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Basics of the aircraft cabin environment
Enable a hygienic environment and contaminant control

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Overview Cabin Environment in relation to Hygiene

- Air Supply
  - System architecture
  - Contamination control
  - Pandemics

- Water/Waste
  - Potable water supply
  - Waste water Disposal

- Galley/Food
  - System Design & Interfaces
  - Food cooling requirements & technologies
Air Supply System Architecture

The Air supply system has three main functions: supply air and pollutant removal; pressurization of the aircraft; temperature control and cooling of technical equipment.
Air Purity and Contaminant Control

- Ozone (during cruise)
- Odours (during ground operation)
- Catalytic converters for depletion of Ozone / VOC
- Pathogens outside air: adiabatic compression in engine
- Pathogens inside: HEPA filters, also odours

Conditioned, filtered, pure air = Passenger well-being

- HEPA* Filter
- Particles free air
- Gaseous** Filter
- no odour

* HEPA: High Efficiency Particulate Air filter
* VOC: Volatile Organic Compounds; ** Option on A330/A340 only

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Risk of virus transmission is minimized by avoiding longitudinal flow, use of HEPA filters, low humidity of cabin air (5-15 %). Studies [1], [2] indicate that proximity, specifically in the few rows in front of the index case, is a major factor in the transmission.


[2]. Olsen SJ, Chang HL, Cheung TY, Tang AF, Fisk TL, Ooi SP, Kuo HW, Jiang DD, Chen KT, Lando J, Hsu KH, Chen TJ, Dowell SF (2003), New England Journal of Medicine, Massachusetts Medical Society, USA
Cabin Environment in relation to Hygiene

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Potable water system architecture

Lavatories & Galleys

Compressor

Ground Pressure Connection

Water Tanks

Service Panel

Water treatment module (A350 XWB only)
**Function A:** UV - Disinfection of the upload water flow

The A350 water treatment system provides an effective **first** Barrier against **external contamination** during water upload.

**Function B:** Continuous UV - water treatment with full circulation, that:
- guards the water from **internal** (re-)contamination within the system
- provides a **second barrier that gives hygienic system robustness**

**Benefit:** Decreased system maintenance costs by significant prolongation of the maintenance-disinfection interval
Waste water system architecture

Lavatories & Galleys

Waste Tanks

Drain Masts

Service Panel

Vacuum Generators

Overboard Vents

Cabin intercommunication Data System (CIDS)
Waste water system description

The waste disposal system is composed of:

- the toilet system,
- the waste water drain-system.

The toilet system discharges the waste from the toilets and the Galley Waste Disposal Units (GWDUs) into the waste tanks.

Vacuum generators create the necessary vacuum on the waste tanks to ensure the waste flow.

The toilet system servicing is carried out from the waste service panel. The waste water drain-system discharges overboard the waste water from the galley sinks and the lavatory washbasins through heated drain masts.

The control and indication of the waste tanks (and potable water tanks) inside the cabin is done via the FAP (Flight Attendant Panel).
For Maintenance, Service (Filling/Draining) & Disinfection the Safety Procedures in the Aircraft Maintenance Manual have to be considered!
Cabin Environment in relation to Hygiene

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Galleys: Wet or Dry Type

**Wet Galleys:**
- used to store and prepare food and drinks
- connected to potable and waste water, air extraction, cabin ventilation and power supply (Air from Galley & toilet area is discharged overboard (no recirculation))

**Dry galleys:** not connected to any system and are used for storage

**Wet & dry galleys** are often cooled by a supplemental cooling system (ATA 21-57)
Galley Cooling Requirements

- Proper Cooling of Food is not yet part of Airworthiness Requirements → No explicit FAR or JAR requirement yet
- Local rules of each country in which airline certifies the aircraft apply
- The airlines expect the fulfillment of these local rules
- Before 1997 *Handbook on Sanitation of Airlines*, Publication No. 308, (1982 Reprint) which includes 1) Sanitary Construction of Aircraft Galleys and Galley Components, September, 1982 Reprint was setting a global standard of 7 °C (45°F)
- 1997 US Food and Drug Administration (FDA) Food Code explicitly requested 5 °C (41°F)
- 1997 In response to the FDA Food Code the “Arrête du 29 septembre 1997 fixant les conditions d’hygiène applicables dans les établissements de restauration collective a caractère social” of France asked for 4 °C (39°F)
- This is expected to become the European standard in the Airline Community
Methods of Supplemental Cooling

**Passive Cooling Methods: “No work done”**

*Dry Ice:* Heat is absorbed via sublimation of CO$_2$, Cooling effect typically lasts in 4 hours, no control possible, commonly used in S/A

**Active Cooling Methods: “Work done”**

- **Primary Loop Cooling:** Air Chiller, Wine Chiller, Freezer etc.

- **Secondary Loop Cooling:** Remote Chiller System and Supplemental Cooling System
Primary Loop Cooling

**Principle:** Generate cold at locations where cooling is needed!

- Standalone units (decentralized cooling)
- Cabin air is used as heat sink

- *Transport of air to big distances* is not feasible (pressure losses, big duct diameters such as 100~150mm) ⇒ Alternative is Secondary Loop Cooling: transportation over longer distances with liquid loops in centralized system, cabin or outside air as heat sink
## Trolley Cooling Principles

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<th>Air Over</th>
<th>Air Through</th>
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<td>• Fast pull down capability</td>
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**Air Over** involves a closed loop system where air is circulated over the trolleys to maintain a consistent temperature. **Air Through** systems allow air to flow through the trolleys, which may result in cooler surfaces but can lead to condensation and insufficient insulation.

### Air Over

- **Advantages**
  - Up to 50% less cooling demand per trolley
  - No direct contact to Air Flow
  - Thermal Comfort in galleys is better

- **Disadvantages**
  - Slow pull down capabilities

### Air Through

- **Advantages**
  - Fast pull down capability

- **Disadvantages**
  - Insufficient thermal insulation of trolleys
  - Less thermal comfort/cold trolley surfaces
  - Heavy Condensation on trolleys
Summary

- Public Health as well as internal requirements are considered for the design of aircraft environmental systems to establish a good level of hygiene.
- External sources (e.g. water supply) and interfaces (e.g. catering cooling chain) to be considered to prevent contamination.
- An overview about the aircraft design of air, water/waste and galley systems has been given.

Thank you for your attention!