



# Introduction of engineering controls in military dental clinical setting during the COVID-19 Pandemic



Col Jean-Pierre Picard

Canadian Armed Forces Chief Dental Officer

02 September 2020

**fdi** Section  
Defense Forces Dental Services

Canadian Forces  
Health Services Group



Groupe des Services de  
santé des Forces Canadiennes

# Initial Situation in Canada

- **Canadian Provincial Dental Regulators** limited care to that required to address **emergency dental conditions** while **avoiding** aerosol generating procedures (**AGPs**) and was available in **only a few designated clinics**.
- COVID-19 required **different precautions** than dental teams have been employing **since the early 1980s**.
- The Royal Canadian Dental Corps (RCDC) **adjusted** the use of PPE from **standard universal precautions** to **transmission-based precautions**.
- The RCDC was **lacking the capability to follow the Public Health Agency of Canada infection prevention recommendations** for the provision of care to patients with suspected or confirmed COVID-19 in **particular for AGPs**.





# Direction

“Develop a capability providing the ability to safely treat dental conditions where aerosol generating procedures (AGPS) are necessary for probable/confirmed cases of COVID-19”

Canadian Forces  
Health Services Group



Groupe des Services de  
santé des Forces Canadiennes

**Public Health Agency of Canada:**  
**Infection prevention and control for coronavirus disease  
(COVID-19) – Interim guidance for acute healthcare settings**

**AGPs:**

- **Strategies to reduce aerosol generation** should be applied.
- ...**AGMPs should be performed in an airborne infection isolation room (AIIR)** whenever feasible.
- If AIIRs are unavailable, **AGMPs should be carried out using a process and environment that minimizes the exposure risk for HCWs**, ensuring that patients, visitors, and others in the healthcare setting are not exposed to SARS-CoV-2 (e.g., **single room with door closed** and away from high-risk patients).

<https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/health-professionals/interim-guidance-acute-healthcare-settings.html#a4.11>

Canadian Forces  
Health Services Group



Groupe des Services de  
santé des Forces Canadiennes

# **US Centers for Disease Control and Prevention:** **Interim Infection Prevention and Control Recommendations for** **Patients with Suspected or Confirmed Coronavirus Disease 2019** **(COVID-19) in Healthcare Settings**

## **Implement Engineering Controls:**

- Design and install engineering controls to reduce or eliminate exposures by shielding HCP and other patients from infected individuals. Examples of engineering controls include:
  - physical barriers or partitions to guide patients through triage areas
  - curtains between patients in shared areas
  - **air-handling systems (with appropriate directionality, filtration, exchange rate, etc.) ...**

