0 Program Elements

5.1 Hazard Identification and Risk Assessment

a. Hazard identification and risk assessment should be performed to determine the risks of COVID-19 transmission;

b. Appropriate controls and procedures in the workplace should be implemented based on the risk assessment and following the hierarchy of controls;

c. Multiple risk assessments may be necessary for different jobs, groups (workers, visitors, customers, contractors), and zones of transition (employee arrival or departure, shift changes, clocking in and out);

d. Risk assessments should be updated when the nature of the hazard, work, public health guidance, or research surrounding SARS-CoV-2 changes in order to support continuous improvement;

e. Joint Health and Safety Committees (JHSC) and Health and Safety representatives should participate in the implementation of controls and procedures; and

f. Risk assessments should include consideration of vulnerable workers and workers with disabilities.

5.2 Communication

Employers should, as applicable:

a. Create, update, and inform employees of relevant policies, processes, and procedures to include the operational circumstances during COVID-19;

b. Ensure that all policies comply with provincial/territorial/national public health orders and guidelines, and occupational health and safety laws, regulations, and guidance;

c. Communicate with employees on current local public health guidance;

d. Communicate with key stakeholders (e.g., managers, supervisors, employees, unions, contractors, vendors) frequently in an honest and transparent manner;

e. Ensure all communication and signage is accessible, available in accessible formats, and in compliance with any provincial/territorial/national accessibility standards; and

f. Consult with workers, labour groups, and union officials.

5.3 Domain I: Safer Operation of Building Systems During COVID-19

Note: *The impact of any changes to the building system on occupants and on the building envelope should be reviewed by a building systems expert before implementation.*

5.3.1 HVAC Systems

HVAC system considerations prior to reopening or resuming operations during COVID-19 should include, as applicable:

a. Ensuring that all HVAC equipment is working in accordance with the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 62.1-2019 *Ventilation for Acceptable Indoor Air Quality;*

b. Recommissioning the HVAC system for older buildings as per CAN/CSA Standard Z320-11 *Building Commissioning* (CSA Z320);

c. Adjusting the air handling unit to maximize outdoor air intake and indoor air exhaust outdoors;

d. A visual inspection of all air distribution systems for dust and dirt accumulation, damaged insulation system, or possible fungal growth on coils, drain pans, ducts, and inside casings;

e. Clearing any debris and/or obstructions at outdoor air intakes and bird/insect screens; and

f. Maintaining HVAC systems in commercial buildings as per ASHRAE Standard 180-2018 *Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems;*

g. Verifying control dampers and actuators are functioning across their full control range; and

h. Flushing out of the HVAC system by operating it for a minimum of 48 to 72 hours as required by organizational procedures or regulations, before occupancy.

When operating a building system at reduced occupancy during the COVID-19 pandemic, HVAC system considerations may include, as applicable:

a. Optimizing air exchange rate (e.g., amount of fresh air) in accordance with the building specifications and ASHRAE Standard 62.1-2019 *Ventilation for Acceptable Indoor Air Quality* by:

- **i.** Disabling demand-controlled ventilation (DCV);
- **ii.** Upgrading fans to handle higher air flows or filter pressure drops;
- **iii.** Opening outdoor air dampers to reduce the amount of recirculated air.

b. Where some air must be recirculated, consult a qualified person for increasing natural ventilation and improving filtration of the air handling unit (e.g., MERV-13 or higher);

c. Ensuring installed filters are properly gasketed and tightly fit to minimize leakage;

d. The cautious use of portable air purifiers and/or air disinfection devices for specific areas/situations (e.g., purifiers with HEPA filters, UVGI devices);

e. Maintaining normal operating temperatures and relative humidity in accordance with ASHRAE 55-2013 *Thermal Environmental Conditions for Human Occupancy;*

f. Bypassing or shutting down heat/energy recovery equipment systems that may contaminate the air flowing into the outdoor air supply, if feasible; and

g. Operating the ventilation system for longer hours (particularly before and after working hours even if at a reduced rate).

5.3.2 Cooling Towers and Evaporative Systems

When operating a building system that includes cooling tower(s) or evaporative system(s) during the COVID-19 pandemic, considerations may include, as applicable:

a. Cleaning, maintaining, and operating cooling towers as per municipal, provincial, and federal regulations;

b. Verifying the maintenance of water treatment target levels by performing chemical testing of the system water;

c. Avoiding non-continuous operations of cooling towers and evaporative systems; and

d. Consider testing for *Legionella* and assessing water quality in high risk buildings

5.3.3 Building Water Systems

Building water systems considerations prior to reopening or resuming operations during COVID-19 should include, as applicable:

a. Undertaking remedial flushing of the system under the guidance of a qualified person, which should include:

- **i.** Removing, cleaning/descaling, and disinfecting aerators and shower heads, where possible;
- **ii.** Inactivating electronically activated faucets and thermostatic mixing valves, where possible;
- **iii.** Flushing the service line(s);
- **iv.** Flushing cold water and then hot water in primary piping;
- **v.** Flushing all water fixtures;
- **vi.** Inspecting and refilling plumbing traps if they have dried out.

b. Flushing, cleaning, maintaining, and verifying the proper operations and maintenance of devices that use water, decorative features, and point of use devices as recommended by the device manufacturer and consider replacing filters;

c. Ensuring that the hot water system is operated at temperatures that limit the growth of *Legionella* greater than 49°C throughout the system and greater than or equal to 60°C in hot water heater and adjusting as necessary;

d. Ensuring disinfection systems to prevent *Legionella* (if present) are operating as intended to and adjusting as necessary;

e. Considering *Legionella* testing for high risk buildings using an approved culture method, after remedial flushing and once temperature and disinfection levels have stabilized; and

  i. Where high levels of *Legionella* are found after system clean-up, remediate using methods such as repeat flushing, shock chlorination, or thermal disinfection, and conduct follow-up testing as per ASHRAE 188-2018 *Legionellosis: Risk Management for Building Water Systems* and PSPC MD-15161 *Control of Legionella in Mechanical Systems.*

f. Consider testing for lead and copper after flushing, recommissioning, and remediation interventions are complete.

When operating building systems at reduced occupancy during the COVID-19 pandemic, water system considerations may also include, as applicable:

a. Undertaking preventive flushing of the system at intervals suitable for the building and occupants under the guidance of a qualified person, which should include:

  i. Flushing the service line(s);

  ii. Flushing cold water and then hot water in primary piping;

  iii. Flushing all water fixtures.

b. Ensuring that the hot water heater system is operated at temperatures that limit the growth of *Legionella* greater than 49°C throughout the system and greater than or equal to 60°C in the hot water heater and adjusting as necessary; and

c. Ensuring disinfection systems to prevent *Legionella* (if present) are operating as intended to and adjusting as necessary.

Employers should ensure the health and safety of employees during building recommissioning procedures. This may include, as applicable:

a. Implementing prevention measures using the hierarchy of controls to minimize exposure to hazards; and

b. Providing alternative safe source of drinking water while water systems are recommissioned.

5.3.4 Washrooms

Washroom considerations should include, as applicable:

a. Maintaining negative room pressure in washrooms;

b. Keeping doors and windows of interior washrooms closed provided there is adequate ventilation to prevent stagnant air;

c. Replacing or restricting use of faucet aerators that cause excessive spray to prevent aerosolization;

d. Encouraging occupants to flush toilets with the lid closed and installing lids where there are none;

e. Restricting use of hand dryers and providing disposable paper towels instead;

f. Installing alcohol-based hand sanitizer dispensers where soap and water is not available;

g. Following appropriate cleaning and disinfecting practices as recommended by public health authorities; and

h. Maintaining physical distancing by using signage and closing off adjacent stalls, urinals, or sinks.

5.3.5 Other Building Operations

Other considerations prior to reopening or when operating building systems during the COVID-19 pandemic may include, as applicable:

a. Assessing the building for mould and excess moisture and proceeding with any clean-up and remediation required;

b. Inspecting for damage to natural gas lines and other specialized equipment; and

c. Inspecting and maintaining life and personnel safety equipment such as fire sprinkler systems, safety eyewash systems and showers, fire alarms/smoke detectors.

5.4 Domain II: Workplace Organization During COVID-19

Note: *Tasks and processes conducted in the workplace need to be examined to determine how they are impacted by COVID-19 considerations. For example, physical distancing, barriers, and PPE requirements will alter the way many tasks are performed. Safe work procedures (SWP) will need to be developed that describe updated procedures.*

5.4.1 Physical Distancing to Reduce Close Contact

Employers should implement measures that enable proper physical distancing at workplaces.

If physical distancing is not possible, employers should implement controls, as applicable:

a. Reducing the number of workers on-site or in a work area based on business operations;

b. Splitting workers into groups (cohorts) and minimizing contact between these groups;

c. Placing physical barriers between workers (e.g., engineering control); and

d. Use of protective equipment, including masks, face coverings, or eye protection.

5.4.2 Work and Worker Scheduling

Employers should implement measures that reduce close contact in the workplace, as applicable:

a. Implement flexible work schedules for employees;

b. Offer extended hours of operation to help decrease crowding;

c. Change hours of operation to factor in enhanced cleaning schedules;

d. Postpone non-essential work-related travel;

e. Encourage virtual participation in events;

f. Postpone tasks that cannot be executed as per physical distancing recommendations;

g. Limit unnecessary visits to the workplace by contractors, visitors, and non-essential service providers; and

h. Perform necessary maintenance work during shifts with the fewest employees on-site.

5.4.3 Workplace Design and Common Workplace Areas

Employers should, as applicable:

a. Alter workspaces as needed to promote physical distancing among workers and their clients/visitors in all areas;

b. Utilize portable buildings/outdoor environments if the facility is too small to maintain physical distancing;

c. Use signage (on the floor, furniture, walls, etc.) to indicate standing or sitting locations, directional travel and/or occupancy limits, proper hand hygiene, and cough/sneeze etiquette;

d. Ensure walkways are accessible for all workers when implementing one-way traffic;

e. Place tactile ground surface indicators for visually impaired workers to help maintain physical distancing and direct flow of traffic;

f. Assign workplace tools, equipment, and computer systems to each individual or sanitize between use and post reminder signage for hand hygiene and sanitization;

g. Encourage staff to bring their own meals and drinking water; and

h. Remove communal items that cannot be easily sanitized (e.g., cutlery, plates, cups).

5.4.4 Elevators

Employees should, as applicable:

a. Use stairways where possible;

b. Maintain physical distancing in elevators;

c. Use face coverings/masks where physical distancing is not possible; and

d. Practice good hand hygiene before/after the use of elevators.

