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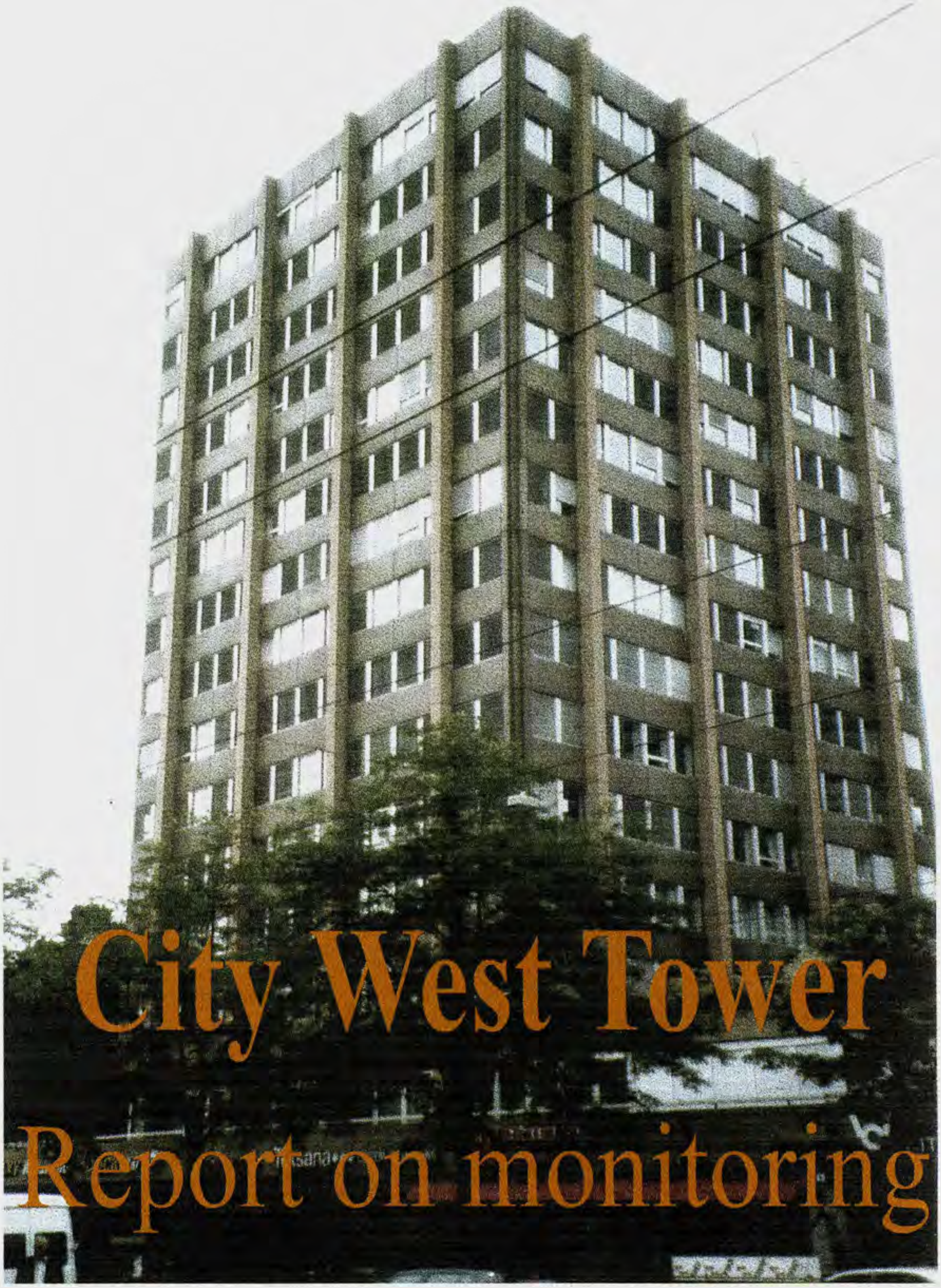

City West Tower

Report on monitoring

Roulet Claude-Alain and Pascal Cretton

LABORATOIRE D'ÉNERGIE SOLAIRE ET DE PHYSIQUE DU BÂTIMENT
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23 FEBRUARY 1999

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SUMMARY

Spot measurements and monitoring of building data were planned within the EC Joule-Thermie OFFICE research project. Monitored data include meteorological data, internal temperatures, energy and water consumption. Spot measurement addresses air tightness of window, performance of the main air handling unit, CO_2 concentration and questionnaires to occupants.

