

Measurements of Thermal Conditions, Part 2 – As Oy Kullervonkatu 17, Lohja

Client: NCC Finland Oy

Task

In two of the residences (residences no. 13 and 14), a Mobair 2010 air-heating outdoor air vent (manufacturer's brochure, Appendix 1) was installed in the ventilation window of the living room and bedrooms. The client wanted to test whether these vents would yield a draught-free result. These residences' original outdoor air vents in the upper frames of the windows were removed, the inlet holes were plugged, and the supply air was routed into each residence exclusively through the Mobair 2010 air-heating outdoor air vents in the living room and bedrooms. As a point of comparison for these measurements, measurements were also made in two other residences (residences no. 10 and 21) that had the original outdoor air vents in the upper frame of the window.

These thermal condition measurements comprised room temperatures, exhaust air volumes, and draught measurements in the four examined residences. In the draught measurements, the air flow speed and temperature were recorded from the draughtiest (according to the indicator smoke) measurement point. The measured values of air flow speed and temperature (gauged at the same measurement point) were used to determine a draught curve value, a parameter for which guideline values have been issued by the authorities. The supply air temperatures for the residences in question were measured from both the older outdoor air vents and the Mobair 2010 air-heating outdoor air vents.

Measurements

The measurements were carried out in accordance with the SFS 5511 standard¹, in the residences (selected by the client) presented in Table 1.

Table 1. Residences and vents included in the study.

Residence # and (type)	Storey	Vent
13 (3 bedrooms + kitchen + sauna)	3	Mobair 2010 air-heating outdoor air vent
14 (3 bedrooms + kitchen + sauna)	4	Mobair 2010 air-heating outdoor air vent
10 (3 bedrooms + kitchen + sauna)	3	Outdoor air vent in the upper frame of the window (no preheating)
21 (3 bedrooms + kitchenette + sauna)	5	Outdoor air vent in the upper frame of the window (no preheating)

The air temperature in the living room and bedrooms was measured at a height of 1.1 m from the floor in the middle of the room. The draught was measured at the draughtiest measurement point (as determined by the indicator smoke) in the living room and bedrooms. In accordance with the SFS 5511 standard, the measurements were carried out only in the occupancy zone.¹ "Occupancy zone" here refers to the room section whose lower surface is demarcated by the floor, whose upper surface is 1.8 m above the floor, and whose lateral surfaces are located at least 0.6 m from the walls. The measured temperature and flow speed values were used to determine a draught curve value, which can be used to assess the sensation of draught in humans.³

The draught was measured with a SwemaAir 300 multi-purpose climate meter combined with a SWA 03 sensor, a direction-independent, hot-wire-based draught sensor that measures air flow speed (m/s) and air flow temperature (°C). The 3-minute average of the parameters was measured in this assessment. The uncertainty of the flow speed

measurements is estimated to be $\pm 10\%$, and the uncertainty of the flow temperature is estimated to be ± 0.2 °C.

The air temperature in the rooms was measured with a Fluke 52 thermometer. The uncertainty of the measurements is estimated to be ± 0.2 °C.

Exhaust air volumes were measured with a SwemaAir 300 multi-purpose climate meter combined with a Swema 125 hot-wire-based anemometer funnel. The uncertainty of the measurements is estimated to be $\pm 10\%$.

All of the aforementioned uncertainty estimates represent 95% of the coverage probability.

The measurements of the residences were carried out on 12 November 2002. On the date of measurement, the outdoor temperature was between -13 and -9 °C. Wind speed from the northwest was approximately 4-5 m/s. According to the measurement guidelines, the outdoor temperature must be -5 °C or colder during measurements.

