

**CABIN AIR FILTRATION**  
HELPING TO PROTECT OCCUPANTS FROM  
INFECTIOUS DISEASES



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## **Latest Technologies for Commercial Aircraft:**

- Why is the Cabin Air environment different?
- Mechanisms of Air Filtration
- True HEPA Filter Elements for Bacteria & Virus Removal
- Filter Element Treatments
- Filter Elements for Odour/VOC Removal

## **Conclusions**

- Lower Relative Humidity
- Lower Oxygen Levels
- High Airborne Particulate and VOC's
- Change in Routine
- Stress Level
- Time Zone Changes
- Sleep Deprivation
- People travel when they are sick
- People are seated for long periods
- High Passenger Density
- Mechanical Vibration and High Noise Level

## **PARTICULATE**

## **GASES**

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Dust

Organic Vapours

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Fibres

Odours

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Skin Flakes

Carbon Dioxide

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Bacteria

Ozone

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Viruses

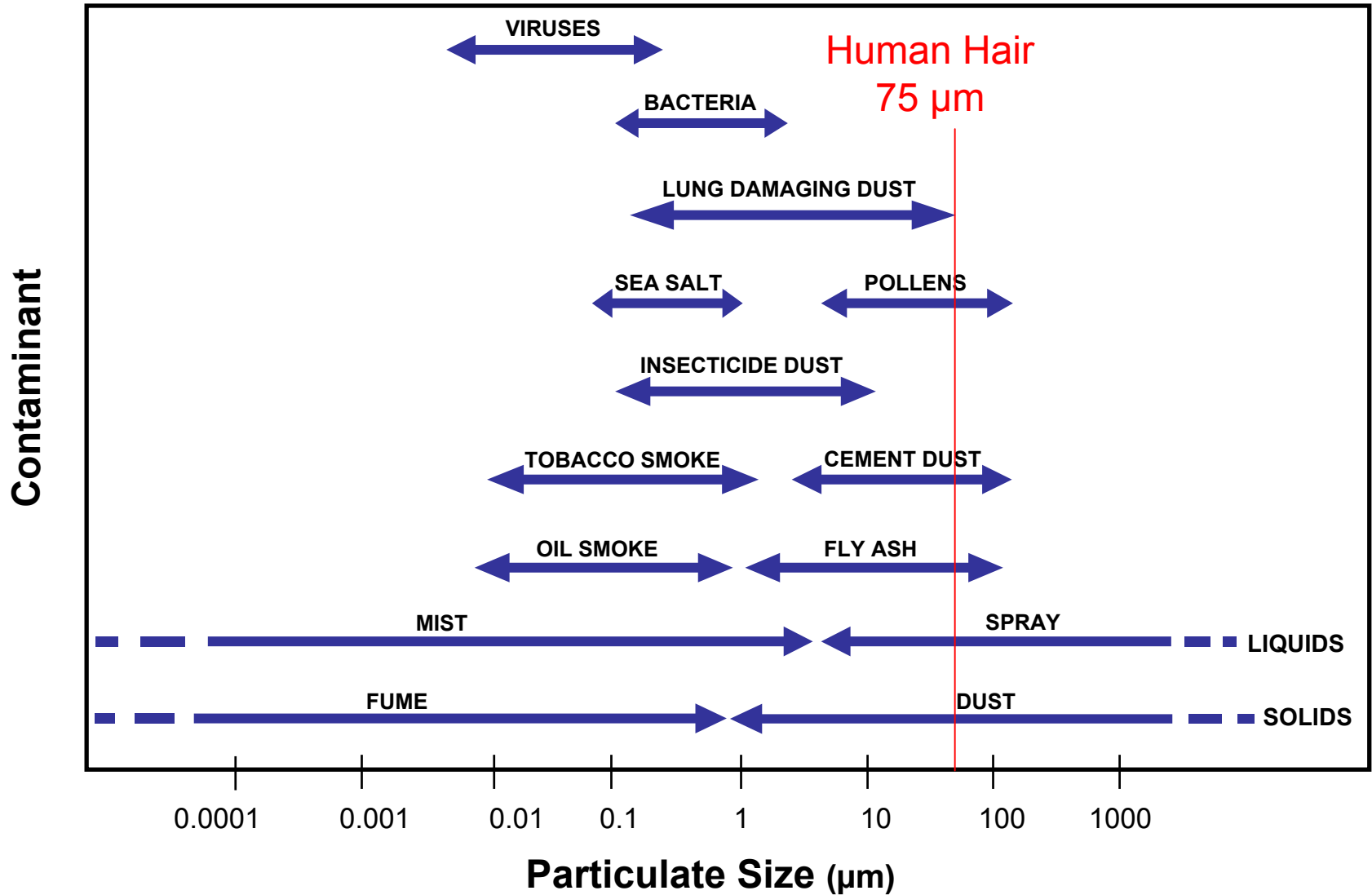
Water Vapour

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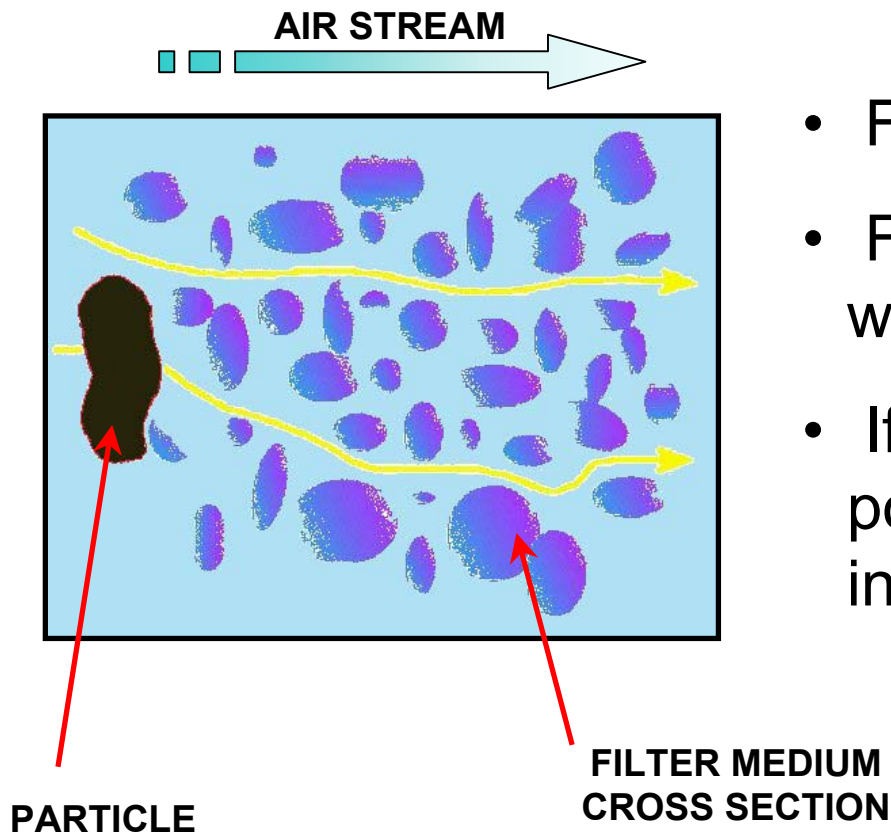
ETS (Droplets)

ETS (Vapours)

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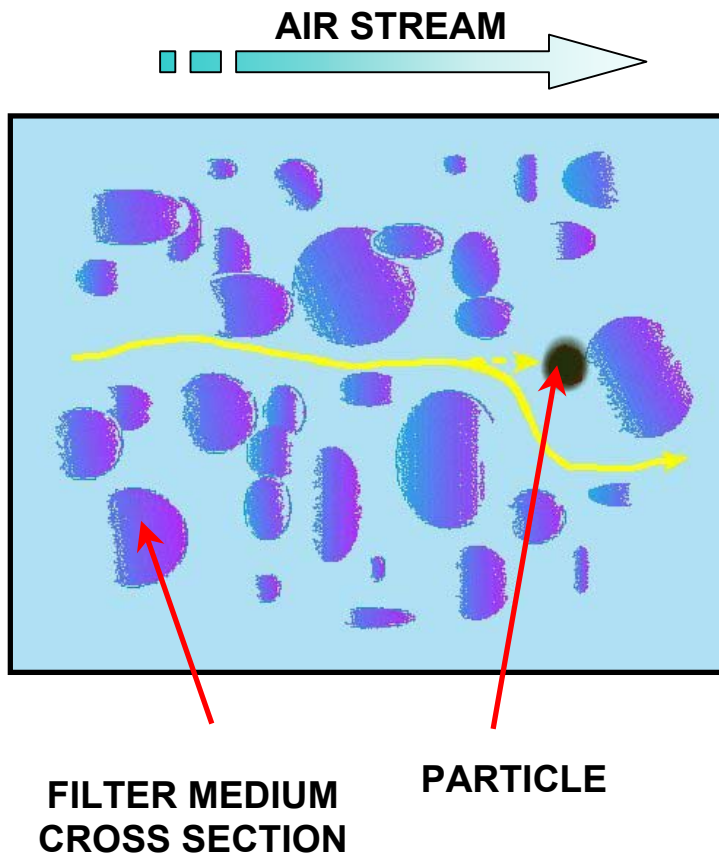