Monitoring has shown that indoor air temperatures are within the comfort range most of the time, and rather homogeneous. Temperatures on top and bottom of building are the same. Northern part of the building is nevertheless one degree colder than the other parts.

The main part of energy consumption is for heating. Half of electrical energy use is for air handling units. Energy signatures have shown that heating and cooling both occur in May and September, and that the district heating terminal is oversized. Cooling energy is correlated to outdoor temperature, but not to solar radiation. Another regression applied to heat use gave an equivalent solar collecting area in good agreement with that provided by calculations according to prEN 832.

From spot measurements it is concluded that pulsed airflow rate and recirculation rates are close to the planned values, while exhaust air flow rate is less that half of the pulsed air flow rate. The measured window is reasonably airtight. The air distribution ensures a full mixing, with an air change rate of about 5/h. Carbon concentration is very low indoors, indicating a large airflow rate per person.

FOREWORD

Spot measurements and monitoring of building data were planned within the EC Joule-Thermie OFFICE research project. Monitored data include meteorological data, internal temperatures, and energy and water consumption. Spot measurement addresses air tightness of window, performance of the main air handling unit, CO_2 concentration and questionnaires to occupants.

The aims of these measurements are:
- To collect data to fit the simulation models to reality
- To collect information on the performance of the building, with regard to indoor environment quality and energy use
- To asses the relative energy consumption for heating, cooling, ventilation and other appliances
- To assess the air tightness of the facade as well as the actual airflow rates in the main unit, and to compare them to design airflow rates.

This report presents the methods used and the results of measurements performed from April 22, 1997 to May 31, 1998.

BUILDING DESCRIPTION

General information

Much information on this building is already available for various reasons.

The owner is one of the pioneers in energy conservation in Switzerland. In particular, it recorded energy use of its buildings since many years. For this particular building, yearly energy records are available since 1985, and monthly energy records are available for the last year.

In addition, being conscious that this building offers a rather poor comfort at a relatively high-energy cost, it ordered several studies in view of a retrofit.

This building was the object of the pilot study on December 9, 1994 *[Roulet et al, 1994]* within the frame of the European Audit Project *[Bluyssen et al, 1995]*. From this, opinion of the occupants on indoor environment, as well as BSI[1] and information on indoor air quality is known. The main air-handling unit was also measured at this occasion.

Building

This building is an office tower located downtown Bern. It has a large ground level, mainly occupied by shops, parking and storage lots, and 13 office levels above ground level.

Building year: 1969-1971. Owner occupied since 1972

Size: 19 floors (4 below ground), total floor area: 11'688 m² (tower only: 7'400 m²)

Orientation: square plan N-S and E-W (see Figure 1)

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1 Building Symptom Index, indicating how sick the building is.

HVAC Systems

Water radiator heating, heat provided by district heating.

Main air handling unit with cooling, heating, and recirculation. Air humidifier is installed but was disconnected in 1993. Several secondary air handling units.

Design fresh air supply: 47 l/s person or 34'800 m³/h (measured is 29'000 m³/h).

Air supplied and extracted in the ceiling: supply near the facades, extract by the centre of building.

Occupants

The office part of the building is completely occupied by the same government agency. The 240 employees are mainly professionals involved in planning, building, and maintenance of buildings (architects, engineers). They are very often out of office.

Offices

The investigated offices are located at the second and tenth floor. Its plan shows a large open office located all around the building with service rooms, elevators and staircase in the centre of the North facade (Figure 1). Each floor hosts between 10 and 20 employees. There are some closed rooms on some floors for managers or used as meeting rooms.