<https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html>

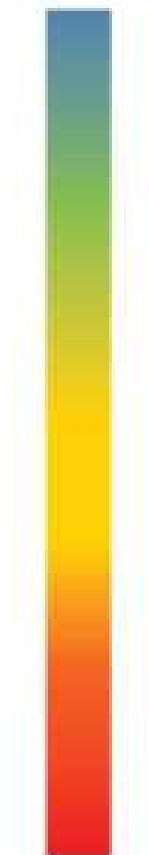
Canadian Forces  
Health Services Group



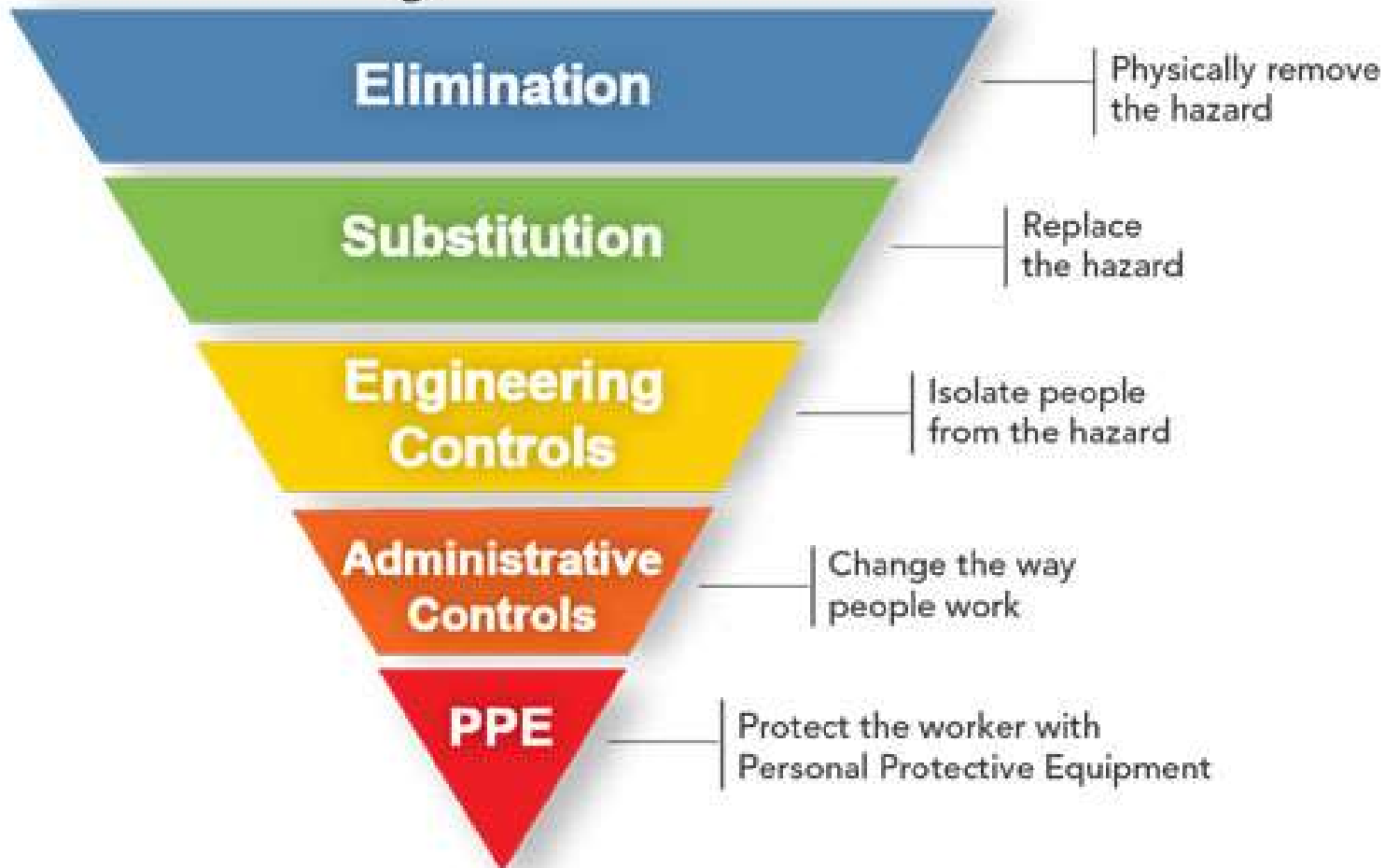
Groupe des Services de  
santé des Forces Canadiennes

