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Internal Environments for Aircraft

BRE, February 2004

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Presentation Content 1/2

Latest Technologies for Commercial Aircraft:

- HEPA Filter Elements for Recirculated Air
- HEPA Filter Elements for Bacteria & Virus Removal
- Treatment of Filter Elements
- Filter Elements for Odour/VOC Removal

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Presentation Content 2/2

Future Filtration Solutions/New Technologies :

- To Improve Quality of Recirculated Air
- To Improve Quality of Outside Air
- To Improve Environmental Disposal
- To Reduce Ozone Levels in cabin

Conclusions

Latest Technologies

HEPA Filters for Recirculated Air

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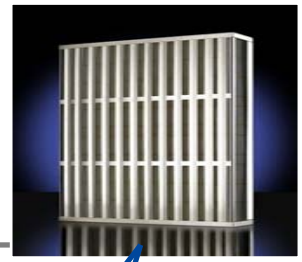
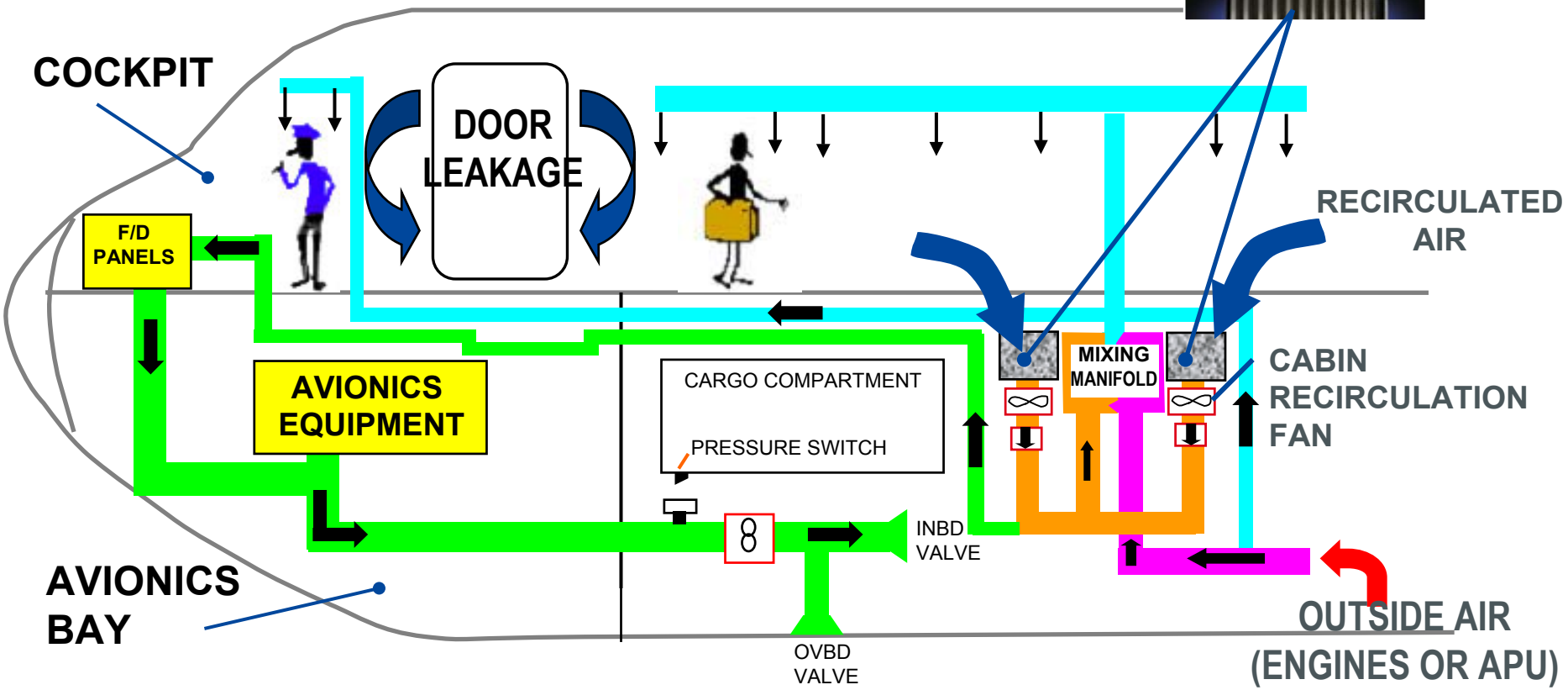
Modern A/C use a mixture of approx. 50/50 outside air/re-circulated air