Employers should, as applicable:

a. Encourage physical distancing in elevators;

b. Limit the number of people using elevators at the same time, depending upon the size of the elevator;

c. Encourage hand hygiene before/after the use of elevators; and

d. Encourage the use of stairways as alternatives to elevators, where possible.

5.4.5 Workplace Cleaning and Disinfectant Practice

Employers should, as applicable:

a. Provide access to soap and warm water and/or alcohol-based hand sanitizer approved by Health Canada;

b. Encourage frequent handwashing and hand sanitization;

c. Clean shared equipment after each use;

d. Disinfect commonly touched surfaces/areas frequently;

e. Develop a checklist of all surfaces that must be cleaned, including location and timing;

f. Clean then disinfect hard-surfaces using Health Canada approved hard-surface disinfectants;

g. Keep records of cleaning;

h. Provide a safe place to dispose of used tissues, wipes, PPE, and other potentially contaminated materials in lined, no-touch waste receptacles; and

i. Supply appropriate PPE to the cleaning staff.

5.4.6 Personal Protective Equipment

Note: *Use of PPE should occur after a risk assessment and in combination with other control strategies.*

Employers should, as applicable:

a. Support the use of PPE for reduction of COVID-19 exposure in addition to engineering, administrative, and other mitigation controls;

b. Assess the need for PPE and select appropriate PPE based on the nature of work (PPE for non-COVID-19 related hazards is still required);

c. Ensure that PPE use is implemented as part of a protective equipment program as per government regulations;

d. Provide training on the use, disposal, and maintenance of PPE as per government regulations; and

e. Manage waste generated from increased frequency of cleaning and increase use of single-use items (including PPE) as per any other non-contaminated waste.

5.4.7 Respirators

Employers should, as applicable:

a. Where respirators are required, refer to CAN/CSA Standard Z94.4-18 *Selection, Use and Care of Respirators* (CSA Z94.4).

5.4.8 Face Coverings

Employers should, as applicable:

a. Support the use of face coverings where physical distancing is not possible; and

b. Support the use of face coverings in alignment with local/provincial/territorial public health guidelines and/or recommendations.

5.4.9 Hand Hygiene and Gloves

Employers should, as applicable:

a. Support good hand hygiene by ensuring that handwashing facilities and alcohol-based hand sanitizer are available and accessible;

b. Support the use of single-use disposable gloves only if proper hand hygiene is not possible; and

c. Encourage washing or sanitizing hands before putting on and after taking off gloves.

5.5 Domain III: Supporting Workers to Increase Adherence to Workplace and Public Health Prevention Practices

5.5.1 Monitoring COVID-19 Cases in the Workplace

Employees should, where applicable:

a. Self-monitor for symptoms of COVID-19; and

b. Notify their supervisor/employer if they have symptoms of COVID-19, are pending test results for COVID-19, have been diagnosed with COVID-19, or if they have been potentially exposed to COVID-19.

Employers should, where applicable:

a. Inform workers of the requirement to report a COVID-19 diagnosis or potential contact with a COVID-19 case;

b. Ensure any health information that must be collected is protected in accordance with relevant privacy legislation;

c. Consult with local public health agencies for guidance on monitoring cases;

d. Develop procedures for when known or suspected cases of COVID-19 are reported among workers;

e. Inform Joint Health and Safety Committee representatives of any work-acquired COVID-19 diagnosis;

f. Support contact tracing by setting up a tracking system of all personnel on-site;

g. Develop policies that are protective of employees who may need to self-isolate and are therefore unable to enter the workplace; and

h. If health screening is used, continue to promote physical distancing and the use of other controls among workers.

5.5.2 Accessibility and COVID-19

Employers should, where applicable:

a. Consider accessibility in all aspects of workplace design and reorganization;

b. Provide accessible work options;

c. Ensure that workers with disabilities are represented in consultation around COVID-19 responses;

d. Ensure that accommodation policies are in place, up-to-date, and use objective criteria;

e. Check in with the workers who have existing accommodations; and

f. Support workers in requesting new accommodations that may arise during the COVID-19 pandemic.

5.5.3 Training and Education

Employers should, where applicable:

a. Ensure that managers, supervisors, and employees are trained in all relevant COVID-19 health and safety measures.

5.5.4 Transportation

Employers should, where applicable:

a. Consider forms of travel used by workers and encourage good practices as per public health guidelines; and

b. Support physical distancing in pool vehicles used for travel within or between workplaces.

5.5.5 Health and Safety in New Work Environments

Employers should, where applicable:

a. Perform risk assessments of safety, ergonomic, and psychosocial hazards for new work environments;

b. Develop policies and best practices regarding new work environments;

c. Ensure regular communication with colleagues in new work environments;

d. Provide work from home accommodations for equipment or ergonomic enhancements, if possible (e.g., chairs, keyboard, extra monitor).

5.5.6 Psychological Health

Employers should, where applicable:

a. Identify potential psychosocial hazards in the workplace;

b. Educate managers and supervisors on the signs and symptoms of psychological stress;

c. Provide targeted or enhanced support to workers who may be at higher risk of psychological stress;

d. Provide targeted or enhanced support to workers who are more likely to be exposed to psychosocial hazards or are at a higher risk of psychosocial stress; and

e. Maintain communication with isolating workers and support their safe return to work.

5.5.7 Financial Supports

Employers should, where applicable:

a. Ensure workers are aware of support programs offered by federal and provincial/territorial governments.

6.0 Proposed Annexes

During the expert review and consultation process several areas were identified as potential topics for future discussion or where more specific guidance may be needed.

6.1 Planning and Preparedness for Future Pandemics

6.2 Summary of Standards and Guidelines Relevant to COVID-19 and Workplaces, Including CSA Standards and Those from Other Standard-Setting Bodies

6.3 Characteristics of Physical Barriers

6.4 Outline of Steps Involved in Hazard Identification and Risk Assessment

6.5 Optimizing Ventilation Systems in the Workplace

6.6 Personal Protective Equipment Supply Management

6.7 Sector-Specific Guidance, Examples:

- Accommodation and food services
- Agriculture
- Arts and entertainment
- Construction
- Education and childcare
- Manufacturing
- Food processing
- Mining
- Mining, oil, and gas
- Personal services
- Retail
- Transportation
- Remote work camps and other congregate living settings

6.8 Procedures for Managing Known/Suspected Cases of COVID-19 at the Workplace

6.9 Managing Workplace Accommodations (Including Legal and Privacy Aspects)

6.10 Workplace Safety Perception and Confidence

6.11 Waste Management Issues

References

A scan of guidelines, technical standards, peer-reviewed scientific literature, and grey literature related to COVID-19 and reopening workplaces or return to work was completed. In order to differentiate between the different sources and types of evidence we have added a notation to the reference list:

*: scholarly articles (peer-reviewed, non–peer-reviewed, preprints)

**: consensus-based standards, existing guidelines, government resources

***: grey literature, company specific guidelines, news articles

[1]* K. Yuki et al., "COVID-19 Pathophysiology: A Review," *Clin. Immunol.,* vol. 215, Jun. 2020, https://doi.org/10.1016/j.clim.2020.108427

[2]* J. Zheng, "SARS-CoV-2: An Emerging Coronavirus that Causes a Global Threat," *Int. J. Biol. Sci.,* vol. 16, no. 10, pp. 1678–1685, 2020, https://doi.org/10.7150/ijbs.45053

[3]* I. Astuti and Ysrafil, "Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2): An Overview of Viral Structure and Host Response," *Diabetes Metab. Syndr. Clin. Res. Rev.,* vol. 14, no. 4, pp. 407–412, Jul. 2020, https://doi.org/10.1016/j.dsx.2020.04.020

[4]* A. C. Walls *et al.,* "Structure, Function, and Antigenicity of the SARS-CoV-2 Spike Glycoprotein," *Cell,* vol. 181, no. 2, pp. 281-292.e6, Apr. 2020, https://doi.org/10.1016/j.cell.2020.02.058

[5]*** E. Callaway, "The Race for Coronavirus Vaccines: A Graphical Guide," *Nature,* Apr. 28, 2020. https://www.nature.com/articles/d41586-020-01221-y

[6]* T. Singhal, "A Review of Coronavirus Disease-2019 (COVID-19)," *Indian J. Pediatr.,* vol. 87, no. 4, pp. 281–286, Apr. 2020, https://doi.org/10.1007/s12098-020-03263-6

[7]* Z. Z. Hu *et al.,* "Clinical Characteristics of 24 Asymptomatic Infections with COVID-19 Screened among Close Contacts in Nanjing, China," *Sci. China Life Sci.,* vol. 63, no. 5, pp. 706–711, May 2020, https://doi.org/10.1007/s11427-020-1661-4

[8]* A. Gupta *et al.,* "Extrapulmonary Manifestations of COVID-19," *Nature Medicine,* vol. 26, no. 7, pp. 1017–1032, Jul. 2020, https://doi.org/10.1038/s41591-020-0968-3

[9]** Government of Canada, "Epidemiological Summary of COVID-19 Cases in Canada," Aug. 13, 2020. [Online]. Available: https://health-infobase.canada.ca/covid-19/epidemiological-summary-covid-19-cases.html

[10]* F. Zhou *et al.,* "Articles Clinical Course and Risk Factors for Mortality of Adult Inpatients with COVID-19 in Wuhan, China: A Retrospective Cohort Study," *Lancet,* vol. 395, 2020, https://doi.org/10.1016/S0140-6736(20)30566-3

[11]* M. W. Tenforde *et al.,* "Symptom Duration and Risk Factors for Delayed Return to Usual Health Among Outpatients with COVID-19 in a Multistate Health Care Systems Network — United States, March–June 2020," *MMWR. Morb. Mortal. Wkly. Rep.,* vol. 69, no. 30, pp. 993–998, Jul. 2020, https://doi.org/10.15585/mmwr.mm6930e1

[12]** Government of Canada, "CORONAVIRUS DISEASE 2019 (COVID-19) DAILY EPIDEMIOLOGY UPDATE," 2020. Accessed: Aug. 14, 2020. [Online]. Available: https://health-infobase.canada.ca/covid-19/epidemiological-summary-covid-19-cases.html

[13]** John Hopkins Coronavirus Resource Center, "COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at John Hopkins University." Accesssed: Aug. 14, 2020. [Online]. Available: https://coronavirus.jhu.edu/map.html

[14]*** T. MacCharles, "82% of Canada's COVID-19 Deaths Have Veen in Long-Term Care, New Data Reveals," *Toronto Star,* May 7, 2020. [Online]. Available: https://www.thestar.com/politics/federal/2020/05/07/82-of-canadas-covid-19-deaths-have-been-in-long-term-care.html

[15]** M. Cascella *et al., Features, Evaluation and Treatment Coronavirus (COVID-19),* Treasure Island, FL: StatPearls Publishing, 2020. [Online]. Available: https://www.ncbi.nlm.nih.gov/books/NBK554776/