# Hierarchy of Controls

Most effective



Least effective



<https://www.cdc.gov/niosh/topics/hierarchy/>

Canadian Forces  
Health Services Group

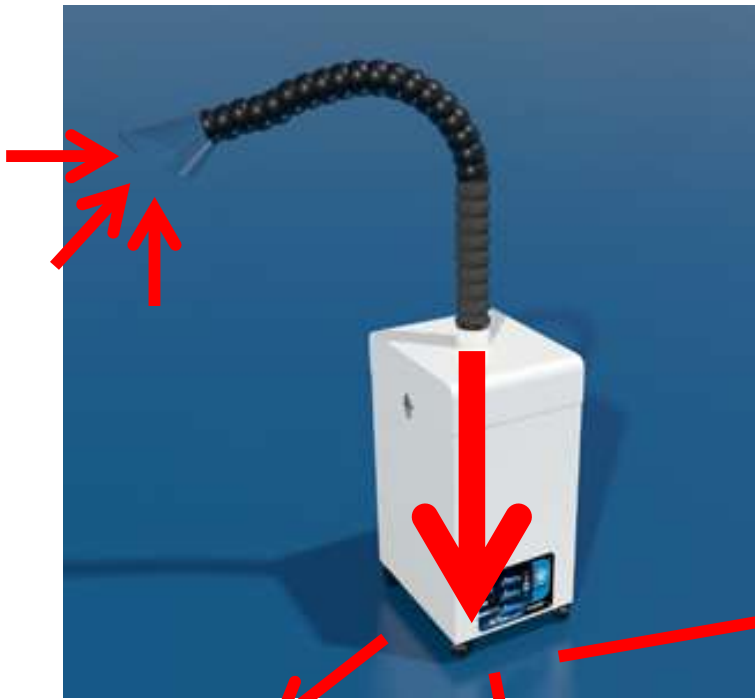


Groupe des Services de  
santé des Forces Canadiennes

# RCDC acquired Air Filtration Units (AFUs)

## *Chairside AFU*

**Operating air flow:** 4,247 L/min (150 CFM)  
**Filters:** 2-inch pre-filter + 6-inch HEPA\*



## *Ambient AFU*

**Operating air flow:** 7,928 L/min (280 CFM)  
**Filters:** 2-inch pre-filter + 6-inch HEPA\*



\*High Efficiency Particulate Air  
(99.97% @ 0.3  $\mu\text{m}$ )

Canadian Forces  
Health Services Group



Groupe des Services de  
santé des Forces Canadiennes

# **US Centers for Disease Control and Prevention:** **Interim Infection Prevention and Control Guidance for Dental Settings During the COVID-19 