

# Thermal Comfort

## An Aviation topic?

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# Cold feet sensation on the flight deck of commercial aircraft



**A possible prevention measure?**

## Cold feet sensations in the flight deck of Airbus A 320/A 321 aircraft

- Cold feet, caused by uncomfortable floor temperature
- Large vertical air temperature gradient
- Airbus A 320/A321 on medium haul-flights without underfloor heater, only

„even with sick socks and lined shoes both pilot's feet started to get numb“

## Possible causes

- very low outside temperature at normal flight level (FL 350- 390): about - 60° C ( -76° F, 213 K)
  - associated with cooling of aircraft skin
- lack of underfloor-heater (cost reduction)
- flight instruments with low or no heat emission

## Investigation

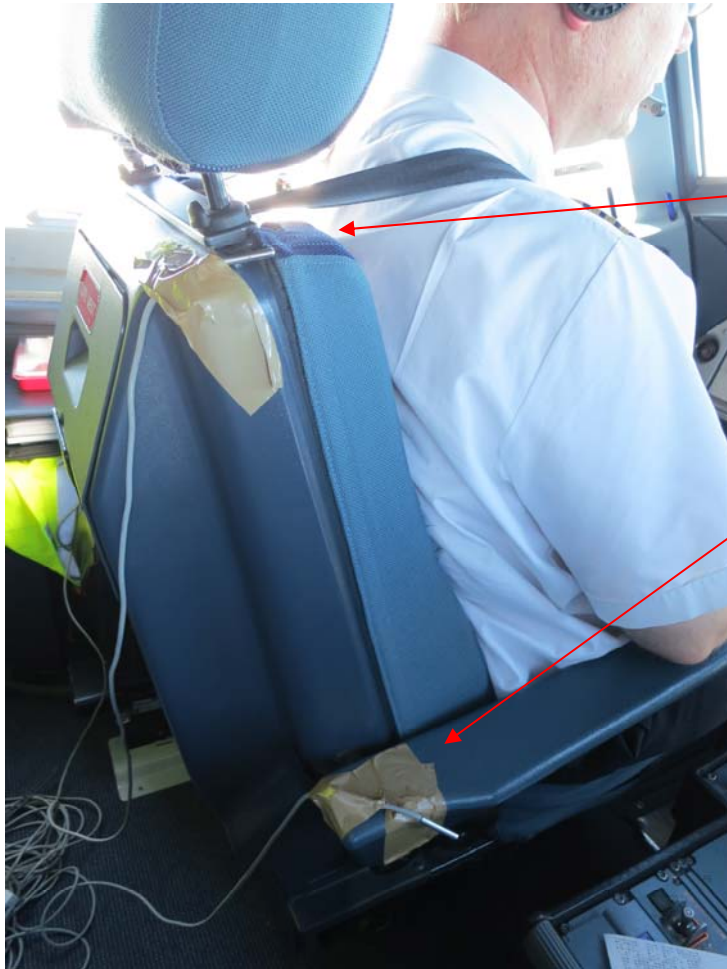
- The objectives were to evaluate the thermal local discomfort in the area of the pilot seat especially focusing on
  - Cold feet and warm head at the same time
  - Cold feet, caused by uncomfortable floor temperature

Taking into account: DIN ISO 7730" "Ergonomics of the thermal environment - Analytical determination and interpretation of thermal comfort using calculation of the PMV (Predicted Mean Vote) and PPD (Predicted Percentage of Dissatisfied) indices and local thermal comfort criteria"

## Method

- The thermal situation in the flight deck of 3 Airbus A 320/321 has been investigated on 6 medium – haul flights from Germany to Egypt and Teneriffa (Spain) and Fuerteventura (Spain)
  - 2 flights with under-floor heater (foot warmer)
  - 4 flights without under-floor heater (foot warmer)
- Measured (inflight, 4 - 5 hrs):
  - course of floor temperature near the pedals
  - vertical temperature profile at the pilots seat at three measuring points

