

# Investigation of indoor climate in a naturally ventilated building

Indoor Air 2008

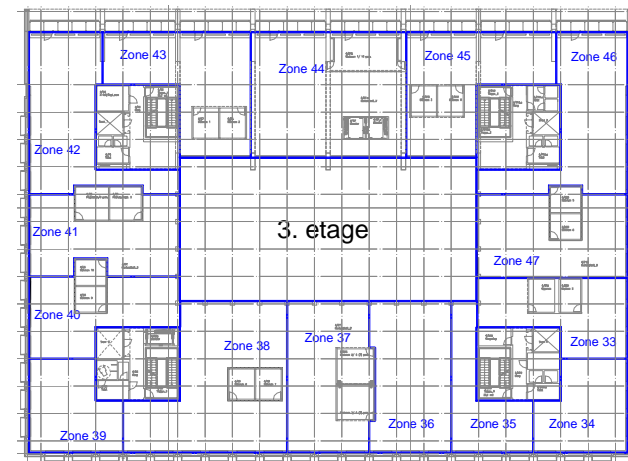
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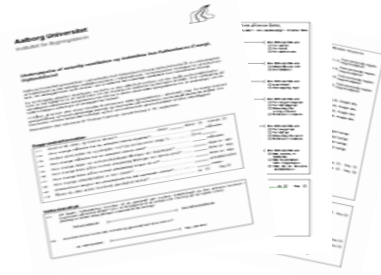


# Introduction to the Office Building



- Five-storied office building.
- The ground floor is mechanically ventilated.
- Second to fifth floors are naturally ventilated.
- All windows have a manually and an automatically controlled part.
- Each floor is divided into 14 zones controlled by an automatic control system which measures temperature (all zones) and CO<sub>2</sub> (four zones at each floor).

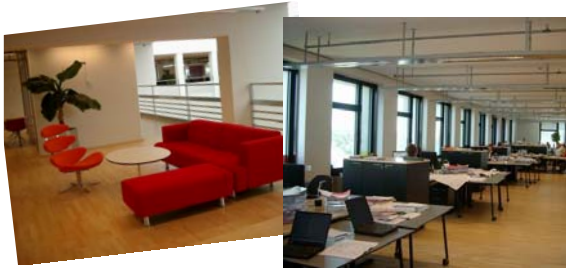




# Questionnaire

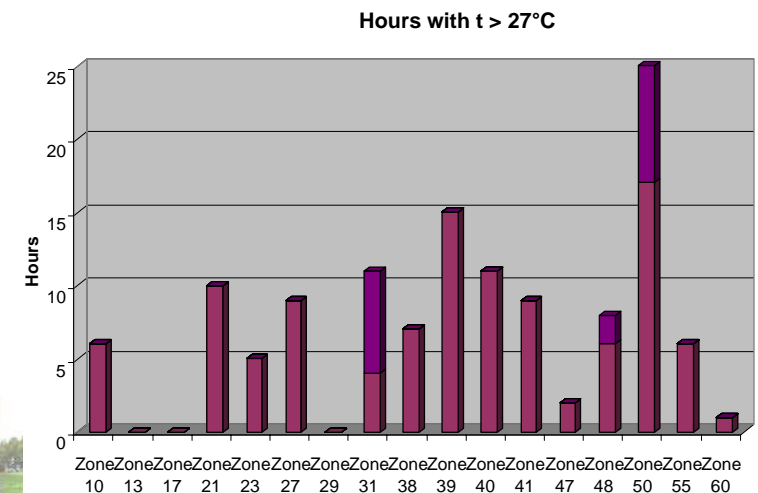
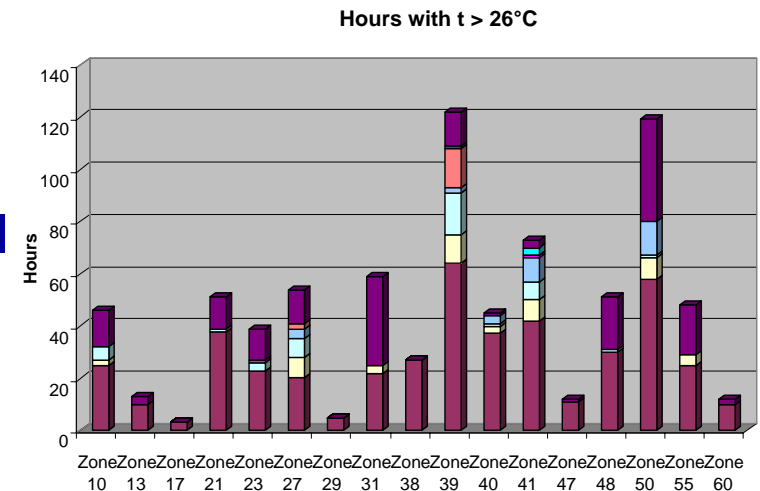
- **Aim**
  - To obtain a general evaluation of the indoor climate in the building
  - To find critical zones in the building
- **Result**
  - Overall results were good
- **Problems**
  - Insufficient use of solar shadings in offices facing south and west
  - Draught in zones with high internal heat gains
  - Internal noise