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Latest Technologies

HEPA Filters for Recirculated Air

HEPA = High Efficiency Particulate Air Filter

European Standard EN 1822-1:

HEPA filter = 85% to 99.995% efficiency

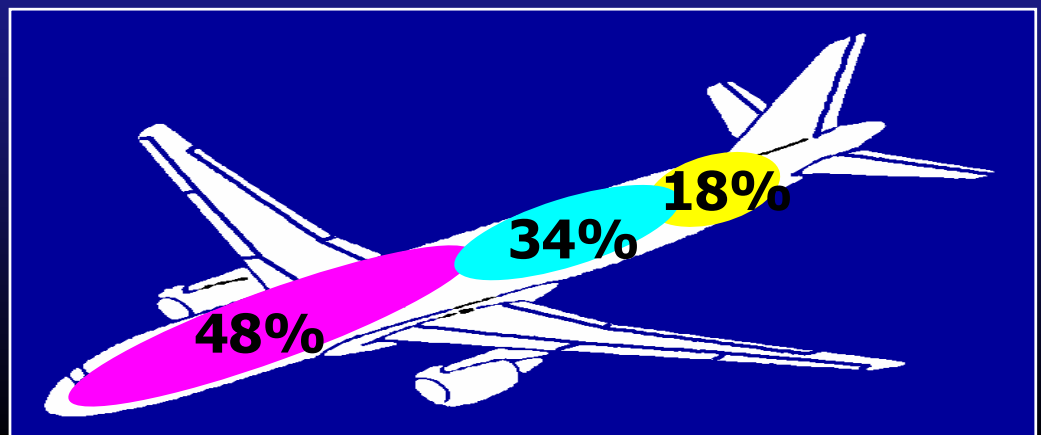
(classes H10 to H14)

HEPA filters on latest commercial aircraft:

99.99% sodium flame / 99.97% D.O.P. efficiency

UK House Of Lords Investigation……

Cabin Air Filter Standards on UK fleet



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Latest Technologies
Bacteria/Virus Removal Filters

Improve air quality by removing bacteria and viruses

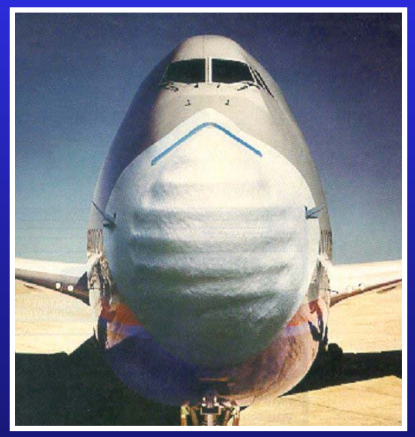

Photo reproduced courtesy of United Airlines

Bacteria

Typical size range 0.5 to 1.5 µm

Virus

Typical size range 0.01 to 0.1µm
(Corona virus 0.08 to 0.16 µm dia.)