## Direct Interception



- For particle sizes  $> 10\mu\text{m}$
- Filter consists of matrices with defined pores.
- If the particles are larger than the pores, they are removed by direct interception.

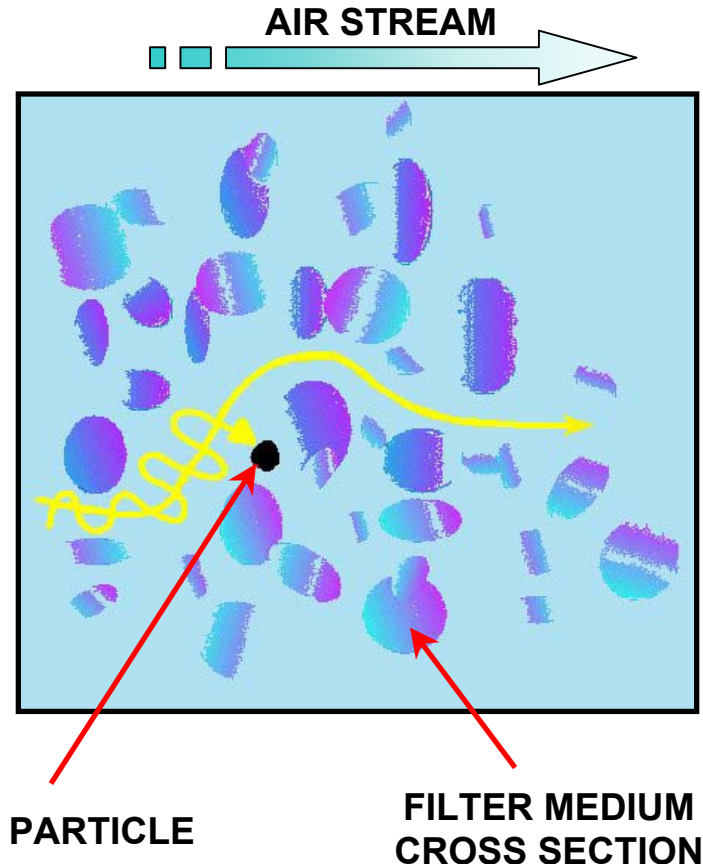
## Inertial Impaction



- $0.5 \mu\text{m} < \text{particle size} < 10 \mu\text{m}$
- Filter removes particles smaller than the pore size by inertial impaction.
- Particles of higher density than air deviate from the air stream path and impact on the solid surfaces or walls of the pores, where they adhere.