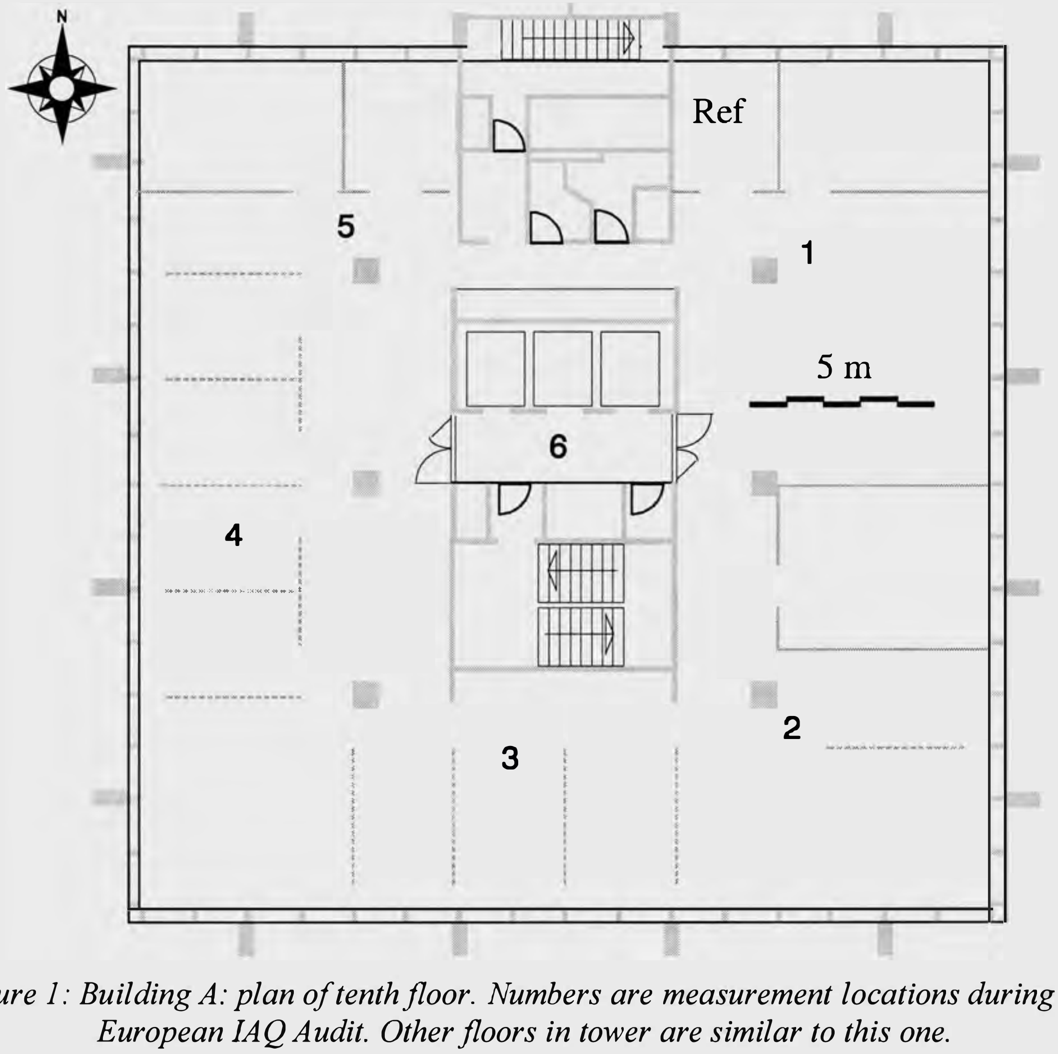


Figure 1: Building A: plan of tenth floor. Numbers are measurement locations during the European IAQ Audit. Other floors in tower are similar to this one.

Wall material inside insulation	metal
Wall covering	dispersion paint
Floor covering	felt carpet
Ceiling material	acoustic tiles
Lighting	ceiling fluorescent tubes and daylighting
VDU/work place	23/18
Floor area/workplace	22 m²
Volume/workplace	55 m³

Peculiarities

The building is in poor condition and consumes much heating energy. The owner intends to refurbish it completely in 1999. Smoking is allowed in separate rooms. Windows can be open but are generally not.

RETROFIT AND MEASUREMENT PLANNING

Retrofit measures and checking measurements

The table below gives the planned retrofit measures, as well as the measurements and simulation planned to check their effectiveness. This plan was discussed with and agreed by a representative of the building owner. The building retrofit was first planned for 1988 but is now delayed. Therefore, measurements were not perturbed by retrofit word.

Retrofit measure	Checking measurement
Building	
Glazing with a U-Value of 2.6 W/(m²·K) will be replaced by low-e coated glazing having 1.3 W/(m²·K) U-value.	None
The frames of the windows are kept but will be sealed.	Air tightness of windows.
A new one, automatically operated will replace the existing, inefficient shading device.	Temperature monitoring.
The thermal insulation will be improved only on a few parts of the construction (the corners, the parapet and parts of the wall in the staircase).	None
Electrical equipment	
The lighting system will only be replaced only in the central zones of the building. In the offices it has been replaced a short time ago.	Electric energy use (global, including appliances)
Due to changes in the use of the rooms, parts of the electrical system will be modified.	None