# Measurement



Two measuring points at the pilots seat

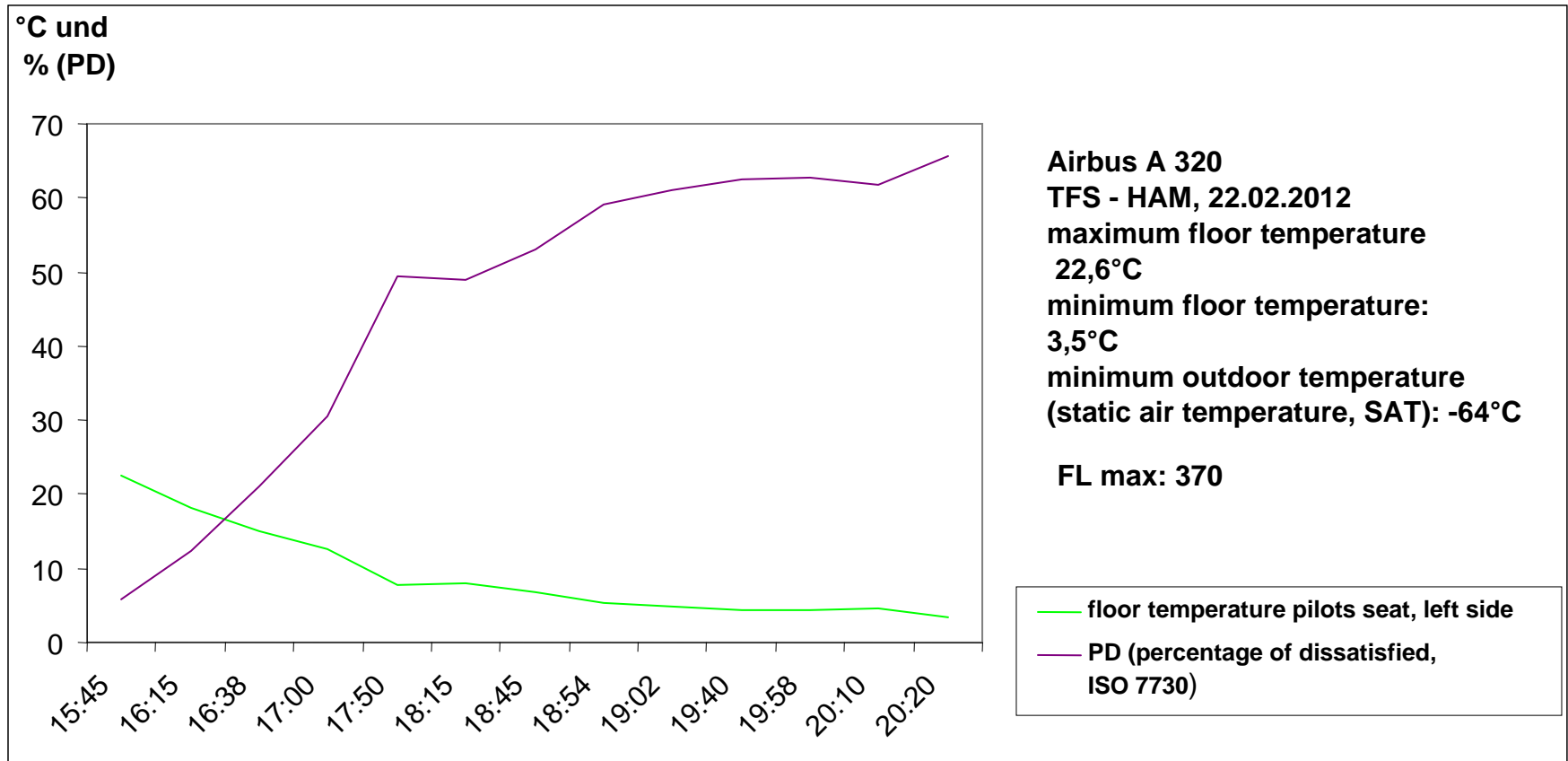
# Measurement