Response**

## **Engineering Controls:**

- Consider the use of a *portable HEPA air filtration unit* while the patient is actively undergoing, and immediately following, an aerosol-generating procedure.
- The use of these units will *reduce particle count* (including droplets) in the room and will *reduce the amount of turnover time*, rather than just relying on the building HVAC system capacity.
- Place HEPA unit within vicinity of patient's chair, but not behind DHCP. Ensure DHCP are not positioned between the unit and the patient's mouth. Position the unit to ensure that it does not pull air into or past the breathing zone of the DHCP.

<https://www.cdc.gov/coronavirus/2019-ncov/hcp/dental-settings.html>

Canadian Forces  
Health Services Group

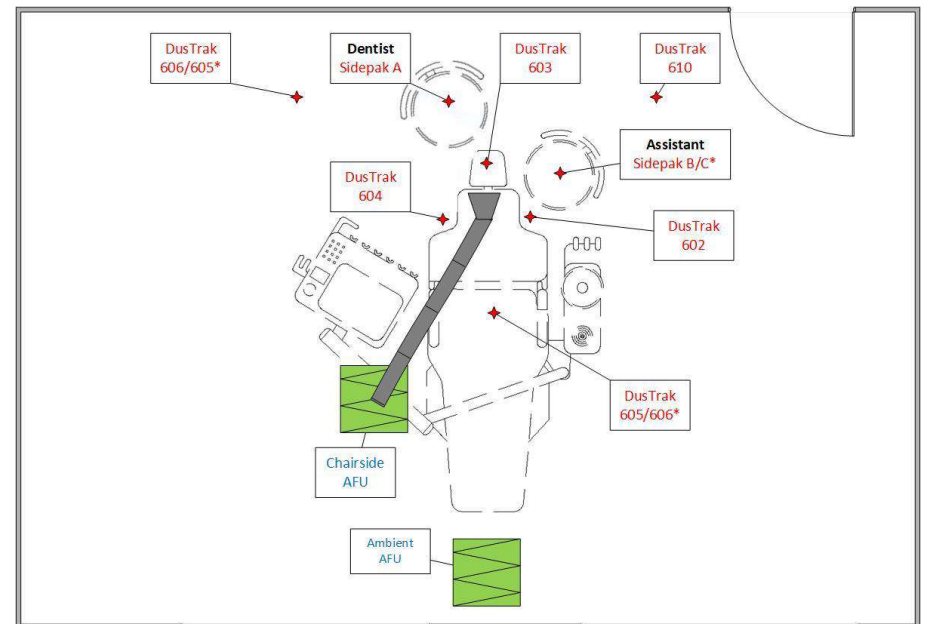
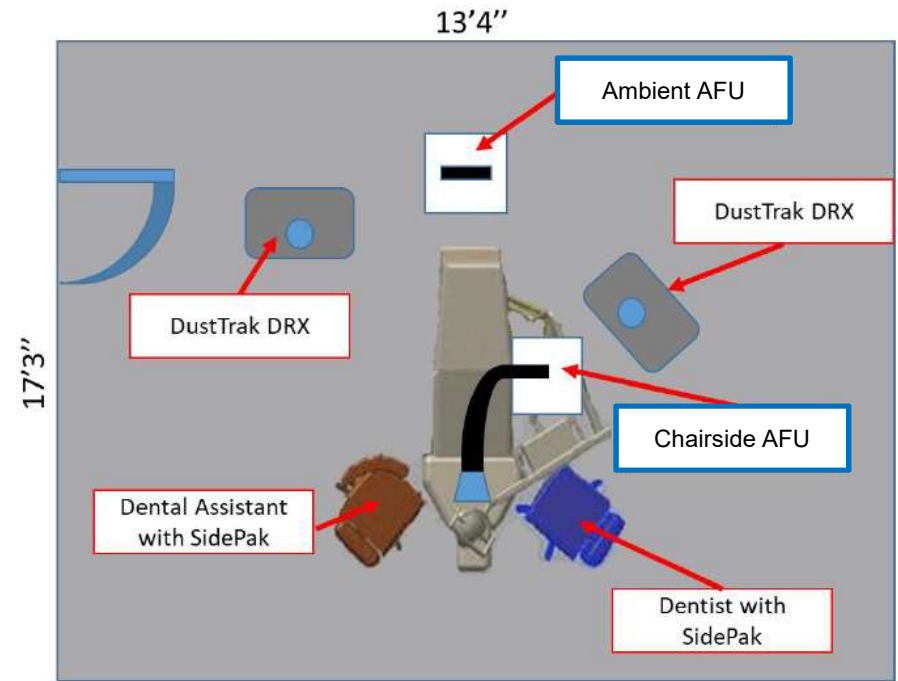