'True HEPA' cabin air filters have a microbial removal efficiency of > 99.999%

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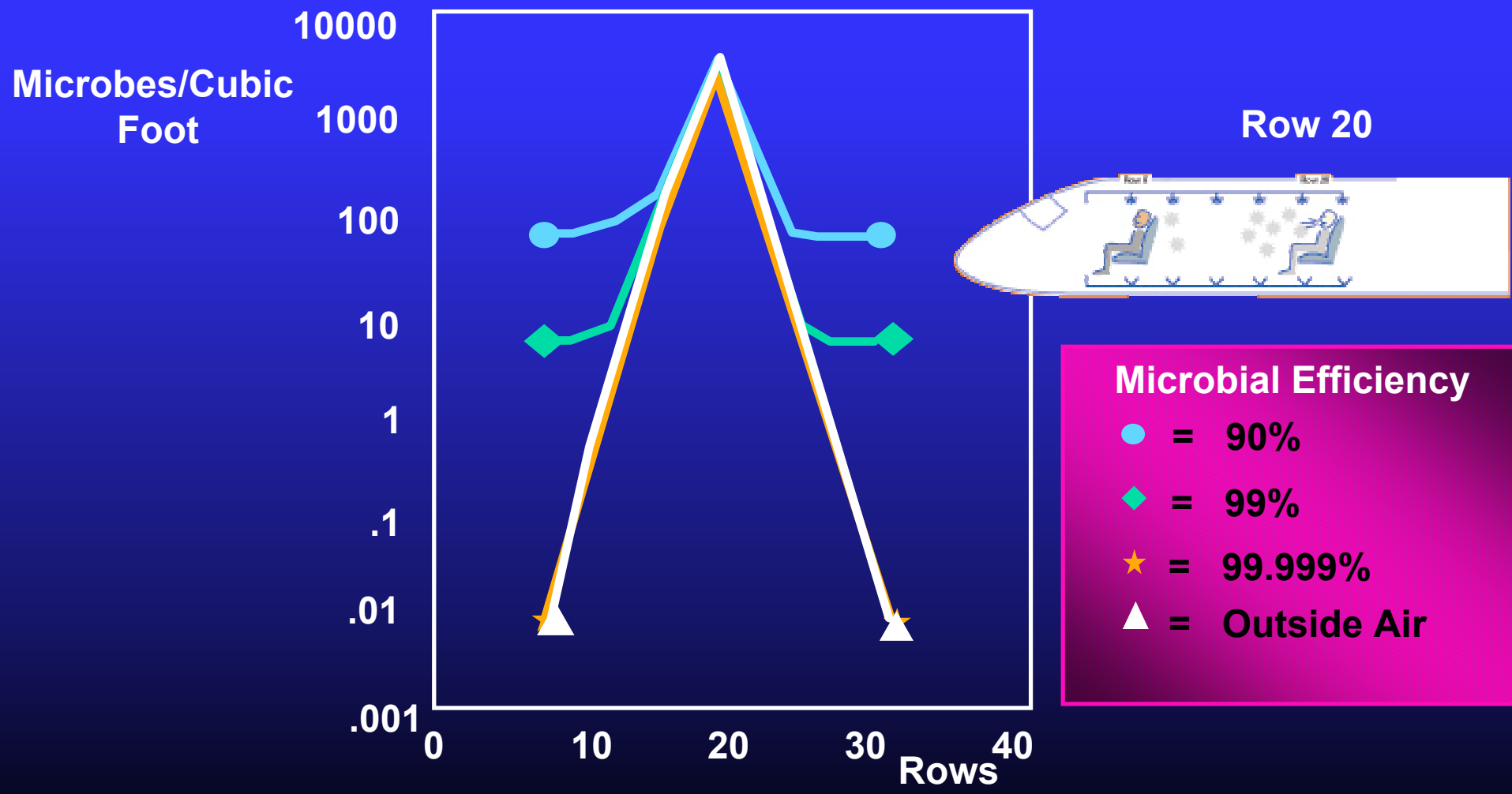
Latest Technologies

Bacteria/Virus Removal Filters



True HEPA filters = Microbial equivalent of outside air

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Latest Technologies
Filter Element Treatment

- Antimicrobial treatments are not necessary or recommended for cabin air filters.
- Once captured within the filter media, survival rate of micro organisms 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

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Latest Technologies

Odour/VOC Removal

Volatile Organic Compounds (VOCs)

- Hydraulic Fluids
- Engine & APU Lubricants
- Jet Fuels
- De-Icing Fluids
- In-Flight Catering
- Human bio effluent

These trace chemicals are present in both the recirculated air and outside air entering the ECS.