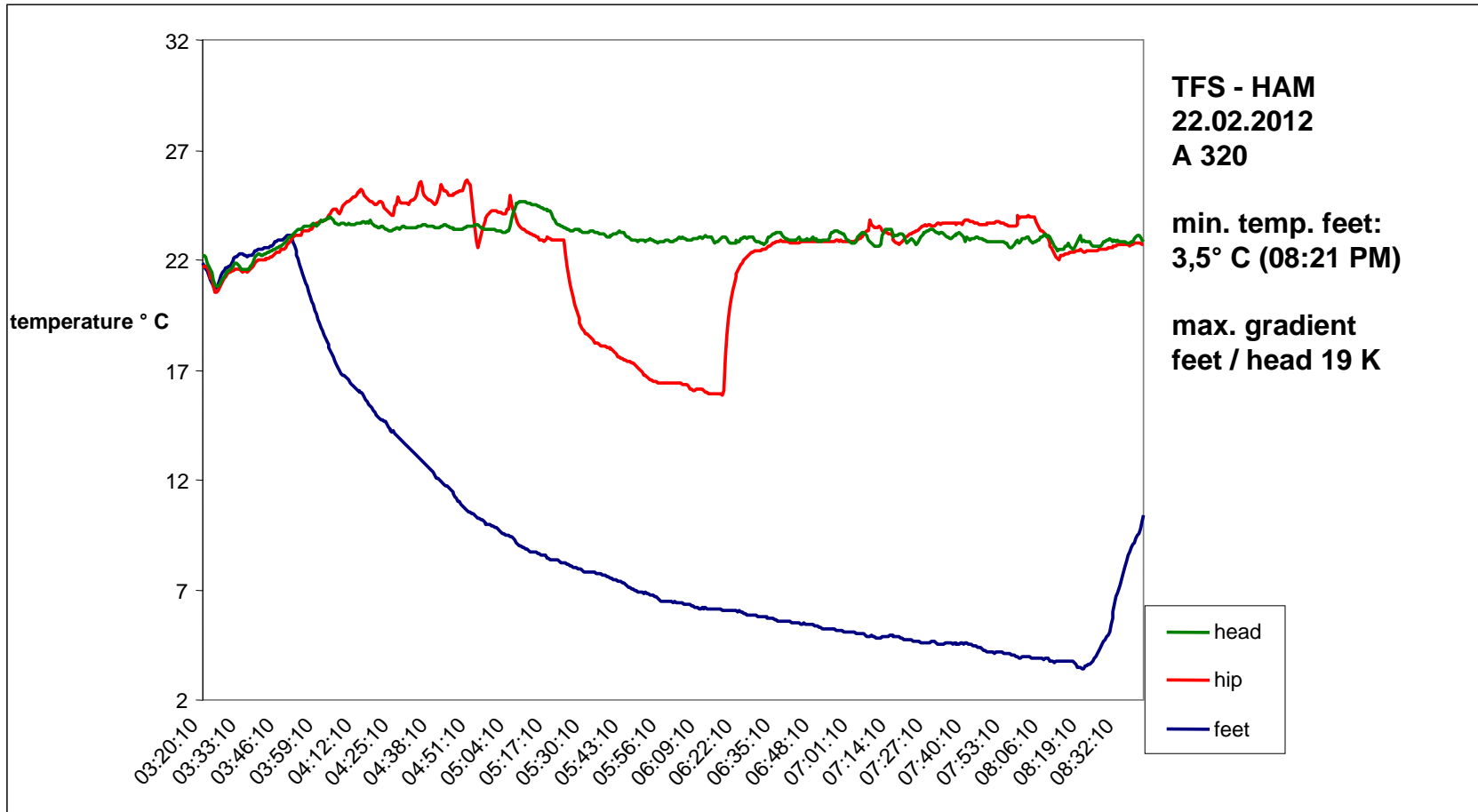
## Results (floor temperature and resulting percentage of dissatisfied (PD))