Groupe des Services de  
santé des Forces Canadiennes



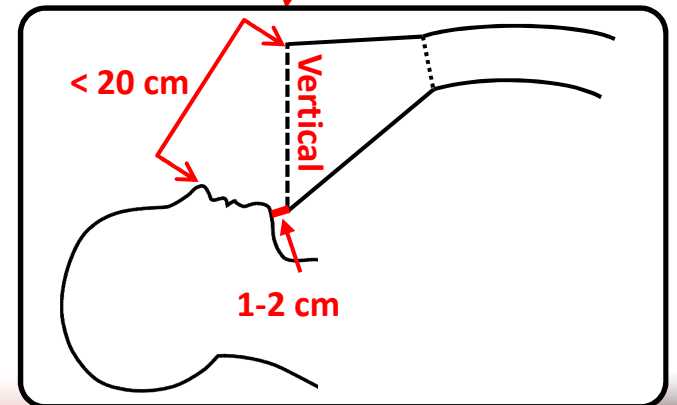
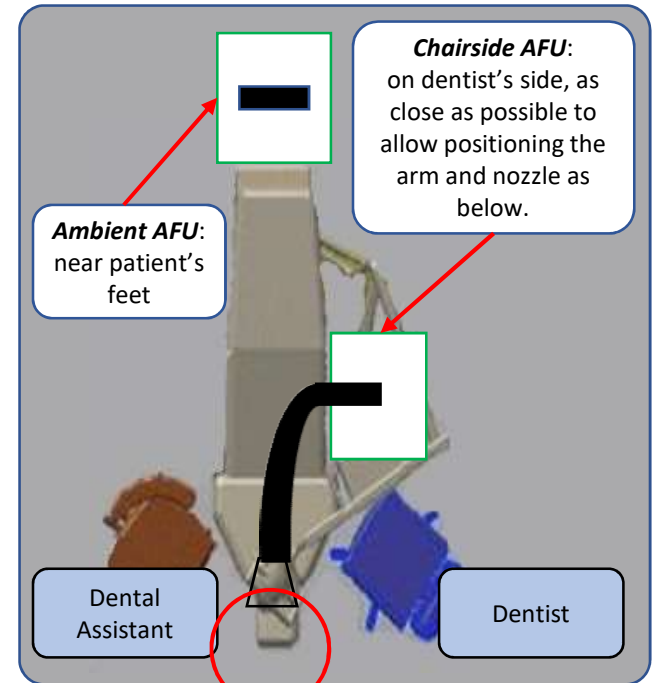
# AFUs Testing