# Long-term measurements

- **Aim**
  - To evaluate the air quality and thermal conditions in the building during a year (by holding it up against recommendations from Danish regulations)
- **Results**
  - Average of 52 hours > 26°C
  - Average of 8 hours > 27°C
  - CO<sub>2</sub>-level always below 1000 ppm





## Short-term measurements

- Measurements were made one week during summer, winter and spring
- Two zones were found from the questionnaire
- The following were investigated

In the zones:

- Thermal comfort (room temperature, draught, internal heat load, solar shading)
- Air quality (indicated by CO<sub>2</sub>) & relative humidity
- Local air change rates

In the building:

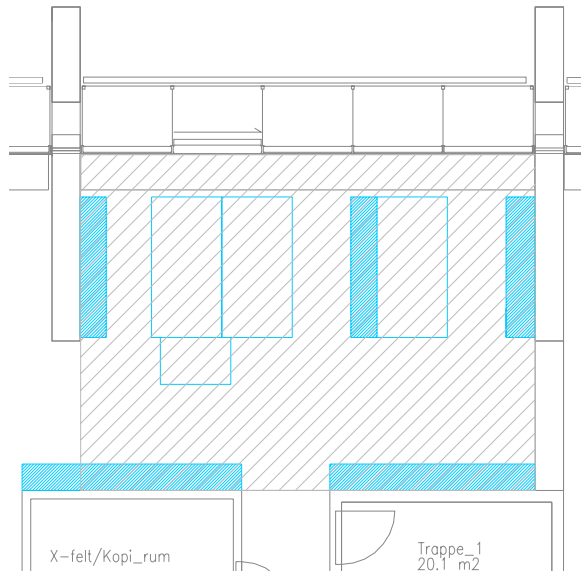
- Ventilation capacity (infiltration, air change rate during service hours, air distribution between floors)



# The zones

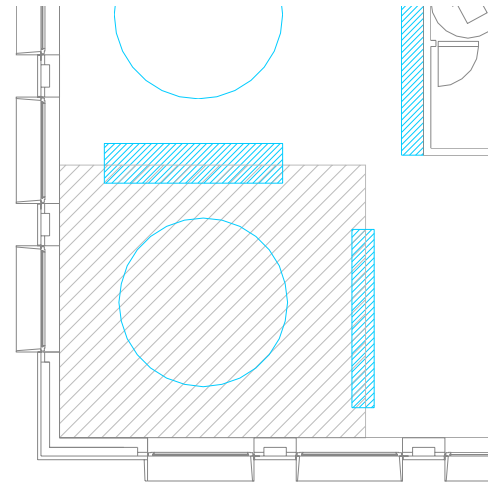
**A**

3 windows towards west  
3 workplaces  
Int. heat load = 16 W/m<sup>2</sup>



**B**

2 windows towards east  
2 windows towards south  
6 workplaces  
Int. heat load = 34 W/m<sup>2</sup>





# Results - short-term measurements

- Zone A
  - Thermal comfort all year round
  - High air change rates due to high internal heat gains and solar gains
- Zone B
  - Thermal comfort all year round but close to the upper limit
  - Problems with draught

!!! Internal heat load = 34 W/m<sup>2</sup>



# Results - short-term measurements

- The entire building
  - Average air change rate  $3\text{h}^{-1}$  to  $5\text{h}^{-1}$
  - Good indoor air quality in the building
  - Low temperature gradient ( $0.2^{\circ}\text{C}/\text{m}$ ) and  $\text{CO}_2$  gradient up through the building
  - Low air change rates in the closed building  $0.1\text{h}^{-1}$  to  $0.2\text{h}^{-1}$





# Conclusions

- Good thermal comfort and excellent perceived indoor air quality can be obtained in a building with open plan offices ventilated by natural ventilation by window openings in the façade
- Integration of the ventilation strategy at an early stage in the building design is important
- Simple guidance for the users is important to obtain an optimum use of e.g. solar shadings and manual opening of the windows