### aircraft without underfloor heater



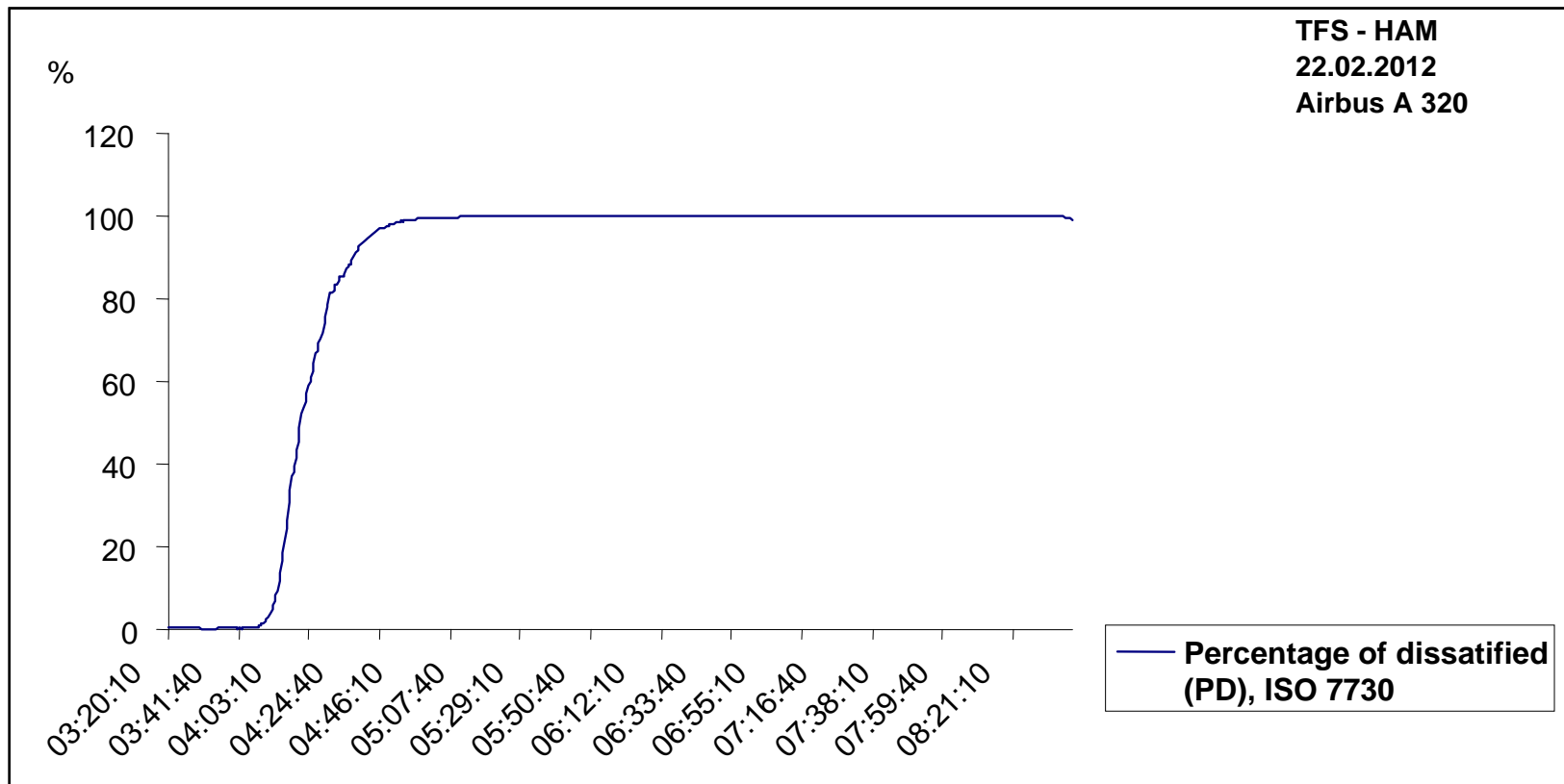
# Results (vertical temperature gradient)