- 1) Ottawa – NDHQ Carling Clinic (8 Apr 20)
  - **Familiarization** and preliminary tests
- 2) Ottawa – Montfort Clinic (22 Apr 20)
  - Determined **optimal positioning**
  - **Standardized test methodology**
- 3) Mobile Dental Clinic (MDC) (23 Apr 20)
  - Test **AFUs with the MDC’s HVAC** system modified with HEPA filtration
- 4) Ottawa – Montfort Clinic (26-27 May 20)
  - **Validation** of results with the Quality Engineering Test Establishment (QETE)
  - **More stringent** methodology
  - **2x more sampling sensors** (8 vs 4)
  - **Enhanced data analysis**



# Optimal Positioning

- Goal is to **maximize the capture velocity** at the source (patient's mouth) while allowing freedom of movement for dental providers
- First determined by **literature review**, then capture velocity measurements and **smoke tube visualisation** to confirm and optimize positioning



# Testing in Clinic: Standardized Methodology



- Measurement of **PM<sub>10</sub>** (*particulate matter 10 μm in size and smaller*) in **ambient air & breathing zone** of dental providers using **laser photometers**
- Drilling **natural teeth** on a mannequin using standard dental armamentarium: *handpieces, burs, high-volume evacuation*
- **Aerosol-Generating Procedure (AGP):** *drilling with high-speed handpiece*
- **Non-Aerosol-Generating Procedure (NAGP):** *drilling with low-speed handpiece*

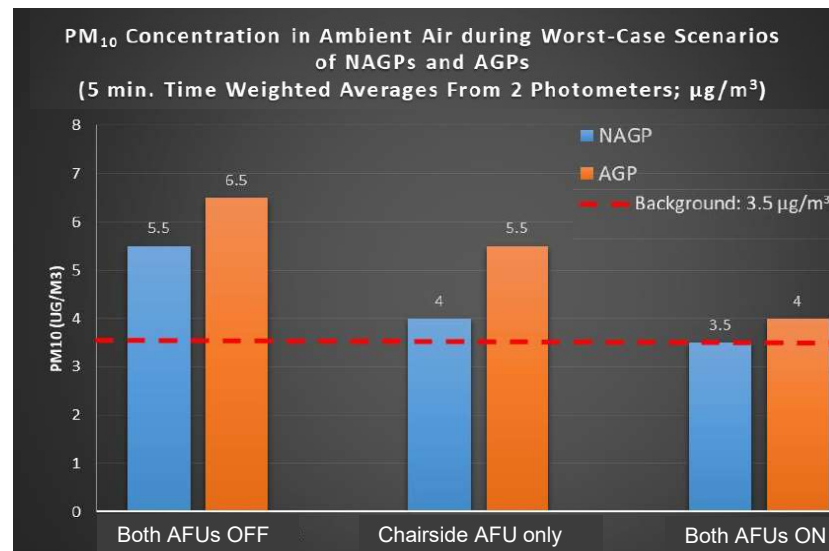
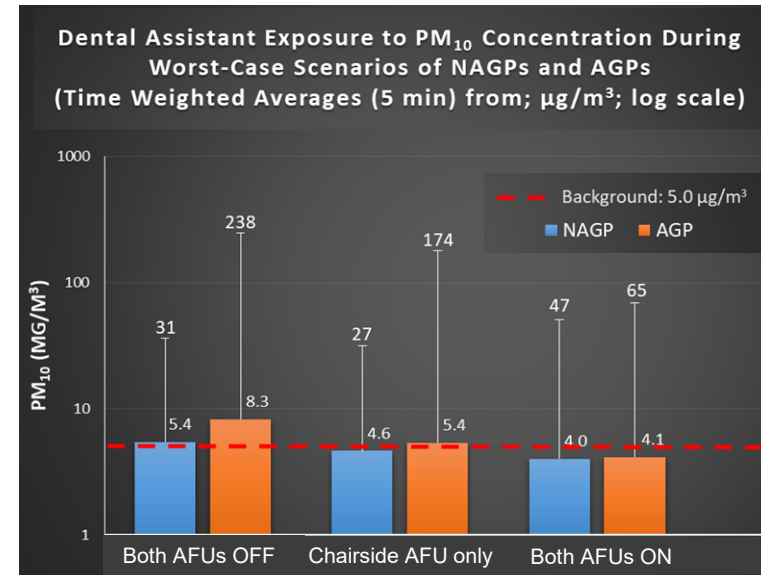
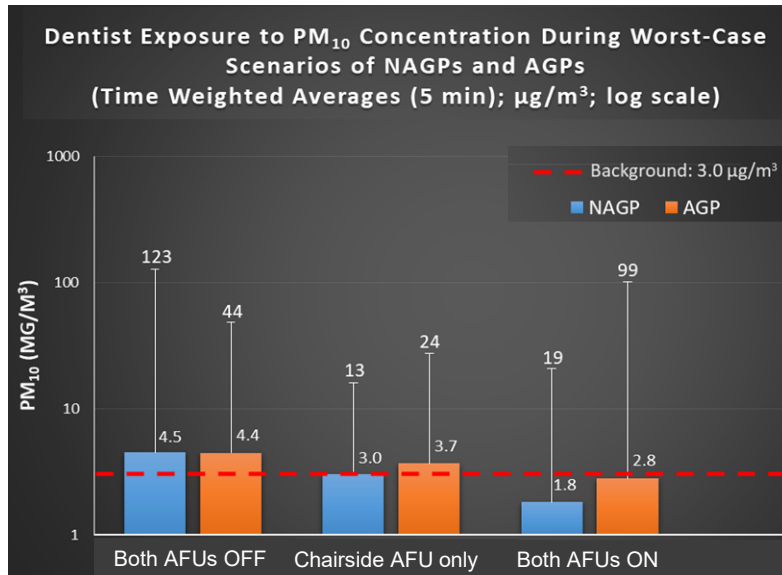
6 Permutations Assessed