[16]* C. C. Lai *et al.,* "Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) and Coronavirus Disease-2019 (COVID-19): The Epidemic and the Challenges," *Int. J. Antimicrob. Agents,* vol. 55, no. 3, p. 105924, Mar. 2020, https://doi.org/10.1016/j.ijantimicag.2020.105924

[17]* J. Bullard *et al.,* "Predicting Infectious SARS-CoV-2 from Diagnostic Samples," *Clin. Infect. Dis.,* 2020, https://doi.org/10.1093/cid/ciaa638

[18]* X. He *et al.,* "Temporal Dynamics in Viral Shedding and Transmissibility of COVID-19," *Nat. Med.,* vol. 26, no. 5, pp. 672–675, May 2020, https://doi.org/10.1038/s41591-020-0869-5

[19]* J. A. Otter *et al.,* "Transmission of SARS and MERS Coronaviruses and Influenza Virus in Healthcare Settings: The Possible Role of Dry Surface Contamination," *J. Hosp. Infect.,* vol. 92, no. 3, pp. 235–250, Mar. 2016, https://doi.org/10.1016/j.jhin.2015.08.027

[20] *Z. Sun *et al.,* "Potential Factors Influencing Repeated SARS Outbreaks in China," *Int. J. Environ. Res. Public Health,* vol. 17, no. 5, Mar. 2020, https://doi.org/10.3390/ijerph17051633

[21]* N. van Doremalen *et al.,* "Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1," *N. Engl. J. Med.,* vol. 382, no. 16, pp. 1564–1567, Apr. 2020, https://doi.org/10.1056/NEJMc2004973

[22]* D. Cucinotta and M. Vanelli, "WHO Declares COVID-19 a Pandemic," *Acta Biomed.,* vol. 91, no. 1, pp. 157–160, 2020, https://doi.org/10.23750/abm.v91i1.9397

[23]** A. R. Fehr and S. Perlman, "Coronaviruses: An Overview of Their Replication and Pathogenesis," in *Coronaviruses: Methods and Protocols,* Springer New York, 2015, pp. 1–23.

[24]** J. Atkinson *et al.,* eds., *Natural Ventilation for Infection Control in Health-Care Settings,* Geneva, Switzerland: World Health Organization, 2009. [Online]. Available: https://www.ncbi.nlm.nih.gov/books/NBK143281/

[25]* K. C. Wong and K. S. Leung, "Transmission and Prevention of Occupational Infections in Orthopaedic Surgeons," *J. Bone Jt. Surg. Am. Vol.,* vol. 86, no. 5, pp. 1065–76, 2004.

[26]* J. Gralton *et al.,* "The Role of Particle Size in Aerosolised Pathogen Transmission: A Review," *J. Infect.,* vol. 62, no. 1, pp. 1–13, Jan. 2011, https://doi.org/10.1016/j.jinf.2010.11.010

[27]* K. Tran *et al.*, "Aerosol Generating Procedures and Risk of Transmission of Acute Respiratory Infections to Healthcare Workers: A Systematic Review," *PLoS One,* vol. 7, no. 4, pp. 1–8, Apr. 2012, https://doi.org/10.1371/journal.pone.0035797

[28]* W. F. Wells, "ON AIR-BORNE INFECTION* STUDY II. DROPLETS AND DROPLET NUCLEI," *Am. J. Epidemiol.,* vol. 20, no. 3, pp. 611–618, Nov. 1934, https://doi.org/10.1093/oxfordjournals.aje.a118097

[29]* B. E. Scharfman *et al.,* "Visualization of Sneeze Ejecta: Steps of Fluid Fragmentation Leading to Respiratory Droplets," *Exp. Fluids,* vol. 57, no. 2, pp. 1–9, Feb. 2016, https://doi.org/10.1007/s00348-015-2078-4

[30]* L. Bourouiba, "A Sneeze," *N. Engl. J. Med.,* vol. 375, no. 8, p. e15, Aug. 2016, https://doi.org/10.1056/NEJMicm1501197

[31]* L. Bourouiba, "Turbulent Gas Clouds and Respiratory Pathogen Emissions: Potential Implications for Reducing Transmission of COVID-19," *J. Am. Med. Assoc.,* vol. 323, no. 18, pp. E1–E2, May 2020, https://doi.org/10.1001/jama.2020.4756

[32]* L. D. Stetzenbach *et al.,* "Detection and Enumeration of Airborne Biocontaminants," *Curr. Opin. Biotechnol.,* vol. 15, no. 3, pp. 170–174, Jun. 2004, https://doi.org/10.1016/j.copbio.2004.04.009

[33]* L. Morawska *et al.,* "Size Distribution and Sites of Origin of Droplets Expelled from the Human Respiratory Tract During Expiratory Activities," *J. Aerosol Sci.,* vol. 40, no. 3, pp. 256–269, 2009, https://doi.org/10.1016/j.jaerosci.2008.11.002

[34]* L. Setti *et al.,* "Airborne Transmission Route of COVID-19: Why 2 Meters/6 Feet of Inter-Personal Distance Could Not Be Enough," *Int. J. Environ. Res. Public Health,* vol. 17, no. 8, p. 2932, Apr. 2020, https://doi.org/10.3390/ijerph17082932

[35]* Z. Guo *et al.,* "Aerosol and Surface Distribution of Severe Acute Respiratory Syndrome Coronavirus 2 in Hospital Wards, Wuhan, China, 2020," *Emerg. Infect. Dis.,* vol. 26, no. 7, Jul. 2020, https://doi.org/10.3201/eid2607.200885

[36]** World Health Organization, "Q&A: How Is COVID-19 Transmitted?" Jul. 9, 2020. [Online]. Available: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/question-and-answers-hub/q-a-detail/q-a-how-is-covid-19-transmitted

[37]** World Health Organization, "Transmission of SARS-CoV-2: Implications for Infection Prevention Precautions," Jul. 9, 2020. [Online]. Available: https://www.who.int/news-room/commentaries/detail/transmission-of-sars-cov-2-implications-for-infection-prevention-precautions

[38]* S. Yezli and J. A. Otter, "Minimum Infective Dose of the Major Human Respiratory and Enteric Viruses Transmitted Through Food and the Environment," *Food Environ. Virol.,* vol. 3, no. 1, pp. 1–30, Mar. 2011, https://doi.org/10.1007/s12560-011-9056-7

[39]* B. Rockx *et al.,* "Synthetic Reconstruction of Zoonotic and Early Human Severe Acute Respiratory Syndrome Coronavirus Isolates That Produce Fatal Disease in Aged Mice," *J. Virol.,* vol. 81, no. 14, pp. 7410–7423, Jul. 2007, https://doi.org/10.1128/jvi.00505-07

[40]* T. Watanabe *et al.,* "Development of a Dose-Response Model for SARS Coronavirus," *Risk Anal.,* vol. 30, no. 7, pp. 1129–1138, Jul. 2010, https://doi.org/10.1111/j.1539-6924.2010.01427.x

[41]* L. E. Gralinski *et al.,* "Mechanisms of Severe Acute Respiratory Syndrome Coronavirus-Induced Acute Lung Injury," *MBio,* vol. 4, no. 4, Aug. 2013, https://doi.org/10.1128/mBio.00271-13

[42]* N. Nikitin *et al.,* "Influenza Virus Aerosols in the Air and Their Infectiousness," *Adv. Virol.,* vol. 2014, 2014, https://doi.org/10.1155/2014/859090

[43]** Government of Canada, "Coronavirus Disease (COVID-19): Prevention and Risks." Accessed: Jun. 3, 2020. [Online]. Available: https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/prevention-risks.html?topic=ex-col-faq#p

[44]** Centers for Disease Control and Prevention, "Social Distancing," Jul. 15, 2020. [Online]. Available: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/social-distancing.html

[45]** Government of Canada, "Risk Mitigation Tool for Workplaces/Businesses During the COVID-19 Pandemic." Accessed: Jun. 8, 2020. [Online]. Available: https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/guidance-documents/risk-informed-decision-making-workplaces-businesses-covid-19-pandemic.html?topic=ex-col-faq

[46]** Government of Canada, "Updated: Public Health Management of Cases and Contacts Associated with Coronavirus Disease 2019 (COVID-19)," Jul. 13, 2020. [Online]. Available: https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/health-professionals/interim-guidance-cases-contacts.html

[47]** S. M. Teutsch, "A Framework for Assessing the Effectiveness of Disease and Injury Prevention," 1992. Accessed: Jun. 03, 2020. [Online]. Available: https://www.orau.gov/cdcynergy/web/im/Content/activeinformation/resources/Assessment_Framework.pdf

[48]* *Centers for Disease Control and Prevention and the National Institute for Occupational Safety and Health, "Hierarchy of Controls," Jan. 13, 2015. [Online]. Avaiable: https://www.cdc.gov/niosh/topics/hierarchy/default.html

[49]* A. R. Keefe *et al.,* "A Scoping Review to Identify Strategies that Work to Prevent Four Important Occupational Diseases," *Am. J. Ind. Med.,* vol. 63, no. 6, pp. 490–516, Jun. 2020, https://doi.org/10.1002/ajim.23107

[50]*** T. Dawson, "As the COVID-19 Pandemic Hit, Provinces Declared States of Emergency. Now Many Are Up for Renewal," *National Post,* Apr. 15, 2020. [Online]. Available: https://nationalpost.com/news/provincial-states-of-emergencies-were-issued-a-month-ago-most-are-coming-up-for-renewal

[51]** Government of New Brunswick, "Renewed and Revised Mandatory Order COVID-19," Aug. 6, 2020. [Online]. Available: https://www2.gnb.ca/content/dam/gnb/Corporate/pdf/EmergencyUrgence19.pdf

[52]** Government of Prince Edward Island, "Pre-Travel Approval Process," Aug. 10, 2020. [Online]. Available: https://www.princeedwardisland.ca/en/information/justice-and-public-safety/pre-travel-approval-process

[53]** Government of Nunavut, "COVID-19 (Novel Coronavirus)," Aug. 14, 2020. [Online]. Available: https://www.gov.nu.ca/health/information/covid-19-novel-coronavirus

[54]** Government of Yukon, "Border Enforcement During COVID-19," Aug. 13, 2020. [Online]. Available: https://yukon.ca/en/health-and-wellness/covid-19/border-enforcement-during-covid-19

[55]** Government of Northwest Territories, "Travel + Moving Around," Jun. 24, 2020. [Online]. Available: https://www.gov.nt.ca/covid-19/en/services/travel-moving-around

[56]** Government of British Columbia, "BC's Restart Plan," Jul. 21, 2020. [Online]. Available: https://www2.gov.bc.ca/gov/content/safety/emergency-preparedness-response-recovery/covid-19-provincial-support/bc-restart-plan.