aircraft without underfloor heater



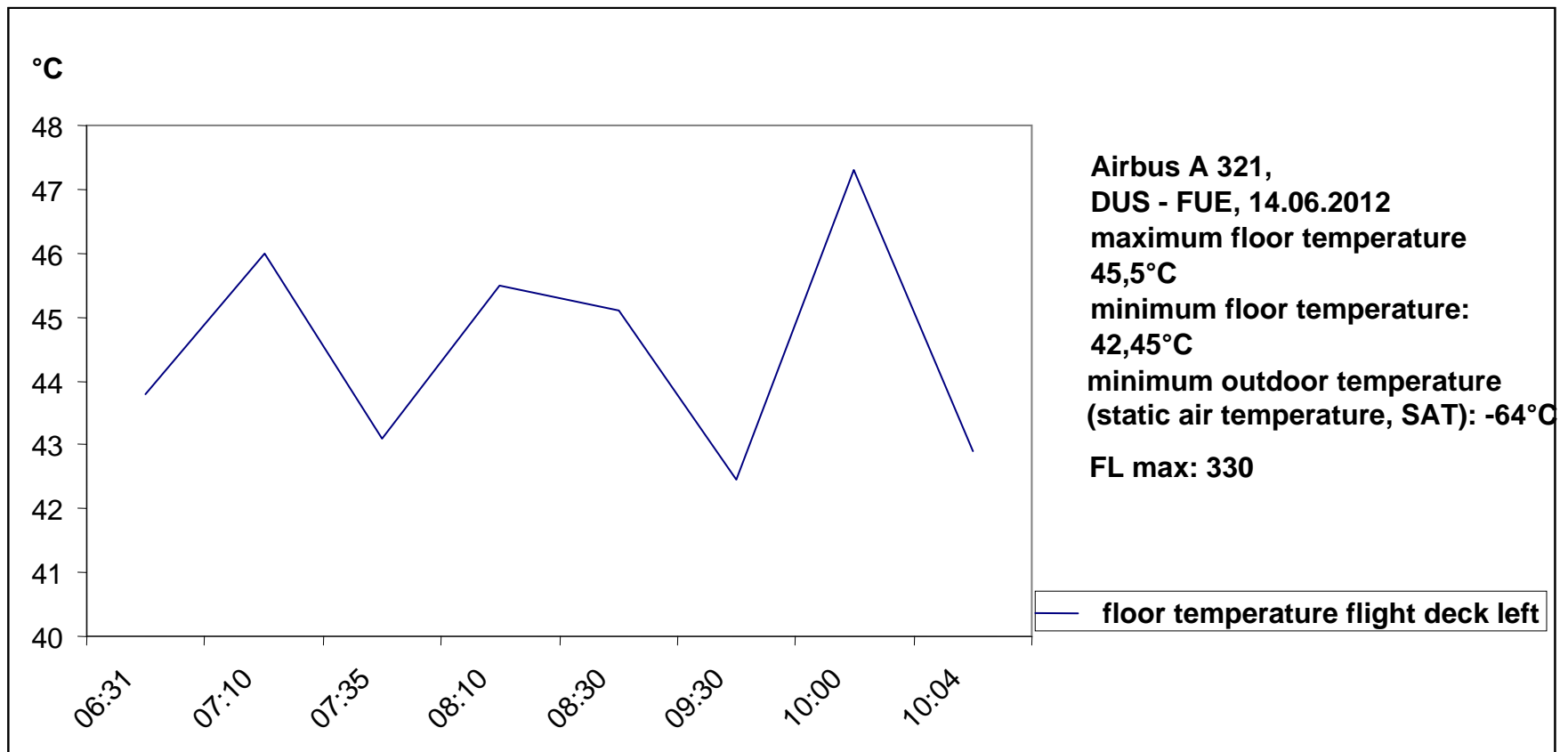
# Results (resulting percentage of dissatisfied (PD), ISO 7730, vertical temp. gradient)