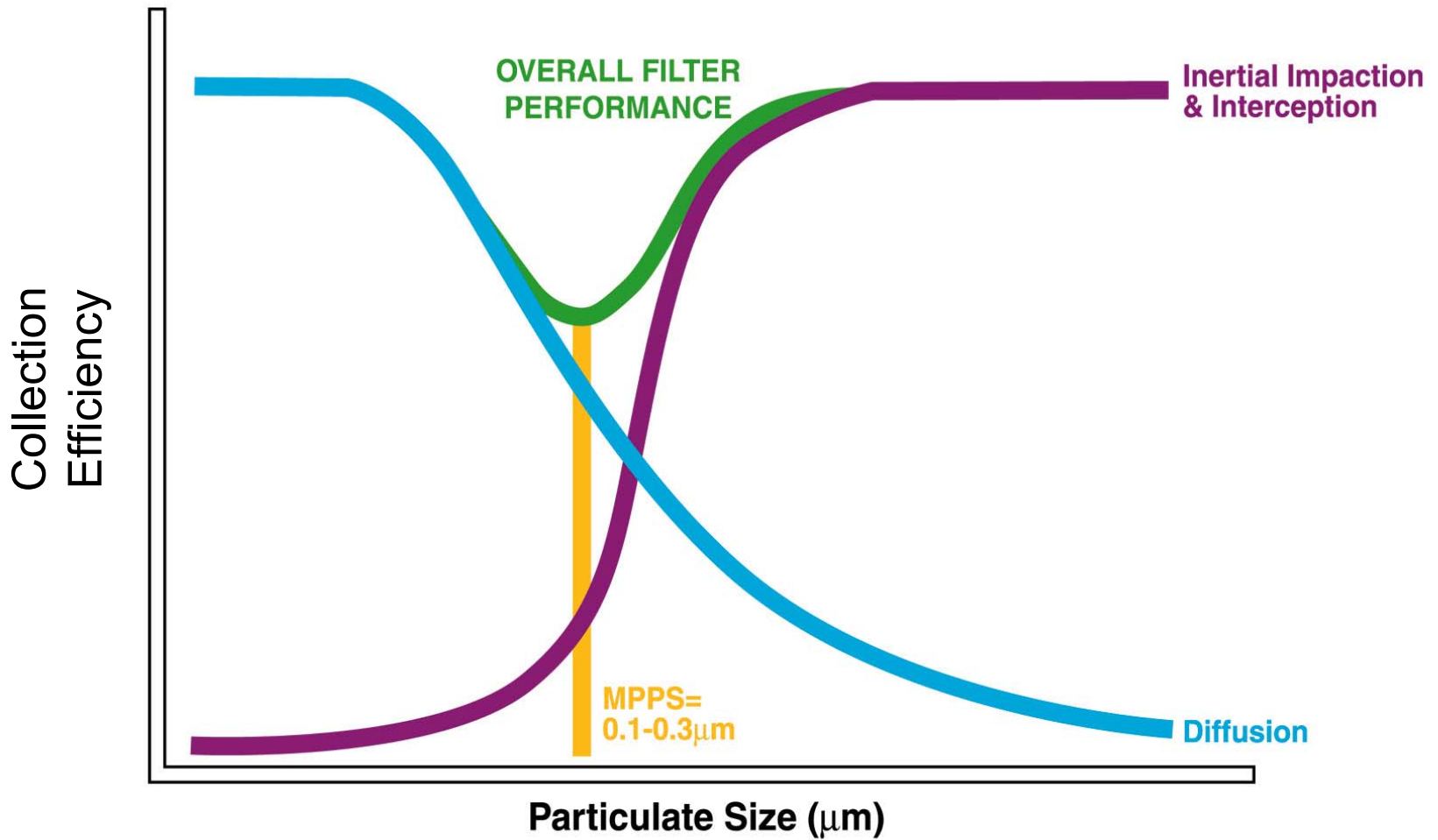
## Bacteria Removal

## Diffusional Interception



- Small particles  $\leq 0.1 \mu\text{m}$ .
- For very small particles such as viruses, Brownian motion causes them to be collected on individual fibres and pore walls.
- Particles in the range  $0.1 \mu\text{m}$  and below are efficiently removed by this mechanism.

## Virus Removal



## Pall filters have been challenged with the following bacteria and viruses:

### Bacteria

Brevundimonas diminuta 0.3 $\mu$ m by 0.6 $\mu$ m length (previously known as Pseudomonas diminuta)

Bacillus subtilis - 0.7  $\mu$ m diameter

### Virus

MS2 Coliphage - 0.023  $\mu$ m diameter

(Corona virus 0.08 to 0.16  $\mu$ m dia. Bird/Avian Flu virus, H5N1 current strain, approximately 0.1  $\mu$ m dia)