[57]*** A. V. Esensoy *et al.,* "#HowsMyFlattening – Ontario." Accessed: Jun. 2, 2020. [Online]. Available: https://howsmyflattening.ca/#/dashboard

[58]** Statistics Canada, "Labour Force Survey, April 2020," May 8, 2020. [Online]. Available: https://www150.statcan.gc.ca/n1/daily-quotidien/200508/dq200508a-eng.htm

[59]** Centre for Addiction and Mental Health, "COVID-19 National Survey Dashboard." Accessed: Aug. 3, 2020. [Online]. Available: https://www.camh.ca/en/health-info/mental-health-and-covid-19/covid-19-national-survey

[60]* J. Dryden and S. Rieger, "Inside the Slaughterhouse," *CBC News,* May 6, 2020. https://newsinteractives.cbc.ca/longform/cargill-covid19-outbreak

[61]* S. Rodriguez, "Third Ontario Migrant Worker Dies of COVID-19," *CBC News,* Jun. 21, 2020. [Online]. Available: https://www.cbc.ca/news/canada/london/third-ontario-migrant-worker-dies-of-covid-19-1.5621487

[62]*** M. Neira and the World Health Organization, "COVID 19 at the Workplace: Public Health and Social Measures for Prevention and Mitigation," May 29, 2020. [Online]. Available: https://wfsgi.org/sites/default/files/inline-files/WHO.pdf

[63]** WorkSafeBC, "Assessing Risks." Accessed: May 26, 2020. [Online]. Available: https://www.worksafebc.com/en/health-safety/create-manage/managing-risk/assessing-risks

[64]** U.S. Department of Labor, OSHA Administration, "Guidance on Preparing Workplaces for COVID-19," 2020. [Online]. Available: https://www.osha.gov/Publications/OSHA3990.pdf

[65]** Canadian Centre for Occupational Health and Safety, "OH&S Legislation in Canada – Internal Responsibility System," Government of Canada. Accessed: Jun. 3, 2020. [Online]. Available: https://www.ccohs.ca/oshanswers/legisl/irs.html

[66]** Canadian Centre for Occupational Health and Safety, "Health and Safety Report Volume 14 Issue 4," Government of Canada. Accessed: Jun. 3, 2020. [Online]. Available: https://www.ccohs.ca/newsletters/hsreport/issues/2016/04/ezine.html

[67]* B. Fernández-Muñiz *et al.,* "Relation Between Occupational Safety Management and Firm Performance," *Saf. Sci.,* vol. 47, no. 7, pp. 980–991, Aug. 2009, https://doi.org/10.1016/j.ssci.2008.10.022

[68]** Alberta Government and Work Safe Alberta, "Leading Indicators for Workplace Health and Safety: A User Guide," Mar. 1, 2015. [Online]. Available: https://open.alberta.ca/publications/9781460120941

[69]* A. Ghahramani, "Diagnosis of Poor Safety Culture as a Major Shortcoming in OHSAS 18001-Certified Companies," *Ind. Health,* vol. 55, no. 2, pp. 138–148, 2017, https://doi.org/10.2486/indhealth.2015-0205

[70]* A. Finset *et al.,* "Effective Health Communication – a Key Factor in Fighting the COVID-19 Pandemic," *Patient Educ. Couns.,* vol. 103, no. 5, pp. 873–876, May 2020, https://doi.org/10.1016/j.pec.2020.03.027

[71]* J. Wong *et al.,* "Preparing for a COVID-19 Pandemic: A Review of Operating Room Outbreak Response Measures in a Large Tertiary Hospital in Singapore," *Can. J. Anesth.,* vol. 67, no. 6, pp. 732–745, Jun. 2020, https://doi.org/10.1007/s12630-020-01620-9

[72]** Cushman & Wakefield, "Recovery Readiness: A How-to Guide for Reopening your Workplace," Jul. 20, 2020. [Online]. Available: https://www.cushmanwakefield.com/en/insights/covid-19/recovery-readiness-a-how-to-guide-for-reopening-your-workplace

[73]** World Health Organization, "Getting Your Workplace Ready for COVID-19," Mar. 3, 2020. [Online]. Available: https://www.who.int/docs/default-source/coronaviruse/getting-workplace-ready-for-covid-19.pdf

[74]** *International Standard ISO 45001 Occupational Health and Safety Management Systems – Requirements with Guidance for Use,* Mar. 2018. [Online]. Available: https://www.iso.org/standard/63787.html

[75]*** Pegasus, "Improving Worker Consultation & Participation – ISO 45001:2018," Nov. 27, 2018. https://www.pegasuslegalregister.com/2018/11/27/worker-consultation-participation-iso-450012018/

[76]** L. Gerhold, "COVID-19: Risk Perception and Coping Strategies. Results from a Survey in Germany," PsyArXiv, Mar. 25, 2020. [Online]. Available: https://psyarxiv.com/xmpk4

[77]* T. Wise et al., "Changes in Risk Perception and Protective Behavior During the First Week of the COVID-19 Pandemic in the United States," PsyArXiv, Mar. 19, 2020. [Online]. Available: https://doi.org/10.31234/OSF.IO/DZ428

[78]* C. R. Proctor *et al.,* "Considerations for Large Building Water Quality after Extended Stagnation," *AWWA Water Sci.,* vol. 2, no. 4, 2020. https://awwa.onlinelibrary.wiley.com/doi/10.1002/aws2.1186

[79]** Ontario Agency for Health Protection and Promotion (Public Health Ontario), "Legionella: Questions and Answers, 2nd edition," Mar. 2019. [Online]. Available: https://www.publichealthontario.ca/-/media/documents/F/2019/faq-legionella.pdf?la=en

[80]** Centers for Disease Control and Prevention, "Guidance for Reopening Buildings After Prolonged Shutdown or Reduced Operation," May 7, 2020. [Online]. Available: https://www.cdc.gov/coronavirus/2019-ncov/php/building-water-system.html

[81]** United States Environmental Protection Agency, "Water Utility Resources for the COVID-19 Pandemic." Accessed: Aug. 6, 2020. [Online]. Available: https://www.epa.gov/coronavirus/water-utility-resources-covid-19-pandemic#buildings

[82]* M. Rhoads *et al.*, "Responding to Water Stagnation in Buildings with Reduced or No Water Use," https://www.awwa.org/Portals/0/AWWA/Government/20201001 FrameworkforBuildingManagersFINALDistCopy.pdf

[83]* J. Spiegelman *et al.,* "Legionnaires' Disease Cases at a Large Community Hospital – Common and Underdiagnosed," *Int. J. Environ. Res. Public Health,* vol. 17, no. 1, pp. 1–8, Jan. 2020, https://doi.org/10.3390/ijerph17010332

[84]** Public Health Ontario, "Infectious Disease Trends in Ontario – Legionellosis," Nov. 25, 2019. [Online]. Available: https://www.publichealthontario.ca/data-and-analysis/infectious-disease/reportable-disease-trends-annually#/31

[85]* M. Sabria et al., "A Community Outbreak of Legionnaires' Disease: Evidence of a Cooling Tower as the Source," *Clin. Microbiol. Infect.*, vol. 12, no. 7, pp. 642–647, 2006, https://doi.org/10.1111/j.1469-0691.2006.01447.x

[86]* K. A. Hamilton *et al.*, "Outbreaks of Legionnaires' Disease and Pontiac Fever 2006–2017," *Curr. Environ. Heal. Reports,* vol. 5, no. 2, pp. 263–271, Jun. 2018, https://doi.org/10.1007/s40572-018-0201-4

[87]** ASHRAE, "Guideline 12-2020 – Managing the Risk of Legionellosis Associated with Building Water Systems," 2020. [Online]. Available: https://www.techstreet.com/ashrae/standards/guideline-12-2020-managing-the-risk-of-legionellosis-associated-with-building-water-systems?product_id=2111422

[88]** ASHRAE Epidemic Task Force, "Building Readiness in Response to COVID-19," Aug. 7, 2020. [Online]. Available: https://www.ashrae.org/file library/technical resources/covid-19/ashrae-building-readiness.pdf

[89]** Centers for Disease Control and Prevention and the National Institute for Occupational Safety and Health, "Recommendations for the Cleaning and Remediation of Flood-Contaminated HVAC Systems: A Guide for Building Owners and Managers." Accessed: May 20, 2020. [Online]. Available: https://www.cdc.gov/niosh/topics/emres/Cleaning-Flood-HVAC.html

[90]** L. J. Schoen, "Guidance for Building Operations During the COVID-19 Pandemic," *ASHRAE J.,* pp. 72–74, 2020, https://www.ashrae.org/file%20library/technical%20resources/ashrae%20journal/2020journal documents/72-74_ieq_schoen.pdf

[91]** Public Services and Procurement Canada, "Heating Ventilation and Air Conditioning (HVAC) Minimum Requirements-(COVID-19)," Apr. 22, 2020. [Online].
Available: https://wiki.gccollab.ca/images/5/56/PSPC_Communique_-_Heating_Ventilation_and_Air_Conditioning_System_Requirements_-_COVID-19_-_April_22_2020.pdf

[92]* Y. Li *et al.,* "Role of Ventilation in Airborne Transmission of Infectious Agents in the Built Environment – A Multidisciplinary Systematic Review," *Indoor Air,* vol. 17, no. 1, pp. 2–18, 2007, https://doi.org/10.1111 /j.1600-0668.2006.00445.x

[93]** ASHRAE, "ASHRAE Position Document on Infectious Aerosols," Apr. 14, 2020. [Online].
Available: https://www.ashrae.org/file library/about/position documents/pd_infectiousaerosols_2020.pdf

[94]* P. Azimi and B. Stephens, "HVAC Filtration for Controlling Infectious Airborne Disease Transmission in Indoor Environments: Predicting Risk Reductions and Operational Costs," *Build. Environ.,* vol. 70, pp. 150–160, 2013. https://doi.org/10.1016/j.buildenv.2013.08.025

[95]** REHVA, "REHVA COVID-19 Guidance Document," Apr. 3, 2020. [Online]. Available: https://www.rehva.eu/fileadmin/user_upload/REHVA_COVID-19_guidance_document_ver2_20200403_1.pdf

[96]* C. A. Gilkeson *et al.,* "Measurement of Ventilation and Airborne Infection Risk in Large Naturally Ventilated Hospital Wards," *Build. Environ.,* vol. 65, pp. 35–48, 2013, https://doi.org/10.1016/j.buildenv.2013.03.006

[97]* L. Morawska *et al.,* "How Can Airborne Transmission of COVID-19 Indoors Be Minimised?" *Environ. Int.,* vol. 142, pp. 1–7, May 2020, https://doi.org/10.1016/j.envint.2020.105832

[98]** ASHRAE, "Filtration / Disinfection." Accessed: Jun. 3, 2020. [Online]. Available: https://www.ashrae.org/technical-resources/filtration-disinfection

[99]** The Illuminating Engineering Society (IES) Photobiology Committee, "IES Committee Report: Germicidal Ultraviolet (GUV) – Frequently Asked Questions – IES CR-2-20-V1." Accessed: Jun. 4, 2020. [Online]. Available: www.ies.org

[100]* C. M. Walker and G. Ko, "Effect of Ultraviolet Germicidal Irradiation on Viral Aerosols," *Environ. Sci. Technol.,* vol. 41, no. 15, pp. 5460–5465, 2007, https://doi.org/10.1021/es070056u

[101]* B. Rodgers and D. Saputa, "HVAC UV Germicidal Irradiation UV-C Fixtures," *ASHRAE J.,* vol. 59, no. 1, pp. 14–18, 2017.