aircraft without underfloor heater



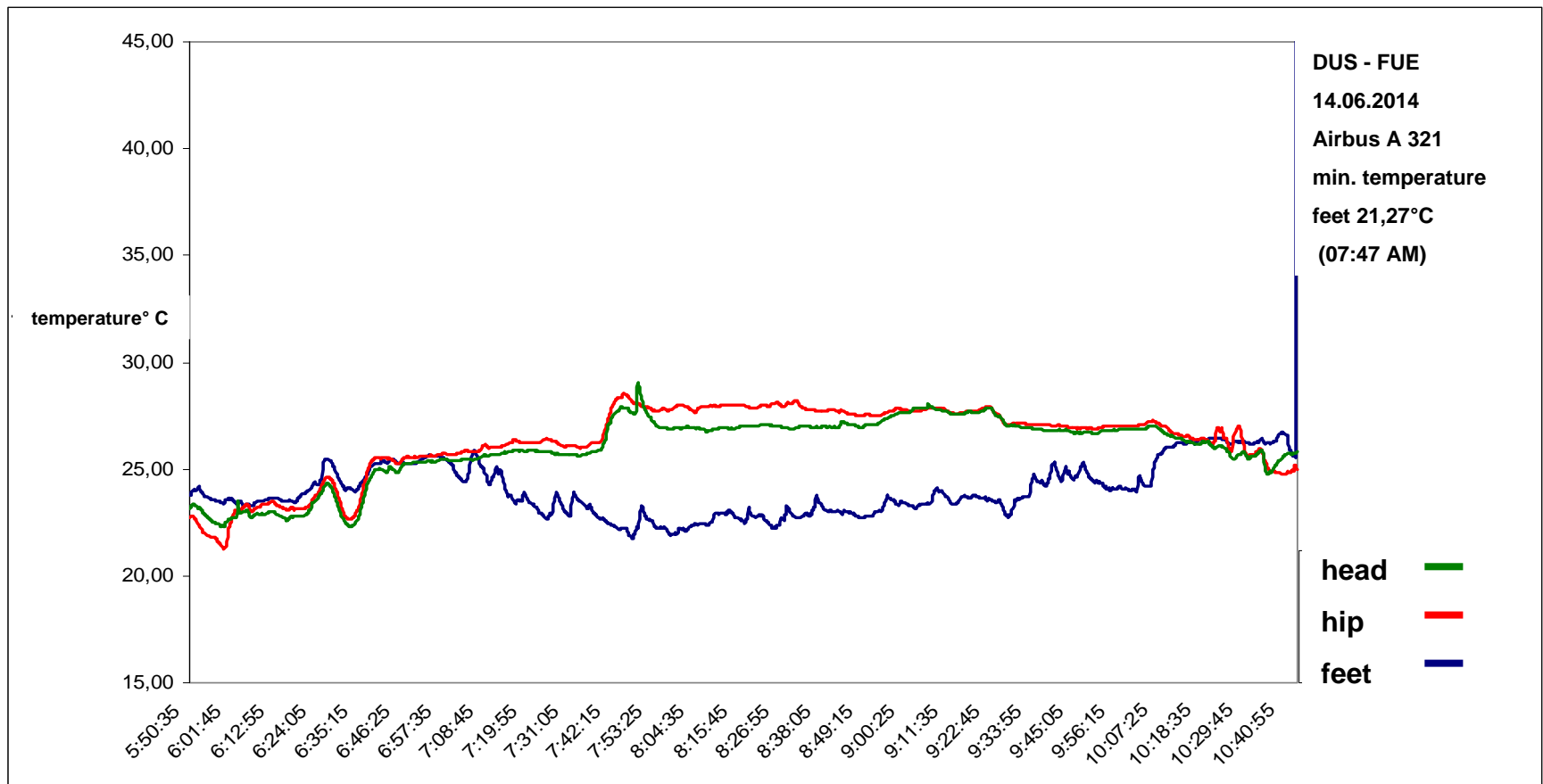
## Results (floor temperature inflight)