It was agreed that the measurements of thermal conditions would be carried out with the reinforcing damper of each residence's cooker hood set at the lowest position. In residences 10 and 21, the windows' outdoor air vents were fully open, and in residences 13 and 14, the Mobair 2010 air-heating outdoor air vent was turned on. In residence 13, the heating cell's bypass flow opening had been partly opened, and as a result, some of the supply air escaped past the heating cell without preheating. In addition to the vents' own filters (EU5), a pre-filter (EU 3) was used in each vent's inlet pipe. In residence 14, the bypass flow opening was almost closed, and thus nearly all of the supply air was preheated. Along with the vents' own filters (EU5), a pre-filter (EU 4) was used in each vent's inlet pipe. The information on filter categories was obtained from the client. The windows of all the examined residences were closed at the time of examination. The doors between the rooms were open.

Guideline values used in the assessment of thermal conditions

The Health Protection Act (Finland) serves as the basis for monitoring the healthiness level of buildings. In turn, the Ministry of Social Affairs and Health issues more detailed ordinances and guidelines on this act's interpretation. Instructions on the guideline values for measurements of temperature and other thermal conditions are provided in the Indoor Air Guidelines published by the Ministry of Social Affairs and Health in 1997.²

The guideline values indicated as "satisfactory" below correspond to the minimum requirements from part D2 of the Finnish National Building Code.³ Failure to meet the below-indicated "acceptable" level of the guideline values constitutes a health hazard according to the Ministry of Social Affairs and Health.

Guideline values:

	acceptable	satisfactory	maximum
Room air temperature (°C)	18	21	24
Air flow speed	draught curve 3	draught curve 2	

The draught curve values are presented in part D2 of the Finnish National Building Code (page 3, figure 1).

Measurement results

The results of the measurements of thermal conditions for each residence are presented in Table 2.

Table 2. Measurements of thermal conditions at the site As Oy Kullervonkatu 17. Draught measurement results that are below the acceptable level set out in the Indoor Air Guidelines are indicated with boldface numbers in the table below.

Residence #	Room	Room air temperature at a height of 1.1 m in the middle of the room (°C)	Air flow speed / temperature / draught curve value (m / s / °C / draught)	Range of supply air temperature at the mouth of the vent's exhaust outlet	Positioning of the room thermostat for floor heating
13 (y)	living room	23.7	0.23 / 23.4 / 1.8	32-38 (1-9) (z)	0
	bedroom 1	23.0	0.23 / 22.1 / 2.6	32-38 (1-9) (z)	"-
	bedroom 2	23.5	0.24 / 21.8 / 2.8	35-45 (0-8) (z)	"-
14 (y)	living room	24.5	0.19 / 24.4 / <1.0	55-60 (17) (z)	0
	bedroom 1	24.8	0.14 / 23.9 / <1.0	45-55 (32) (z)	0
	bedroom 2	24.9	0.12 / 22.3 / <1.0		½
10 (x)	living room	22.4	0.41 / 21.3 / 6.9	-1.8 – 1.0	1/1
	bedroom 1	22.5	0.37 / 20.1 / 6.9	-4.0 – 2.0	"-
	bedroom 2	22.5	0.34 / 20.8 / 5.7	-5.0 – 1.0	"-
	dining area	22.5	0.32 / 20.5 / 5.3		
21 (x)	living room	22.5	0.37 / 20.5 / 6.6	-2.0 – 1.0	0
	bedroom 1	21.9	0.34 / 19.5 / 6.8	-4.5 – 2.0	"-
	bedroom 2	22.0	0.29 / 20.0 / 5.2		"-

(y) = The residence has a Mobair 2010 air-heating outdoor air vent

(x) = The residence has its original outdoor air vents (without preheating) in the upper frame of the window

(z) = The latter of the values shown is for the supply air of the bypass flow opening at the upper edge of the vent

The results of the exhaust air volume measurements for each residence are presented in Table 3.

Table 3. Exhaust air volume measurements at the site As Oy Kullervonkatu 17.