[102]* S. T. Summerfelt, "Ozonation and UV Irradiation – An Introduction and Examples of Current Applications," *Aquac. Eng.,* vol. 28, no. 1–2, pp. 21–36, 2003.

[103]** ASHRAE, *Standard 188-2018 Legionellosis: Risk Management for Building Water Systems,* 2018. [Online]. Available: https://www.techstreet.com/ashrae/standards/ashrae-188-2018?product_id=2020895

[104]** Public Works and Government Services Canada, *MD 15161 – 2013 Control of Legionella in Mechanical Systems: Standard for Building Owners, Design Professionals, and Maintenance Personnel,* Ottawa, ON: PWGSC, 2016.

[105]** Régie du bâtiment du Québec (RBQ), "Guide explicatif sur l'entretien des installations de tours de refroidissement à l'eau," 2014. [Online]. Available: https://www.rbq.gouv.qc.ca/fileadmin/medias/pdf/Publications/francais/guide-explicatif-entretien-tours-refroidissement-eau.pdf

[106]** NYC Health, "COVID-19 Interim Guidance on NYC Cooling Tower Regulations." Accessed: Aug. 30, 2020. [Online]. Available: http://sitecompli.com/wp-content/uploads/2020/03/InterimGuidance_CTS_COVID19.pdf

[107]** Public Services and Procurement Canada, "Building Water Systems Minimum Requirements-(COVID-19)," Jun. 6, 2020. [Online]. Available: https://wiki.gccollab.ca/images/6/64/Building_Water_System_Requirements_-_COVID-19_June_26.pdf

[108]** U.S. Environmental Protection Agency, "Maintaining or Restoring Water Quality in Buildings with Low or No Use," Jul. 2020. [Online]. Available: https://www.epa.gov/sites/production/files/2020-05/documents/final_maintaining_building_water_quality_5.6.20-v2.pdf

[109]** Government of Ontario, "Guide for Maintaining Building Plumbing after an Extended Vacancy," Aug. 18, 2020. [Online]. Available: https://www.ontario.ca/page/guide-maintaining-building-plumbing-after-extended-vacancy

[110]** Government of Quebec, "RECOMMENDATIONS for Restoring Service to Water Systems in Vacant Buildings," 2020. [Online]. Available: https://www.rbq.gouv.qc.ca/fileadmin/medias/pdf/Publications/anglais/ang-recommandations-remise-en-service-eau-batiments-inoccupes.pdf

[111]** ESGLI and ESCMID, "Guidance for Managing Legionella in Nursing & Care Home Water Systems During the Covid-19 Pandemic." Accessed: Aug. 21, 2020. [Online]. Available: https://cdn2.hubspot.net/hubfs/2896031/ESGLI Nursing & Care Home.pdf

[112]** Vancouver Coastal Health, "Water Stagnation Risks Due to Prolonged Reduced Building Occupancy," Mar. 27, 2020. [Online]. Available: http://www.vch.ca/Documents/VCH%20Bulletin%20-%20Building%20Water%20Systems%20and%20COVID19%20.PDF

[113]** Canadian Water and Wastewater Association, "Safely Re-opening Buildings: General Guidance for Water Utilities," May 2020. [Online]. Available: https://cwwa.ca/wp-content/uploads/2020/05/Re-Opening-Buildings-PARTONE_FINAL.pdf

[114]** Government of Ontario, "Flushing and Sampling for Lead," Mar. 14, 2017. [Online]. Available: https://www.ontario.ca/page/flushing-and-sampling-lead

[115]** U.S. Environmental Protection Agency, *3Ts for Reducing Lead in Drinking Water in Schools and Child Care Facilities Revised Manual,* Oct. 2018. [Online]. Available: https://nepis.epa.gov/Exe/ZyPDF.cgi/P100VLI2.PDF?Dockey=P100VLI2.PDF

[116]** Canadian Water and Wastewater Association, "SAFELY RE-OPENING BUILDINGS a FACT SHEET for Building Owners/Operators," May 2020. [Online]. Available: https://cwwa.ca/wp-content/uploads/2020/05/Re-Opening-Buildings-FACT-SHEET_FINAL-amend1.pdf

[117]** U.S. Department of Labor, Occupational Safety and Health Administration, "Legionellosis (Legionnaires' Disease and Pontiac Fever)." Accessed: Aug. 21, 2020. [Online]. Available: https://www.osha.gov/SLTC/legionnairesdisease/control_prevention.html#collapse1

[118]** Government of Canada, "Coronavirus Disease (COVID-19): Summary of Assumptions," Apr. 13, 2020. [Online]. Available: https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/health-professionals/assumptions.html

[119]* W. Zhang *et al.,* "Molecular and Serological Investigation of 2019-nCoV Infected Patients: Implication of Multiple Shedding Routes," *Emerg. Microbes Infect.,* vol. 9, no. 1, pp. 386–389, 2020, https://doi.org/10.1080/22221751.2020.1729071

[120]* Y. Chen *et al.,* "The Presence of SARS-CoV-2 RNA in the Feces of COVID-19 Patients," *J. Med. Virol.,* vol. 92, no. 7, pp. 833–840, 2020, https://doi.org/10.1002/jmv.25825

[121]** Centers for Disease Control and Healthcare Infection Control Practices Advisory Committee, "Guidelines for Environmental Infection Control in Health-Care Facilities," Jul. 2019. [Online]. Available: https://www.cdc.gov/infectioncontrol/pdf/guidelines/environmental-guidelines-P.pdf

[122]* E. L. Best *et al.,* "Potential for Aerosolization of Clostridium difficile after Flushing Toilets: The Role of Toilet Lids in Reducing Environmental Contamination Risk," *J. Hosp. Infect.,* vol. 80, no. 1, pp. 1–5, 2012, https://doi.org/10.1016/j.jhin.2011.08.010

[123]* E. Best *et al.,* "Environmental Contamination by Bacteria in Hospital Washrooms According to Hand-Drying Method: A Multi-centre Study," *J. Hosp. Infect.,* vol. 100, no. 4, pp. 469–475, Dec. 2018, https://doi.org/10.1016/j.jhin.2018.07.002

[124]* M. J. Mendell *et al.,* "Respiratory and Allergic Health Effects of Dampness, Mold, and Dampness-Related Agents: A Review of the Epidemiologic Evidence," *Environ. Heal. Perspect.,* vol. 119, no. 6, pp. 748–756, 2011, https://doi.org/10.1289/ehp.1002410

[125]** Canadian Construction Association, "Mould Guidelines for the Canadian Construction Industry," 2018. [Online]. Available: https://www.cca-acc.com/wp-content/uploads/2019/02/Mould-guidelines2018.pdf

[126]** Centers for Disease Control and Prevention, "Coronavirus Disease 2019 (COVID-19) – How to Protect Yourself," Jul. 31, 2020. [Online]. Available: https://www.cdc.gov/coronavirus/2019-ncov/about/prevention.html

[127]** Ontario Ministry of Health, "COVID-19 Guidance: Essential Workplaces General Advice," Version 1, May 2, 2020. [Online]. Available: http://www.health.gov.on.ca/en/pro/programs/publichealth/coronavirus/docs/2019_essential_workplaces_guidance.pdf

[128]** BC Centre for Disease Control, "Protecting Employees, Contractors, and Employers Working in the Silviculture Sector During the COVID-19 Pandemic." Accessed: Aug. 16, 2020. [Online]. Available: http://www.bccdc.ca/health-info/diseases-conditions/covid-19

[129]** Canadian Centre for Occupational Health and Safety, "Health and Safety Report Volume 12 Issue 11. Accessed: Jun. 3, 2020. [Online]. Available: https://www.ccohs.ca/newsletters/hsreport/issues/2014/11/ezine.html

[130]** City of Toronto, Occupational Health and Safety, People and Equity Division, "Strategies for Community Partners to Practice Physical Distancing and Reduce the Spread of COVID-19," Apr. 1, 2020. [Online]. Available: https://www.toronto.ca/wp-content/uploads/2020/04/95d3-Community-Partners-Physical-Distancing-Spread-Reduction.pdf

[131]***Stantec, "Getting Back to Social – Responding to COVID-19," May 12, 2020. [Online]. Available: https://spotlight.stantec.com/covid-19/getting-back-to-social-responding-to-covid-19

[132]** Candian Centre for Occupational Health and Safety, "Coronavirus (COVID-19) Tips –Construction," Apr. 7, 2020. [Online]. Available: https://www.ccohs.ca/images/products/pandemiccovid19/pdf/construction.pdf

[133]** Government of UK, "Working Safely During COVID-19 in Offices and Contact Centres: Guidance for Employers, Employees and the Self-Employed," Aug. 13, 2020. [Online]. Available: https://www.gov.uk/guidance/working-safely-during-coronavirus-covid-19/offices-and-contact-centres

[134]** Canadian Union of Public Employees, "Workers with Disabilities," Apr. 22, 2015. [Online]. Available: https://cupe.ca/workers-disabilities

[135]** Government of Ontario, "Resources to Prevent COVID-19 in the Workplace," Aug. 7, 2020. [Online]. Available: https://www.ontario.ca/page/resources-prevent-covid-19-workplace

[136]** Government of Canada, "Preventing COVID-19 in the Workplace: Employers, Employees and Essential Service Workers – Work-Related Travel." Accessed: Jun. 10, 2020. [Online]. Available: https://www.canada.ca/en/public-health/services/publications/diseases-conditions/preventing-covid-19-workplace-employers-employees-essential-service-workers.html#_Work-related_travel

[137]** Centers for Disease Control and Prevention, "Interim Guidance for Businesses and Employers Responding to Coronavirus Disease 2019 (COVID-19)," May 2020. [Online]. Available: https://www.cdc.gov/coronavirus/2019-ncov/community/guidance-business-response.html