aircraft with underfloor heater



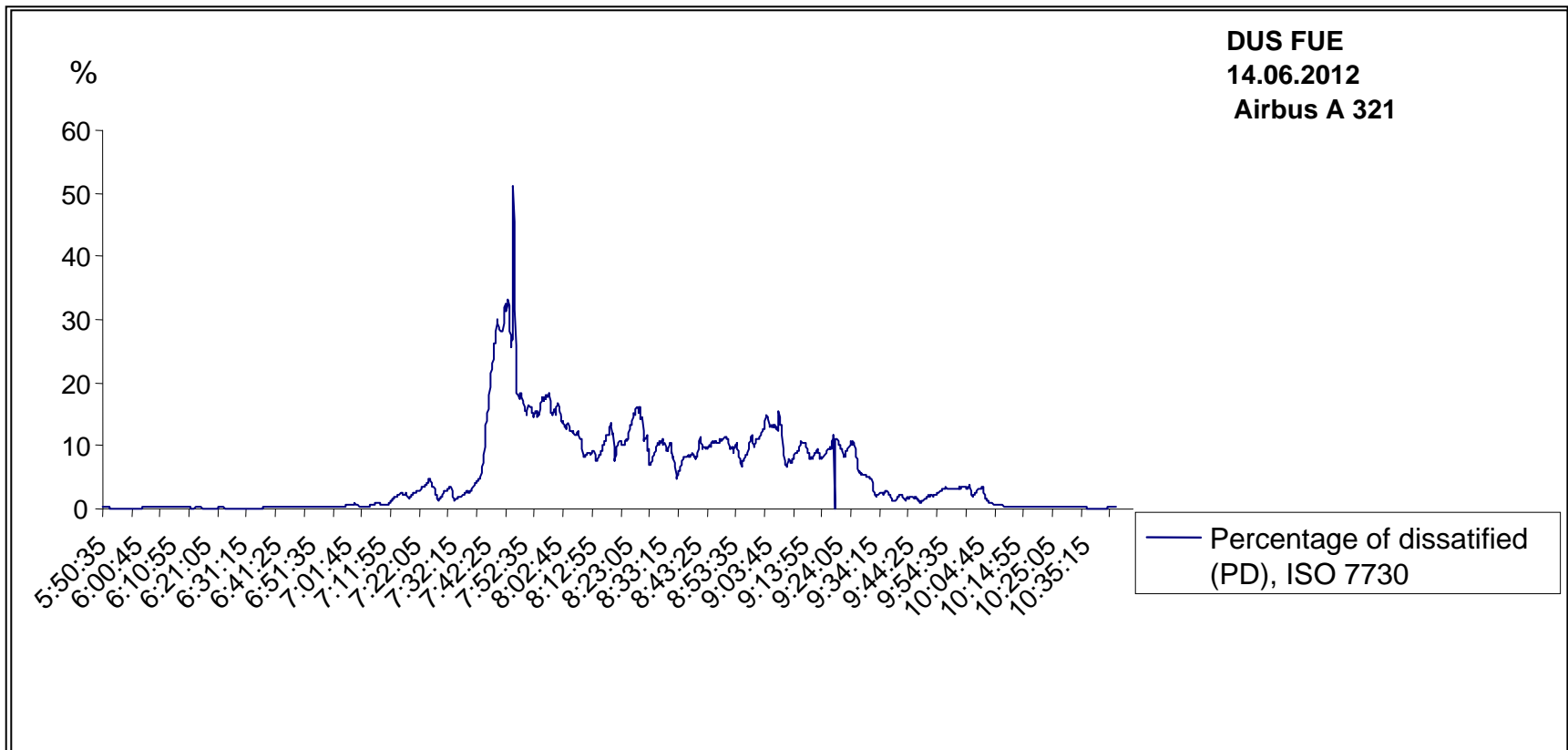
# Results (vertical temperature gradient)

aircraft with underfloor heater



# Results (resulting percentage of dissatisfied (PD), ISO 7730, vertical temp. gradient)

aircraft with underfloor heater



## Discussion

Working as a pilot is

- connected with high responsibility to flight safety
- requires high concentration and attention
- Due to the observed local thermal discomforts in the cockpit of the investigated commercial aircraft without underfloor heating a reduction in attention and concentration of the flight deck crew, especially during the takeoff and landing phase can not be excluded. This must be considered in the risk assessment

## Measures/ Recommendations

**By use of auxiliary electrical heating systems (under-floor heater) an increase of working performance of the cockpit crew is possible. An increase of flight safety is to be expected and thereby a possible peril of passengers can be prevented.**



**Thanks for listening!**  
**Questions?**