- **Both AFUs OFF**
- **Chairside AFU only**
- **Both AFUs ON**
- **Continuous drilling for 5 minutes:** *1 minute per quadrant, then 1 minute on upper anterior tooth*





# Testing in Clinic: Results





# Testing in Clinic: Conclusions

- Estimated efficacy (%):

| Scenario:  |                    | Worst-case |                  |
|------------|--------------------|------------|------------------|
| Personnel→ |                    | Dentist    | Dental Assistant |
| Condition↓ |                    |            |                  |
| NAGPs      | Chairside AFU only | 98         | 100              |
|            | Both AFUs on       | 100        | 100              |
| AGPs       | Chairside AFU only | 53         | 88               |
|            | Both AFUs on       | 100        | 100              |

- **Though an efficacy of 100%** at capturing  $PM_{10}$  was calculated **for specific conditions**, in all cases, **visible droplets were observed landing** on the immediate surrounding environment (**patient's bib**), uncaptured by the Chairside AFU.
- The use of the **Chairside AFU only during both the NAGP and AGP does reduce the airborne particulate concentrations** in the dental clinic.
- When **both AFUs are used during NAGPs and AGPs**, the airborne particulate **concentrations** are reduced even further, **often falling below background levels**.



# Mobile Dental Clinic (MDC)





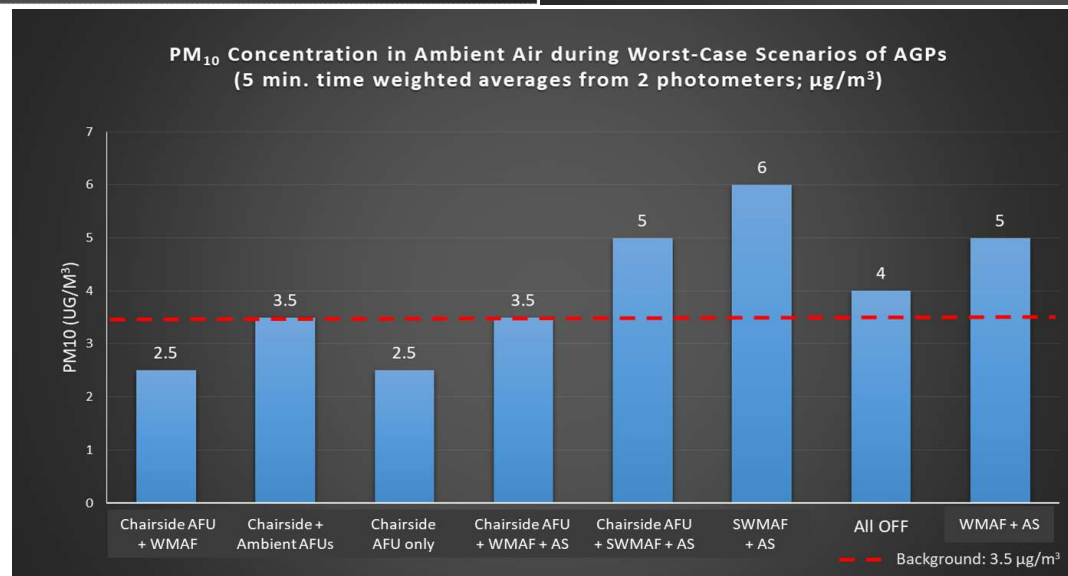
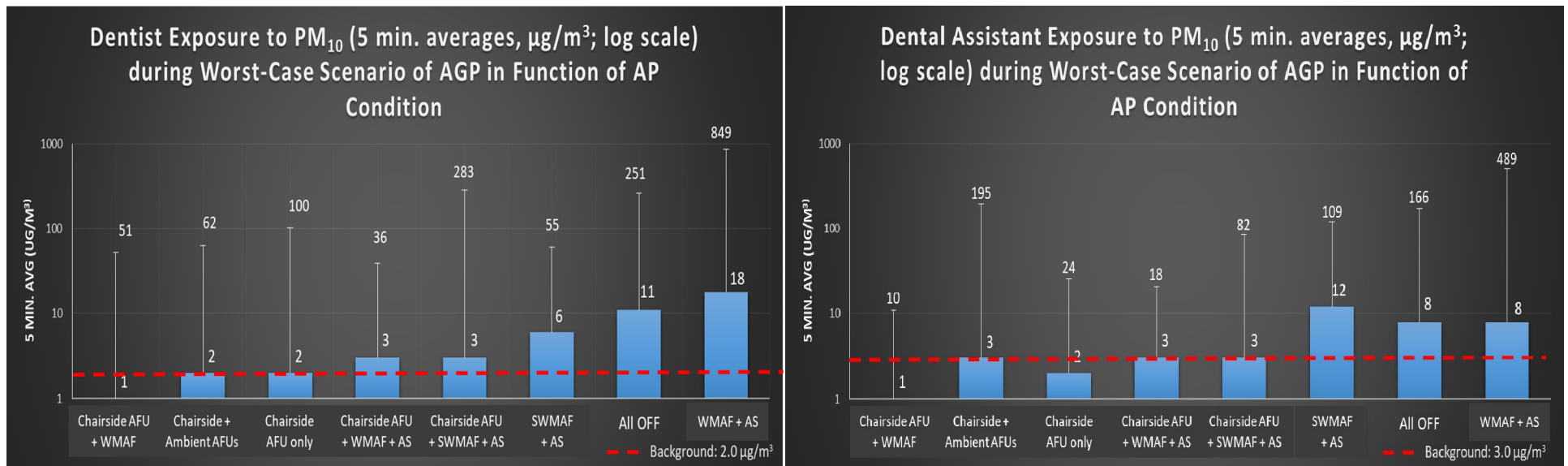
# Testing in MDC: Standardized Methodology

- Similar methodology to testing in clinic but only AGPs
- Tested **chairside and ambient AFUs** in various configurations with other air handling devices:
  - **Air Scrubber (AS)** to create negative pressure (300 CFM)
  - **Wall-Mounted Air Filter (WMAF)** upgrades HVAC system with 12-inch HEPA filter and active/assisted air flow (1080 CFM)
  - **Small WMAF (SWMAF)** upgrades HVAC system with 2-inch HEPA filter and passive air flow (480 CFM)