[138]* E. Angelakis *et al.,* "Paper Money and Coins as Potential Vectors of Transmissible Disease," *Future Microbiol.,* vol. 9, no. 2, pp. 249–261, Feb. 2014, https://doi.org/10.2217/fmb.13.161

[139]*** S. Turnbull, "Bank of Canada Says Retailers Shouldn't Refuse Cash Amid COVID-19 Outbreak," CTV News, Mar. 26, 2020. [Online]. Availabale: https://www.ctvnews.ca/health/coronavirus/bank-of-canada-says-retalers-shouldn-t-refuse-cash-amid-covid-19-outbreak-1.4869460

[140]*** H. Kretchmer, "COVID-19: Is This What the Office of the Future Will Look Like?" World Economic Forum, May 28, 2020. [Online]. Available: https://www.weforum.org/agenda/2020/04/covid19-coronavirus-change-office-work-homeworking-remote-design/

[141]* S. Parry and L. Straker, "The Contribution of Office Work to Sedentary Behaviour Associated Risk," *BMC Public Health,* vol. 13, no. 296, 2013, https://doi.org/10.1186/1471-2458-13-296

[142]* C. Bontrup *et al.,* "Low back pain and its relationship with sitting behaviour among sedentary office workers," *Appl. Ergon.,* vol. 81, p. 102894, Nov. 2019, https://doi.org/10.1016/j.apergo.2019.102894

[143]* P. T. Katzmarzyk *et al.,* "Sitting time and mortality from all causes, cardiovascular disease, and cancer," *Med. Sci. Sports Exerc.,* vol. 41, no. 5, pp. 998–1005, May 2009, https://doi.org/10.1249/MSS.0b013e3181930355

[144]** Centers for Disease Control and Prevention, "Employer Information for Office Buildings," Jul. 9, 2020. [Online]. Available: https://www.cdc.gov/coronavirus/2019-ncov/community/office-buildings.html

[145]** Government of Alberta, "Help Prevent the Spread." Accessed: Aug. 16, 2020. [Online]. Available: https://www.alberta.ca/prevent-the-spread.aspx#p25621s3

[146]** The Middlesex-London Health Unit, "COVID-19 Guidance and Resources for Workplaces and Community Settings," Apr. 2, 2020. [Online]. Available: https://www.healthunit.com/covid-19-resources-workplaces

[147]*** Vancouver Island Strata Owners Association, "COVID-19 Information: Elevator Etiquette." Accessed: May 28, 2020. [Online]. Available: https://www.visoa.bc.ca/wp-content/uploads/2020/04/VISOA-COVID-19-elevator-etiquette-poster.pdf

[148]** Centers for Disease Control and Prevention, "Cleaning and Disinfecting Your Facility," Jul. 28, 2020. [Online]. Available: https://www.cdc.gov/coronavirus/2019-ncov/community/disinfecting-building-facility.html

[149]** Government of Canada, "Hard-Surface Disinfectants and Hand Sanitizers (COVID-19): List of Disinfectants with Evidence for Use against COVID-19." Accessed: Jun. 3, 2020. [Online]. Available: https://www.canada.ca/en/health-canada/services/drugs-health-products/disinfectants/covid-19/list.html#tbl1

[150]* L. E. Charles *et al.,* "Occupational Hazards Experienced by Cleaning Workers and Janitors: A Review of the Epidemiologic Literature," *Work,* vol. 34, no. 1. Work, pp. 105–116, 2009, https://doi.org/10.3233/WOR-2009-0907

[151]* R. D. Lewis *et al.,* "Resuspension of House Dust and Allergens During Walking and Vacuum Cleaning," *J. Occup. Environ. Hyg.,* vol. 15, no. 3, pp. 235–245, 2018, https://doi.org/10.1080/15459624.2017.1415438

[152]** Centers for Disease Control and Prevention, "Cleaning and Disinfection for Community Facilities," May 27, 2020. [Online]. Available: https://www.cdc.gov/coronavirus/2019-ncov/community/organizations/cleaning-disinfection.html

[153]** United States Department of Labor, Occupational Safety and Health Administration, "Standard 1910.132 – General Requirements." Accessed: May 22, 2020. [Online]. Available: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=9777&p_table=STANDARDS

[154]** Canadian Centre for Occupational Health and Safety, "Personal Protective Equipment." Accessed: Jun. 3, 2020. [Online]. Available: https://www.ccohs.ca/oshanswers/prevention/ppe/

[155]** Government of Canada, "Canada Labour Code." Accessed: Jun. 3, 2020. [Online]. Available: https://laws-lois.justice.gc.ca/eng/acts/L-2/

[156]* J. G. Jones, "The Physiological Cost of Wearing a Disposable Respirator," *Am. Ind. Hyg. Assoc. J.,* vol. 52, no. 6, pp. 219–225, Jun. 1991, https://doi.org/10.1080/15298669191364631

[157]* A. T. Johnson *et al.,* "Sweat Rate Inside a Full-Facepiece Respirator," *Am. Ind. Hyg. Assoc. J.,* vol. 58, no. 12, pp. 881–884, 1997, https://doi.org/10.1080/15428119791012225

[158]* J. M. Paull and F. S. Rosenthal, "Heat Strain and Heat Stress for Workers Wearing Protective Suits at a Hazardous Waste Site," *Am. Ind. Hyg. Assoc. J.,* vol. 48, no. 5, pp. 458–463, May 1987, https://doi.org/10.1080/15298668791385048

[159]** ACGIH, 2020 TLVs and BEIs Cincinattie, OH: Signature Publications, 2020. Available: https://www.acgih.org/forms/store/ProductFormPublic/2020-tlvs-and-beis

[160]* C. C. I. Foo *et al.,* "Adverse Skin Reactions to Personal Protective Equipment Against Severe Acute Respiratory Syndrome? A Descriptive Study in Singapore," *Contact Derm.,* vol. 55, no. 5, pp. 291–294, Nov. 2006, https://doi.org/10.1111/j.1600-0536.2006.00953.x

[161]* P. Lin *et al.,* "Adverse Skin Reactions Among Healthcare Workers During the Coronavirus Disease 2019 Outbreak: A Survey in Wuhan and Its Surrounding Regions," *Br. J. Dermatol.,* vol. 183, no. 1, pp. 190–192, Jul. 2020, https://doi.org/10.1111/bjd.19089

[162]** Canadian Standards Association, CAN/CSA-Z94.4-18 Selection, Use, and Care of Respirators, Sept. 2018. [Online]. Available: https://www.3mcanada.ca/3m/en_ca/worker-health-safety-ca/safety-town-square/articles/csa-z94-4-18-review-of-updates-and-changes

[163]** U.S. Food and Drug Administration, "Use of Respirators, Facemasks, and Cloth Face Coverings in the Food and Agriculture Sector During Coronavirus Disease (COVID-19) Pandemic," Apr. 24, 2020. [Online]. Available: https://www.fda.gov/food/food-safety-during-emergencies/use-respirators-facemasks-and-cloth-face-coverings-food-and-agriculture-sector-during-coronavirus

[164]** Canadian Centre for Occupational Health and Safety, "Respirators – Respirators Versus Surgical Masks," Jul. 11, 2017. [Online]. Available: https://www.ccohs.ca/oshanswers/prevention/ppe/surgical_mask.html

[165]*** L. M. Brosseau and M. Sietsema, "COMMENTARY: Masks-for-all for COVID-19 Not Based on Sound Data," Centre for Infectious Disease Research and Policy, Apr. 1, 2020. [Online]. Available: https://www.cidrap.umn.edu/news-perspective/2020/04/commentary-masks-all-covid-19-not-based-sound-data

[166]* A. Davies *et al.,* "Testing the Efficacy of Homemade Masks: Would They Protect in an Influenza Pandemic?" *Disaster Med. Public Health Prep.*, vol. 7, pp. 413–418, 2013, https://doi.org/10.1017/dmp.2013.43

[167]* S. Rengasamy *et al.,* "Simple Respiratory Protection – Evaluation of the Filtration Performance of Cloth Masks and Common Fabric Materials Against 20–1000 nm Size Particles," *Ann. Occup. Hyg.,* vol. 54, no. 7, pp. 789–798, 2010, https://doi.org/10.1093/annhyg/meq044

[168]* M. Van der Sande *et al.,* "Professional and Home-Made Face Masks Reduce Exposure to Respiratory Infections among the General Population," *PLoS One,* vol. 3, no. 7, 2008, https://doi.org/10.1371/journal.pone.0002618

[169]** Government of Canada, "Non-Medical Masks and Face Coverings: About." Accessed: Aug. 16, 2020. [Online]. Available: https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/prevention-risks/about-non-medical-masks-face-coverings.html

[170]* X. Pan *et al.,* "Asymptomatic Cases in a Family Cluster with SARS-CoV-2 Infection," *Lancet Infect. Dis.,* vol. 20, no. 4, pp. 410–411, Apr. 2020, https://doi.org/10.1016/S1473-3099(20)30114-6

[171]* C. Rothe *et al.,* "Transmission of 2019-nCoV Infection from an Asymptomatic Contact in Germany," *N. Engl. J. Med.,* vol. 382, no. 10, pp. 970–971, Mar. 2020, https://doi.org/10.1056/NEJMc2001468

[172]** W. E. Wei *et al.,* "Presymptomatic Transmission of SARS-CoV-2 – Singapore, January 23–March 16, 2020," CDC. MMWR. *Morb. Mortal. Wkly. Rep.,* vol. 69, no. 14, pp. 411–415, Apr. 2020, https://doi.org/10.15585/mmwr.mm6914e1

[173]* R. Li *et al.,* "Substantial Undocumented Infection Facilitates the Rapid Dissemination of Novel Coronavirus (SARS-CoV2)," *Science,* vol. 368, no. 6490, pp. 489–493, May 2020, https://doi.org/10.1126/science.abb3221

[174]* W. G. Lindsley *et al.,* "Efficacy of Face Shields Against Cough Aerosol Droplets from a Cough Simulator," *J. Occup. Environ. Hyg.,* vol. 11, pp. 509–518, 2014, https://doi.org/10.1080/15459624.2013.877591

[175]* U. Schulz and R. Schwarzer, "Soziale Unterstutzung bei der Krankheitsbew Ultigung," Die Berliner Soc. Support Skalen [Social Support coping with Illn. Berlin Soc. Support Scales (BSSS)]. *Diagnostica,* vol. 49, pp. 73–82, 2003.