Photo reproduced courtesy of United Airlines

## Test results show a microbial removal efficiency of > 99.999%

Vezina D.P. et al. *Anesthesiology* (2004); 101:104

## Objective

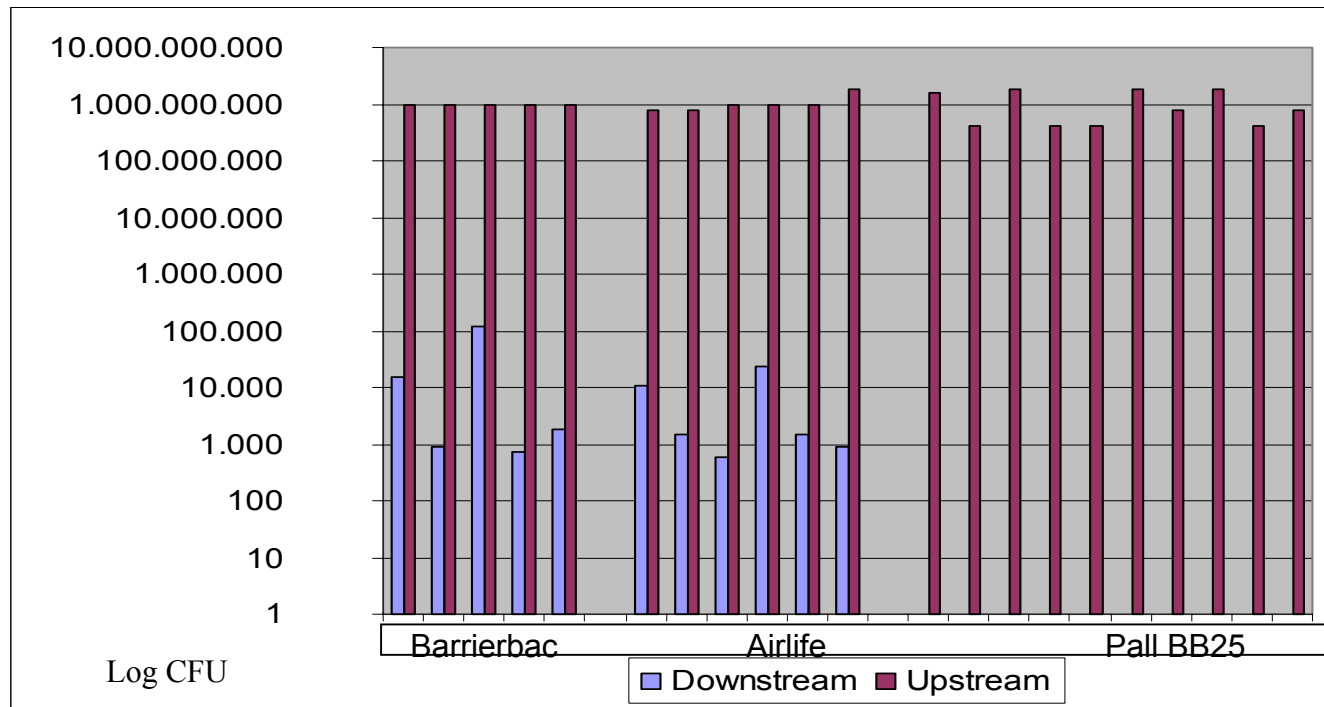
Show the retention efficiency of breathing filters for *Mycobacterium* in a simulated clinical setting

## Method

Aerosolize high concentrations of *Mycobacterium chelonae* between test animals ET tube and filter, test upstream side of system for contamination



**Pall Breathing system filters show an airborne filtration efficiency of >99.999% for bacterial and viral challenges**



Electret controls

Pall Breathing Filter

- Antimicrobial treatments are not necessary or recommended for cabin air filters.
- Once captured within the filter media, survival rate of microorganisms is very low (hours).
- Bacteria require **high humidity\***, **moderate temperature\***, and **nutrition\*** to survive.
- Viruses need to invade **live human\***, **animal\***, or **bacterial cells\*** to survive.

**X = Not present in aircraft environment or filter**



Used CAF, upstream  
after 14 months service

Used CAF, downstream  
after 14 months service



## **Volatile Organic Compounds (VOCs)**

- Hydraulic fluids
- Engine and APU lubricants
- Jet fuels
- De-icing fluids
- In-flight catering
- Human bio effluent

**These trace chemicals may be present in both the recirculated air and outside air entering the ECS.**

## Improve Air Quality by offering BOTH particulate and VOC/Odour removal capability

- Combined filter elements are available for selected aircraft types
- Current technology is a disposable filter element using an adsorbent solid.
- Removes odours & Volatile Organic Compounds
- Proven in-service experience
- Future technologies can be regenerable



- Aircraft cabin environment is unique
- Recommend HEPA filters (>EU13) in recirculation air line
- True HEPA filters remove bacteria and viruses - provide microbial equivalent of outside air
- Treatment of filter elements is not necessary
- Odour/VOC filters are a qualified, available option

*Thank you for your Attention*

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