Residence #	Room	Exhaust air volume (litres / s)	Guideline value according to the design (litres / s)	Minimum guideline value according to part D2 of the Finnish National Building Code (litres / s)
13	kitchen	8.2 (k) 21.5 (a)	8 23	20
	bathroom	12.5	15	15
	lavatory	9.0	10	10
	sauna	6.6	6	6
14	kitchen	7.8 (k) 24.2 (a)	9 26	20
	bathroom	13.2	15	15
	lavatory	8.9	10	10
	sauna	5.6	6	6
10	kitchen	10.5 (k) 26.7 (a)	9 26	20
	bathroom	14.3	15	15
	storeroom	no measurements performed		
	sauna	6.7	6	6
21	kitchen	7.7 (k) 20.0 (a)	8 23	20
	bathroom	12.5	15	15
	lavatory	12.5	10	10
	sauna	6.4	6	6

(k) = With the reinforcing damper of the kitchen cooker hood closed

(a) = With the reinforcing damper of the kitchen cooker hood open

Review of the results

Room temperatures

At almost all the measurement points, the room temperatures exceeded the 21°C threshold of what is regarded as a satisfactory value.

In residence no. 14, the maximum room temperature of 24 °C was exceeded in each of the rooms where measurements were performed.

Draught

Draught measurement results that were below the level defined as "acceptable" in the Indoor Air Guidelines are indicated with boldface numbers in Table 2.

In residence no. 13, the draught measurement were better than the aforementioned "acceptable" level, and in residence no. 14, the draught measurement results were better than the level defined as "satisfactory". By contrast, the draught measurement results from each of the examined rooms of residences no. 10 and 21 were worse than the acceptable level.

In residences 10 and 21, where the outdoor air vent was located in the upper frame of the window (with no preheating), the draughtiest measurement point in the occupancy zone was usually at the edge of this zone, approximately 0.6 m from the wall, on the part of the floor adjacent to the window and the outdoor air vent. According to the measurements and the observations of the indicator smoke, the greatest cause of the draughtiness was un-preheated supply air coming in from the outdoor air vents. The supply air from the outdoor air vents descended rapidly along the surface of the window towards the floor, and after reaching the floor, it then proceeded to flow into the room.


In residences 13 and 14, equipped with Mobair 2010 air-heating outdoor air vents, the preheated supply air rose towards the ceiling surface and then flowed forward and sideways along the ceiling and into the room. The higher draught curve values for residence 13 compared to those of residence 14 are explained by the fact in residence 13, the bypass flow opening of the heating cell of the supply air heater had been opened, and thus some of the supply air escaped past the heating cell without being preheated. The measurement results for this residence were nonetheless within the guideline value threshold. In residence 14, the bypass flow opening was almost closed, and thus nearly all of the supply air was preheated.

During the course of the measurements, the residents were queried about their sense of the draughtiness of their residences. The occupants of residences 10 and 21 viewed their outdoor air vents as draughty, whereas the occupants of residences 13 and 14 saw the Mobair 2010 air-heating outdoor air vent as draught-free.

Exhaust air volume:

Ventilation designers usually allow an uncertainty of about $\pm 10\text{--}15\%$ for adjustments of indoor climate systems, and for fulfilment of values specified in the design. When measurement uncertainty is also taken into account, the measured exhaust air volumes matched both the design guideline values and the minimum guideline values of part D2 of the Finnish National Building Code quite well.

Espoo, 19/11/2002


Ismo Heimonen
Group Director


Keijo Kovanen
Special Researcher

- | | |
|------------------------|---|
| FOOTNOTE
REFERENCES | <ol style="list-style-type: none"> 1. Standard SFS 5511 "Air conditioning, indoor climate of buildings, field measurements of thermal conditions" 2. Handbooks of the Ministry of Social Affairs and Health, 1997:1. Indoor Air Guidelines. p. 72. 3. Finnish National Building Code, part D2. Indoor Climate and Ventilation of Buildings. Regulations and Guidelines, 1987. Ministry of the Environment. |
|------------------------|---|

DISTRIBUTION	Client	Original
	VTT (Archive)	Original