[176]* V. C. C. Cheng *et al.,* "The role of Community-Wide Wearing of Face Mask for Control of Coronavirus Disease 2019 (COVID-19) Epidemic due to SARS-CoV-2," *J. Infect.,* 2020, https://doi.org/10.1016/j.jinf.2020.04.024

[177]* D. K. Chu *et al.,* "Physical Distancing, Face Masks, and Eye Protection to Prevent Person-to-Person Transmission of SARS-CoV-2 and COVID-19: A Systematic Review and Meta-Analysis," *The Lancet,* vol. 395, no. 10242, pp. 1973–1987, Jun. 27, 2020, https://doi.org/10.1016/S0140-6736(20)31142-9

[178]* X. Wang *et al.,* "Association Between Universal Masking in a Health Care System and SARS-CoV-2 Positivity Among Health Care Workers.," *JAMA,* Jul. 2020, https://doi.org/10.1001/jama.2020.12897

[179]* J. S. Brainard *et al.,* "Facemasks and Similar Barriers to Prevent Respiratory Illness Such as COVID-19: A Rapid Systematic Review," medRxiv, Preprints 2020, https://doi.org/10.1101/2020.04.01.20049528

[180]* J. Howard *et al.,* "Face Mask Against COVID-19: An Evidence Review," medRxiv, Preprints 2020, https://doi.org/10.20944/preprints202004.0203.v1

[181]** Workers Health & Safety Centre, "Gloves at Work: Safeguards for Workers Confronting COVID-19?" Accessed: May 26, 2020. [Online]. Available: https://www.whsc.on.ca/Files/Resources/COVID-19-Resources/WHSC_Pandemic_Gloves-at-Work_Safeguards-for-workers.aspx

[182]* T. Kawahara *et al.,* "Inactivation of Human and Avian Influenza Viruses by Potassium Oleate of Natural Soap Component Through Exothermic Interaction," *PLoS One,* vol. 13, no. 9, p. 9, Sep. 2018, https://doi.org/10.1371/journal.pone.0204908

[183]* H. Rabenau *et al.,* "Efficacy of Various Disinfectants Against SARS Coronavirus," *J. Hosp. Infect.,* vol. 61, no. 2, pp. 107–111, 2005, https://doi.org/10.1016/j.jhin.2004.12.023

[184]** Canadian Centre for Occupational and Health Safety, "Coronavirus (COVID-19) Tips-Transportation," Apr. 7, 2020. [Online]. Available: https://www.ccohs.ca/images/products/pandemiccovid19/pdf/transportation.pdf

[185]** Health Canada, "Hard-Surface Disinfectants and Hand Sanitizers (COVID-19): List of Hand Sanitizers Authorized by Health Canada." Accessed: Aug. 16, 2020. [Online]. Available: https://www.canada.ca/en/health-canada/services/drugs-health-products/disinfectants/covid-19/hand-sanitizer.html

[186]* C. W. Rundle *et al.,* "Hand Hygiene During COVID-19: Recommendations from the American Contact Dermatitis Society," *J. Am. Acad. Dermatol.,* Jul. 2020, https://doi.org/10.1016/j.jaad.2020.07.057

[187]** United States Department of Labor, Occupational Safety and Health Administration, "COVID-19 Control and Prevention – Solid Waste and Wastewater Management Workers and Employers." Accessed: Jul. 15, 2020. [Online]. Available: https://www.osha.gov/SLTC/covid-19/solid-waste-wastewater-mgmt.html

[188]* X. Pang *et al.,* "Evaluation of Control Measures Implemented in the Severe Acute Respiratory Syndrome Outbreak in Beijing, 2003," *JAMA,* 2003, https://jamanetwork.com/journals/jama/fullarticle/197893

[189]* V. A. Mouchtouri *et al.,* "Exit and Entry Screening Practices for Infectious Diseases among Travelers at Points of Entry: Looking for Evidence on Public Health Impact," *Int. J. Environ. Res. Public Health,* vol. 16, 4638, Nov. 21, 2019, https://doi.org/10.3390/ijerph16234638

[190]*** T. W. Hudson and N. Hartenbaum, "A Colleague in Manufacturing Has Done 100,000 Temp Screenings and Found 1 Positive. Is There Value in Temperature Screening for Facility Entry? How Are Industry / Manufacturing Companies Utilizing Temperature Screening? What Is the Scientific Evidence Supporting the Benefit of the Practice?" COVID-19 Resource Center, May 16, 2020. [Online]. Available: https://acoem.org/COVID-19-Resource-Center/COVID-19-Q-A-Forum/A-colleague-in-manufacturing-has-done-100,000-temp-screenings-and-found-1-positive-Is-there-value-i

[191]** Government of Canada, "Coronavirus Disease (COVID-19): Your Rights and Responsibilities as an Employee." Accessed: Jul. 12, 2020. [Online]. Available: https://www.canada.ca/en/government/publicservice/covid-19/rights-responsibilities.html

[192]** Ontario Human Rights Commission, "OHRC Policy Statement on the COVID-19 Pandemic," Mar. 13, 2020. [Online]. Available: http://www.ohrc.on.ca/en/news_centre/ohrc-policy-statement-covid-19-pandemic

[193]** S. Morris *et al.,* "A Demographic, Employment and Income Profile of Canadians with Disabilities Aged 15 Years and Over, 2017," Statistics Canada, Nov. 28, 2018. [Online]. Available: https://www150.statcan.gc.ca/n1/pub/89-654-x/89-654-x2018002-eng.htm

[194]** Ontario Human Rights Commission, "Policy on Ableism and Discrimination Based on Disability – What Is Disability?" Jun. 27, 2016. [Online]. Available: http://www.ohrc.on.ca/en/policy-ableism-and-discrimination-based-disability/2-what-disability

[195]** Government of Canada, "COVID-19 and People with Disabilities in Canada." Accessed: Aug. 4, 2020. [Online]. Available: https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/guidance-documents/people-with-disabilities.html#a5

[196]** International Labour Organization, "No One Left Behind, Not Now, Not Ever – Persons with Disabilities in the COVID-19 Response," Apr. 8, 2020. [Online]. Available: https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---ifp_skills/documents/publication/wcms_741287.pdf

[197]** World Health Organization, "Disability Considerations During the COVID-19 Outbreak," Mar. 26, 2020. [Online]. Available: https://www.who.int/publications/i/item/WHO-2019-nCoV-Disability-2020-1

[198]** Government of Canada, "Backgrounder: COVID-19 Disability Advisory Group." Accessed: Aug. 4, 2020. [Online]. Available: https://www.canada.ca/en/employment-social-development/news/2020/04/backgrounder--covid-19-disability-advisory-group.html

[199]*** Fisher Phillips, "FP BEYOND THE CURVE: Back-to-Business FAQs for Employers., Aug. 12, 2020. [Online]. Available: https://www.fisherphillips.com/post-pandemic-faqs

[200]* T. Gupta *et al.,* "Gaps in Workplace Education for Prevention of Occupational Skin Disease," *Ann. Work Expo. Heal.,* vol. 62, no. 2, pp. 243–247, Mar. 2018, https://doi.org/10.1093/annweh/wxx093

[201]* J. Weidman *et al.,* "Effective Intervention Strategy to Improve Worker Readiness to Adopt Ventilated Tools," *J. Constr. Eng. Manag.,* vol. 142, no. 8, p. 04016028, Aug. 2016, https://doi.org/10.1061/(ASCE)CO.1943-7862.0001123

[202]* K. K. B. Clemmensen *et al.,* "Evidence-Based Training as Primary Prevention of Hand Eczema in a Population of Hospital Cleaning Workers," *Contact Derm.,* vol. 72, no. 1, pp. 47–54, Jan. 2015, https://doi.org/10.1111/cod.12304

[203]* E. Held *et al.,* "Prevention of Work Related Skin Problems: An Intervention Study in Wet Work Employees," *Occup. Environ. Med.,* vol. 59, no. 8, pp. 556–561, Aug. 2002, https://doi.org/10.1136/oem.59.8.556

[204]* A. Bregnhøj *et al.*, "Prevention of Hand Eczema among Danish Hairdressing Apprentices: An Intervention Study," *Occup. Environ. Med.,* vol. 69, no. 5, pp. 310–316, May 2012, https://doi.org/10.1136/oemed-2011-100294

[205]* S. S. Steengaard *et al.,* "Hand Eczema among Hairdressing Apprentices in Denmark Following a Nationwide Prospective Intervention Programme: 6-Year Follow-up," *Contact Derm.,* vol. 75, no. 1, pp. 32–40, Jul. 2016, https://doi.org/10.1111/cod.12588

[206]** Workplace Safety & Prevention Services, "Workplace Safety & Prevention Services Guidance on Health and Safety for Personal Care Services Settings During COVID-19." Accessed: Aug. 16, 2020. [Online]. Available: https://www.wsps.ca/WSPS/media/Site/Resources/Downloads/covid-19-personal-services-health-and-safety-guidance.pdf?ext=.pdf

[207]** American Industrial Hygiene Association, "Returning to Work: Rideshare, Taxi, Limo, and other Passenger Drivers-for-Hire," Version 2, May 6, 2020. [Online]. Available: https://aiha-assets.sfo2.digitaloceanspaces.com/AIHA/resources/Returning-to-Work-Rideshare-Taxi-Limo-and-other-Passenger-Drivers-for-Hire_GuidanceDocument.pdf

[208]** Workers Health & Safety Centre, "Confronting COVID-19 Safer Commuting During COVID-19," Jun. 4, 2020. [Online]. Available: https://www.whsc.on.ca/Files/Resources/COVID-19-Resources/WHSC-WebinarPP_Safer-Commuting-During-COVID-19_June4-20_COVID-19-Resources.aspx

[209]* J. Ives *et al.,* "Healthcare Workers' Attitudes to Working During Pandemic Influenza: A Qualitative Study," *BMC Public Health,* vol. 9, 2009, https://doi.org/10.1186/1471-2458-9-56

[210]***S. Mojtehedzadeh, "Many Ontario Workers Are Trying to Refuse Work due to COVID-19 Fears — but the Government Isn't Letting Them," *Toronto Star,* Apr. 27, 2020. [Online]. Available: https://www.thestar.com/business/2020/04/27/many-ontario-workers-are-trying-to-refuse-work-due-to-covid-19-fears-but-the-government-isnt-letting-them.html

[211]***A. Gorlick, "The Productivity Pitfalls of Working from Home in the age of COVID-19," *Stanford News,* Mar. 20, 2020. [Online]. Available: https://news.stanford.edu/2020/03/30/productivity-pitfalls-working-home-age-covid-19/

[212]* N. Bloom et al., "Does Working from Home Work? Evidence from a Chinese Experiment," *Q. J. Econ.,* vol. 130, no. 1, pp. 165–218, Feb. 2015, https://doi.org/10.1093/qje/qju032