Retrofit measure	Checking measurement
Heating system	
The heating system will generally not be replaced.	Heating energy hourly monitoring
The control of the heating groups will be renewed.	Heating energy signature
The heating water temperature will be reduced.	Internal temperature monitoring.
Cooling system	
The cooling system will be replaced completely. In addition, there will be a cold water storage tank and an adiabatic cooling system.	Cooling energy requirement is recorded monthly
The cooling system of the computer centre will be connected to the general cooling system.	None
The heat rejected by the cooling system will be used to heat up sanitary hot water.	None
Ventilation	
Ventilation system will be replaced completely and rebuilt at the state of the art (especially addition of heat recovery).	HVAC system full diagnostic: air flow rates, fan efficiency.
The ventilation system in the offices will be changed to displacement ventilation	Noise level measurement.
The air exchange rate will be reduced to a minimum.	CO_2 short term monitoring.
Plumbing	
The rainwater will be held separately of the other wastewater (now there is a mix system).	Monthly recording of water meter.
Synthetic tubes with acoustic protection will replace the existing wastewater tubes.	None
Building control System	
All new technical-building devices will receive a Direct-Digital-Control-system.	None
The building control system will be replaced and connected with other buildings of the same owner.	None

Measurements performed

Continuous monitoring

Monitored data are recorded and can be delivered in comma separated files (.csv format). This format does not use much space and can easily be read by usual data analysis tools such as Excel. Annex 1 provides more information on these files.

Meteorological data

These were obtained for 1997 and the first half of 1998 from the Swiss Meteorological Institute. The measurement facility is located at Liebefeld, close to Bern. It is at 46.56° latitude North and 7.25° longitude East, at an altitude of 565 meter.

The data recorded hourly include:

- air temperature and humidity,
- solar radiation (global radiation on horizontal and four vertical planes, diffuse radiation on horizontal and vertical planes and radiation on a plane normal to sun),
- infrared radiation balance of horizontal and vertical planes,
- wind velocity and direction.

Indoor temperatures

Indoor temperatures were recorded hourly from Tuesday, 22. April 1997 at noon to Wednesday, 24. June 1998 at 4 AM. TINYTAK one-channel data loggers equipped with a thermocouple were installed in second and tenth floors at a total of nine places (see Figure 2).

Figure 2: Location of TinyTak monitoring thermometers. Left: second floor, right: tenth floor

Inlet and exhaust air temperatures

Inlet and exhaust air temperatures were measured for the same time period as indoor air temperatures in the mechanical ventilation main system, also using TINYTAK one-channel data logger equipped with a thermocouple. The air inlet temperature is close to the outdoor air temperature when the fans are operating. The outlet temperature provides the average indoor air temperature of the building, weighted by local airflow rates.

Daily recording of heating energy

The town services provided the district use of the whole building on a daily basis.

Monthly recording

The building management provided monthly records of

- Main electricity meter, as well as separate meters for some facilities, offices, cooling units and air handling units. However, not all meters are reported. Therefore, electricity use for other appliances is obtained by subtracting energy for the various air handling units, cooling plant, elevators from the readings at the main meter. Therefore, other appliances include not only lighting and office machines, but also the computer centre and a small air-handling unit.
- Main water meter.

Spot measurements

The following spot measurements were performed:

- Air tightness of a window, according to EN ISO 9972
- Air flow rates in main HVAC system, using tracer gas dilution technique
- Fan efficiency, that is the ratio of delivered mechanical power (mass flow rate times pressure differential) by the used electrical power.
- CO_2 monitoring in exhaust air for a short period. This was performed with a portable recording CO_2 analyser.
- Questionnaire in winter and summer.

RESULTS

Outdoor climate

Figure 3 shows monthly averages of some meteorological data during the "OFFICE" year, that is from June 97 to May 98. As usual in continental Europe, the coldest month is February, while the hot days are in July. There is not much wind in this area, and average relative humidity is nearly constant.

As shown on Figure 4, it temperature was below zero during 11% of the 1997-98 winter, median temperature throughout the monitored year was 10°C, and there were very few hot hours (19 hours above 28°C) in Summer 1997.