# Testing in MDC: Results







# Testing in MDC: Conclusions

- The use of the **Chairside AFU** has the **greatest impact** on reducing exposure of dental personnel to aerosols generated during AGPs.
- The use of the **WMAF with the Chairside AFU** leads to a **higher reduction** of  $PM_{10}$  concentrations.
- In many cases, **the use of the Air Scrubber (AS) to create a negative pressure increased concentration of  $PM_{10}$  during AGPs.** The creation of negative pressure through the use of the AS **may have resulted in air turbulence that decreases the efficiency of the Chairside AFU** to capture aerosols generated by dental procedures.



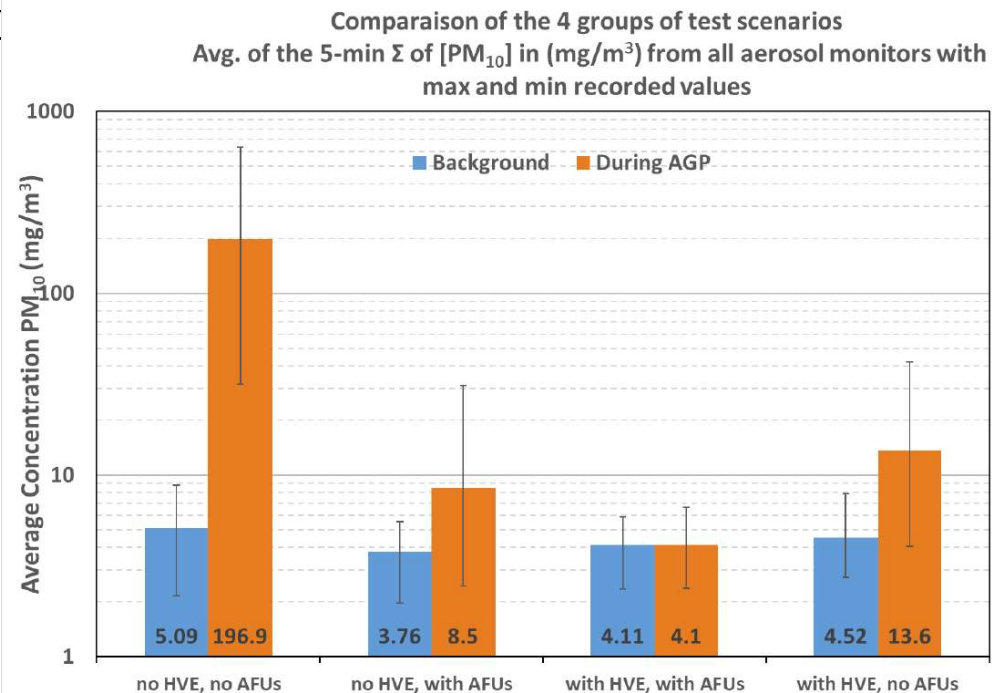
# Validation of results with the Quality Engineering Test Establishment (QETE)

- Air sampling of PM<sub>10</sub> in **breathing zones** of dental providers and in **ambient air** using **8 laser photometers** in standardized array



# Validation of results with QETE

- AGP = **5-minute continuous drilling of natural teeth** using high-speed air-driven handpiece
- **Background** [PM<sub>10</sub>] measured x 10 mins at the start of each day, and x **5 mins before each condition**
- Each condition repeated 3-4x
  - Group 1: HVE off, AFUs off
  - Group 2: HVE off, AFUs on
  - Group 3: HVE on, AFUs on
  - Group 4: HVE on, AFUs off



# Engineering controls in RCDC dental clinics

- **Chairside & ambient AFUs combinations acquired** and being used in most clinics
- **MDCs** being retrofitted with **wall-mounted air filter** and equipped **with chairside AFU**
- RCDC facilities will have **at least one fully enclosed operatory per clinic**
- These engineering controls (**AFUs**) and high-volume evacuation (**HVE**) are **key components to our Interim Clinical Directive on dental treatment during the COVID-19 pandemic**



*Thank you!*

Canadian Forces  
Health Services Group



Groupe des Services de  
santé des Forces Canadiennes