Latest Technologies

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Odour/VOC Removal

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

- Combined filter elements are available for a large proportion of Airbus aircraft types
- Current technology is a disposable filter element using an adsorbent solid.
- Removes odours & Volatile Organic Compounds
- Proven in-service experience

- Future technologies may be regenerable

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Presentation Content 2/2

Future Filtration Solutions/New Technologies :

- To Improve Quality of Recirculated Air
- To Improve Quality of Outside Air
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- To Reduce Ozone Levels in cabin

Conclusions

Future Technologies

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To Improve Quality of Recirculated Air

Regenerable VOC/Odour removal

- Eleven technologies considered initially.
- Three possibilities selected……..
  - **Photo Catalytic Oxidation:** the catalyst (usually TiO2) reacts with the VOCs.
  - **Temperature Swing Adsorption (TSA):** VOCs are removed by solid adsorbent beds which are regenerated by increasing the temperature.
  - **Plasma Oxidation:** ionised gas molecules react with the VOCs.

Future Technologies

To Improve Quality of Recirculated Air

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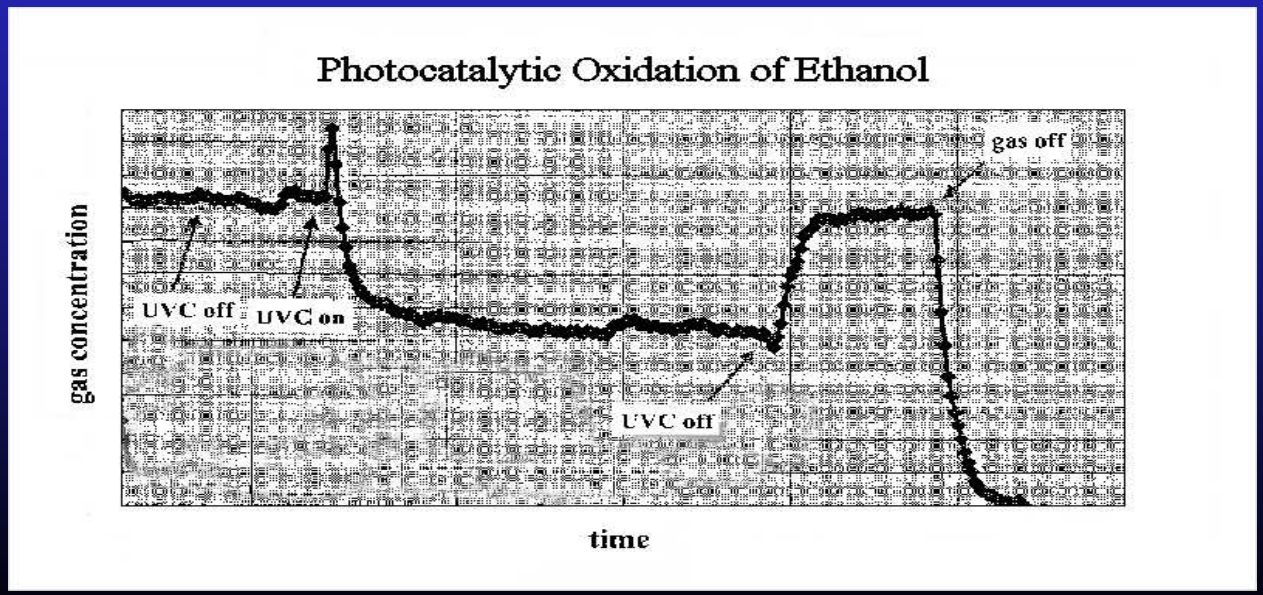
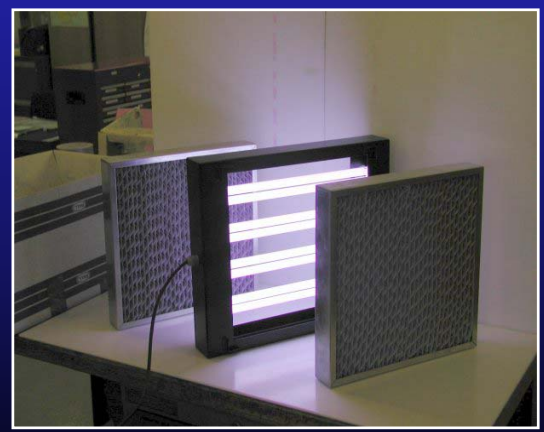
Photo Catalytic Oxidation:

Features	
Low power, No consumable parts	✓
Need to completely oxidise VOCs	x

Prototype tested at Cetiat, France





Future Technologies

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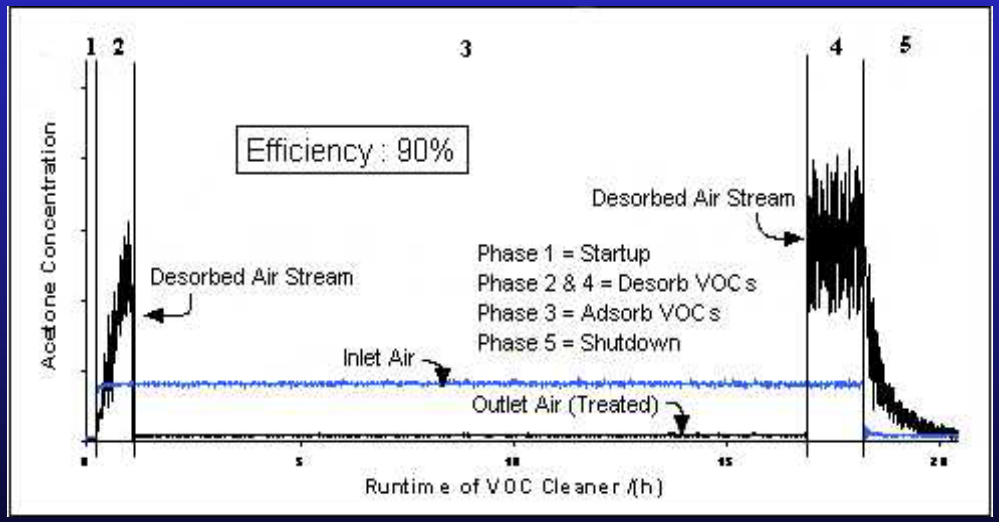
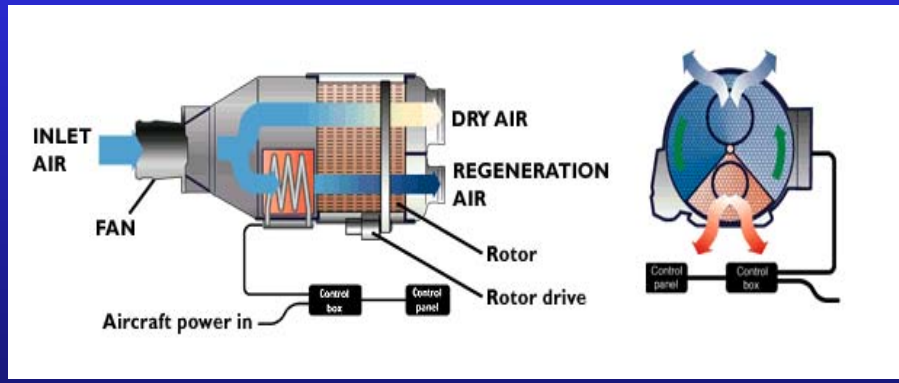
Improve Quality of Recirculated Air

Temperature Swing Adsorption:

Features	
Removes VOCs completely	✓
High Power, Rotating components	x

Image courtesy of CTT





Initial testing demonstrated high power requirement

Future Technologies

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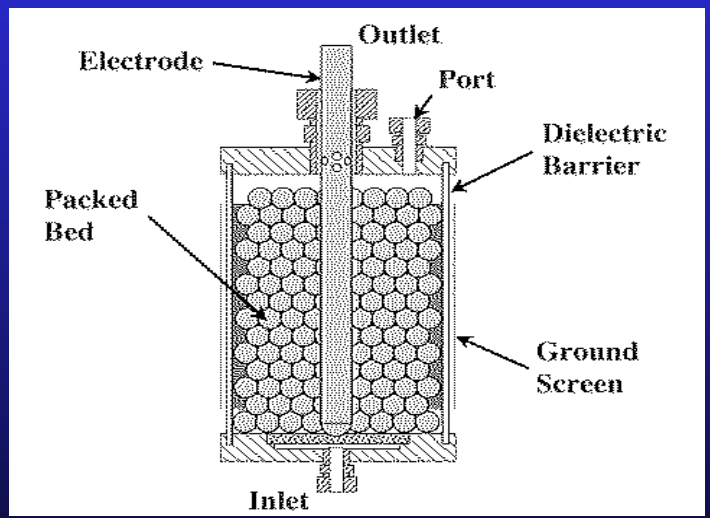
Improve Quality of Recirculated Air

Plasma Oxidation:

Features	
Low Power	✓
High residence time, High V, High Hz	*x*



Not pursued after initial testing

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Future Technologies

Improve Quality of Outside Air

Removal of contamination, odours/VOCs from outside air supply

Possible Locations

- Downstream of the auxiliary power unit (APU) and the engines
- Between the cooling packs and the mixing manifold
- Between the mixing manifold and the inlets to the passenger cabin

Future Technologies

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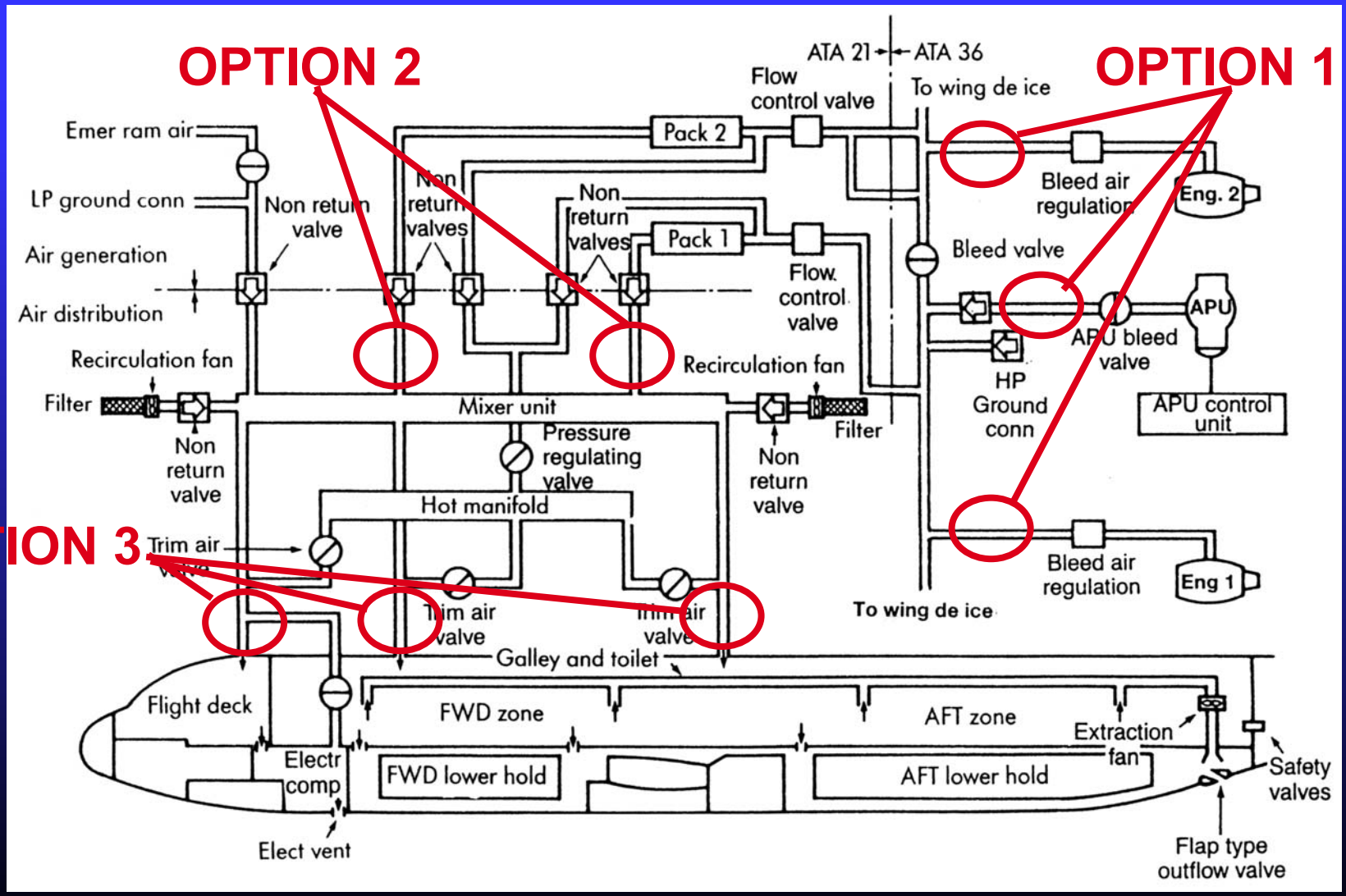
Improve Quality of Outside Air