[213]** Canadian Centre for Occupational and Health Safety, "Telework / Telecommuting," Accessed: Aug. 17, 2020. [Online]. Available: https://www.ccohs.ca/oshanswers/hsprograms/telework.html

[214]** Canadian Centre for Occupational and Health Safety, "Working Alone – General." Accessed: Jul. 31, 2020. [Online]. Available: https://www.ccohs.ca/oshanswers/hsprograms/workingalone.html

[215]** WorkSafeBC, Working Alone: A Handbook for Small Businesses, Jun. 2012. [Online]. Available: https://www.worksafebc.com/en/resources/health-safety/books-guides/working-alone-a-handbook-for-small-business?lang=en

[216]* W. Rana *et al.,* "Mental Health of Medical Workers in Pakistan During the pandemic COVID-19 Outbreak," *Asian J. Psychiatr.,* vol. 51, p. 10208, Jun. 2020, https://doi.org/10.1016/j.ajp.2020.102080

[217]* S. S. Chatterjee *et al.,* "Impact of COVID-19 Pandemic on Pre-existing Mental Health Problems," *Asian J. Psychiatr.,* vol. 51, p. 102071, Jun. 2020, https://doi.org/10.1016/j.ajp.2020.102071

[218]* R. G. Maunder, "Was SARS a Mental Health Catastrophe?" *Gen. Hosp. Psychiatry,* vol. 31, no. 4, pp. 316–317, Jul. 2009, https://doi.org/10.1016/j.genhosppsych.2009.04.004

[219]* W J. Lancee *et al.,* "Prevalence of Psychiatric Disorders Among Toronto Hospital Workers One to Two Years After the SARS Outbreak," *Psychiatr. Serv.,* vol. 59, no. 1, pp. 91–95, Jan. 2008, https://doi.org/10.1176/ps.2008.59.1.91

[220]* H. Yaribeygi *et al.,* "The Impact of Stress on Body Function: A Review," *EXCLI Journal,* vol. 16, pp. 1057–1072, Jul. 21, 2017, https://doi.org/10.17179/excli2017-480

[221]** Canadian Centre for Occupational Health and Safety, "Mental Health – Pyschosocial Risk Factors in the Workplace." Accessed: Aug. 1, 2020. [Online]. Available: https://www.ccohs.ca/oshanswers/psychosocial/mentalhealth_risk.html

[222]** Mental Health Commission of Canada, "National Standard." Accessed: Jul. 31, 2020. [Online]. Available at: https://www.mentalhealthcommission.ca/English/what-we-do/workplace/national-standard

[223]** Mental Health Commission of Canada, "Psychological Health & Safety: An Action Guide for Employers," Jan. 2012. [Online]. Available: https://www.mentalhealthcommission.ca/sites/default/files/Workforce_Employers_Guide_ENG_1.pdf

[224]***Canadian Centre for Mental Health and Sport, "Mental Health Resources." Accessed: Jun. 4, 2020. [Online]. Available: https://www.ccmhs-ccsms.ca/mental-health-resources-1

[225]* G. Jeff, "Impact of the Coronavirus on EAPs: Managing the Fear of Communicable Disease," *J. Empl. Assist.,* 2nd Quarter, pp. 32–34, 2020. Available: https://archive.hshsl.umaryland.edu/bitstream/handle/10713/12504/Gorter%20Article.pdf?sequence=1&isAllowed=y

[226]* S. Hamouche, "COVID-19 and Employees' Mental Health: Stressors, Moderators and Agenda for Organizational Actions," *Emerald Open Res.,* vol. 2, p. 15, Apr. 2020, https://doi.org/10.35241/emeraldopenres.13550.1

[227]* M. Nicola *et al.,* "The Socio-Economic Implications of the Coronavirus and COVID-19 Pandemic: A Review," *Int. J. Surg.,* Apr. 2020, https://doi.org/10.1016/j.ijsu.2020.04.018

Appendix 1 – Hierarchy of Controls: Definitions and Examples

During the expert review and consultation process several individuals requested more details on the hierarchy of controls, including specific examples. In this Appendix we have provided more detailed definitions and examples of controls, with the caveat that controls do not always fit neatly into one category.

Table A1: Definitions for each level of the hierarchy of controls, including example controls for each leve

	Definition	Examples
Elimination	Elimination of a hazard from the workplace	Work relocated to homes as possible; working alone as much as possible; face-to-face meetings replaced with online calls
Substitution	Substitution of the hazard with a less hazardous option	No substitution controls for SARS-CoV-2
Engineering	Interrupting the hazard along its path from source to worker, in order to prevent or decrease worker exposure	Barriers ensure physical distancing by restricting worker access to areas and limiting numbers in defined spaces; enhancements to HVAC systems (e.g., HEPA filtration)
Administrative	Adjustments to work practices, policies, and procedures that prevent or decrease worker exposure	Screening of symptoms and temperatures; policies and procedures for how to respond to symptomatic workers; enhanced protocols for cleaning and disinfection of all touch surfaces; policies preventing shared use of tools and materials; restrictions on communal food and drink; updates of newsletters and online resources; company audits; staggered break times established to minimize group density; dedicated work crew "pods" to contain exposures; installation of supplemental handwashing stations and hand sanitizer dispensers
Personal Protective Equipment	Equipment worn by individuals to prevent or decrease their own exposure	Provision and use of PPE, including gloves, protective eyewear, coveralls, respiratory protection; updating of training for PPE, including safe donning and doffing, updated fit testing procedures, increased use face coverings, enhanced controls over PPE supply and availability

Appendix 2 – Guidance Documents on Reopening Workplaces and Returning to Work

Table A2: List of international, national, provincial, and territorial bodies with guidance on reopening workplaces and returning to work

Level	Organization	Document Name
International	World Health Organization (WHO)	COVID: Occupational Health Employers and Workers Guidance (Risk Communication)
International	European Union (EU)	COVID-19: Back to the workplace—Adapting workplaces and protecting workers COVID-19: Guidance for workplace Practical tips to make home-based telework as healthy, safe and effective as possible
International	International Labour Organization (ILO)	COVID-19: What can employers do? Recovering from the COVID-19 crisis: What policies are needed? An employers' guide on working from home in response to the outbreak of COVID-19 Safe return to work: Guide for employers on COVID-19 prevention ILO Violence and Harassment Convention, 2019 (No. 190): 12 ways it can support the COVID-19 response and recovery An employers' guide on managing your workplace during COVID-19 The Family-friendly policies and other good workplace practices in the context of COVID-19: Key steps employers can take.
International	National Institute for Occupational Safety and Health (NIOSH)	Interim guidance for businesses and employers responding to coronavirus disease 2019 (COVID-19). May 2020 Manufacturing workers and employers – Interim guidance from CDC and the OSHA
International	Occupational Safety and Health Administration (OSHA)	Coronavirus: Guidance on preparing workplaces from COVID-19 Coronavirus (COVID-19): Ten steps all workplaces can take to reduce risk of exposure to Coronavirus Coronavirus (COVID-19): Seven steps to correctly wear a respirator at work poster Coronavirus (COVID-19): Guidance on social distancing at work: OSHA Alert Coronavirus: Prevent worker exposure to Coronavirus (COVID-19): OSHA Alert

Level	Organization	Document Name
International	Healthy and Safety Executive (HSE)	Posters: ▪ COVID-19 Hand hygiene poster ▪ COVID-19 How to prevent coronavirus Safety Culture
International	International Organization for Standardization (ISO)	COVID-19 response: Freely available ISO standards: ▪ ISO 374-5:2016, Protective gloves against dangerous chemicals and microorganisms- Part 5: Terminology and performance requirements for micro-organisms risk ▪ ISO 13688:2013, Protective clothing—General requirements ▪ ISO/TS 16976-8:2013, Respiratory protective devices—Human factors—Part 8: Ergonomic factors ▪ ISO 31000:2018, Risk Management ▪ ISO 22395:2018, Security and resilience—Community resilience—Guidelines for supporting vulnerable persons in an emergency
International	United Nations Children's Fund (UNICEF), World Bank, World Food Program	Framework for Reopening Schools
International	American Industrial Hygiene Association (AIHA)	Back to Work Safely™ Industry-Specific Guidelines for Smaller Businesses
National	Government of Canada	Risk-informed decision-making guidelines for workplaces and businesses during the COVID-19 pandemic Preventing COVID-19 in the workplace: Employers, employees and essential service workers
	Canadian Centre for Occupational Health and Safety	Pandemic guidance for higher-risk and essential occupations and industries
	Public Health Agency of Canada	Coronavirus disease (COVID-19)
Provincial	Government of Alberta	Workplace guidance for business owners Temporary workplace rule changes
Provincial	WorkSafeBC	Preventing exposure to COVID-19 in the workplace: A guide for employers COVID-19: Industry Information
	B.C. Centre for Disease Control	Protecting Workers at Large Industrial Camps During the COVID-19 Pandemic
Provincial	Government of Manitoba	Information for business Key responsibilities of employees, manager and employers Workplace Guidance for Business Owners
	Safe Work Manitoba	Industry-specific COVID-19 information COVID-19 resources

Level	Organization	Document Name
Provincial	Government of New Brunswick	COVID-19 Guidance for Businesses
	WorkSafeNB	COVID-19 COVID-19 Prevention tool for workplaces Workplace Measures to Mitigate the Spread of Coronavirus Disease (COVID-19)
Provincial	Government of Newfoundland and Labrador	COVID-19 Guidance on Personal Protective Equipment (PPE) for Employers Information sheet for businesses and workplaces
Provincial	Government of Nova Scotia	COVID-19: Working COVID-19: Occupational health and safety
Provincial	Government of Ontario	Resources to prevent COVID-19 in the workplace
	Ministry of Health	COVID-19 guidance: Essential workplaces
	Public Health Ontario	IPAC Recommendations for Use of Personal Protective Equipment for Care of Individuals with Suspect or Confirmed COVID-19
Provincial	Government of Prince Edward Island	COVID-19: For business
Provincial	Gouvernement du Québec	Wearing a mask or a face covering in public settings in the context of the COVID-19 pandemic Commission des normes, de l'équité, de la santé et de la sécurité du travail (CNESST) Quebec is going back to work safely
	Institut national de santé publique du Québec	COVID-19: Occupational health
Provincial	Government of Saskatchewan	COVID-19 Workplace Information

CSA Group Research

In order to encourage the use of consensus-based standards solutions to promote safety and encourage innovation, CSA Group supports and conducts research in areas that address new or emerging industries, as well as topics and issues that impact a broad base of current and potential stakeholders. The output of our research programs will support the development of future standards solutions, provide interim guidance to industries on the development and adoption of new technologies, and help to demonstrate our on-going commitment to building a better, safer, more sustainable world.

CSA GROUP™