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Future Technologies

Improve Quality of Outside Air

Contamination & its Effects

- Contamination by airborne particles causes premature malfunction of the bleed air system and components
- Small sticky soot particles cause stiction and build up
  - ➢ protection needed for pneumatic components
  - ➢ Improved reliability, reduced maintenance cost
- Any Odours & Volatile Organic Compounds from outside aircraft or from internal sources will affect cabin air quality
  - ➢ protection needed for passengers and crew

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Future Technologies

Improve Quality of Outside Air

Alternative Solutions

- High temperature (280ºC) particulate filter system.

- Low temperature (70ºC) VOC filter system.

- Proven in-service experience
- Laboratory tested

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Future Technologies

To Improve Environmental Disposal

Typical Designs

Disposable filter elements - organic filter pack, sealed and bonded into a metal outer structure.

Filter Assemblies - metal structure

Future Designs

- **Fully Incinerable or**
- **Recycle individual components**

All plastic construction – fully disposable

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Future Technologies

To Reduce Ozone levels

Ozone Sources:

Engine Bleed Air from Atmosphere

- 1st generation engines used bleed air at 482C – ozone destroyed
- Modern aircraft use engine bleed air at <232C – ozone can survive in the bulk gas phase for hours

Any ozone present can enter through air conditioning ducts.

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Future Technologies

To Reduce Ozone levels

Removal Methods:

- Catalytic Converters (optional)

- ‘Measurements in the Sky’ programme showed ozone levels were within regulatory limits because ozone converters were fitted

- No further development work at this time

Conclusions

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Latest Technologies:

- Recommend HEPA recirculation filters (>EU13)
- True HEPA filters provide microbial equivalent of outside air
- Odour/VOC removal is an option

Future Solutions/New Technologies:

- Regenerable VOC Removal to improve quality of recirculation air
- High temp. filters to improve quality of outside air
- Environmentally friendly filters are an option

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THANK YOU FOR YOUR ATTENTION

ANY QUESTIONS?