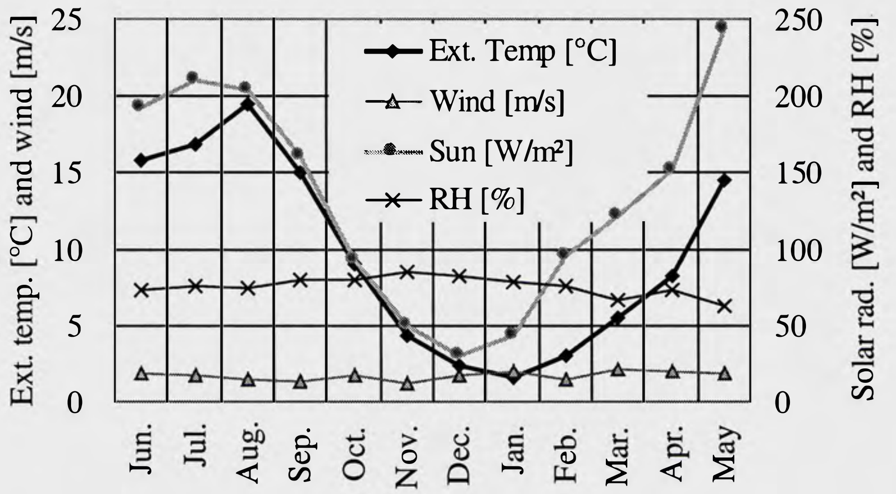


Figure 3: Monthly averages of some meteorological data.

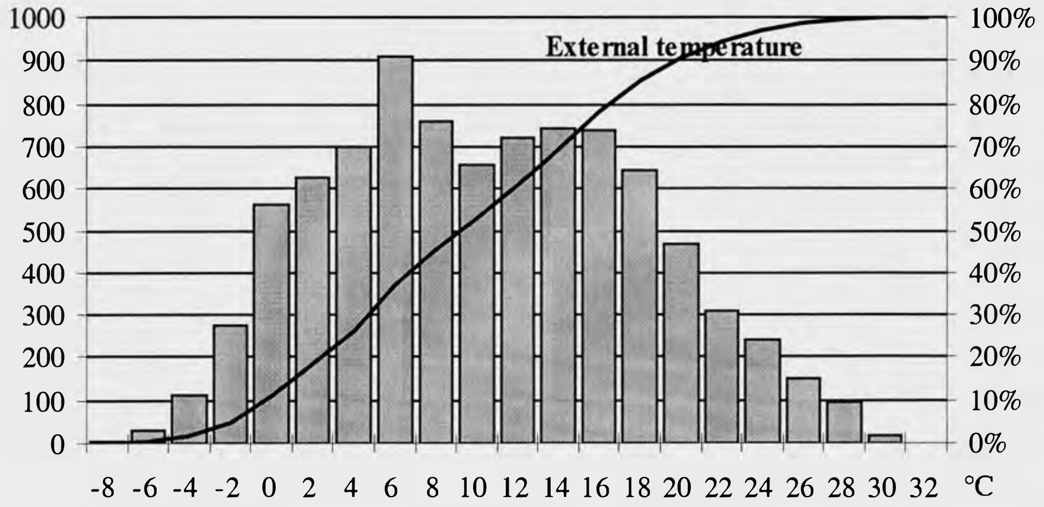


Figure 4: Differential and cumulated frequency distribution of external temperature.

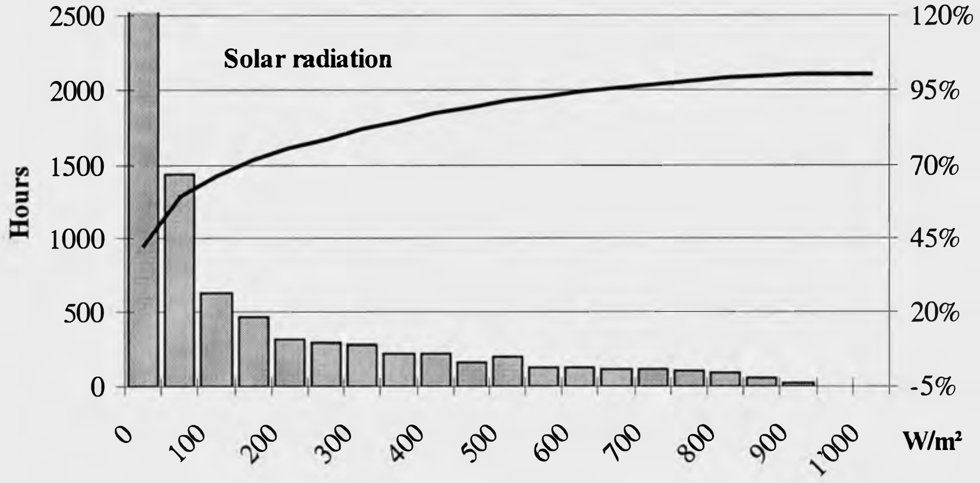


Figure 5: Differential and cumulated frequency distribution of global solar radiation on a horizontal plane.

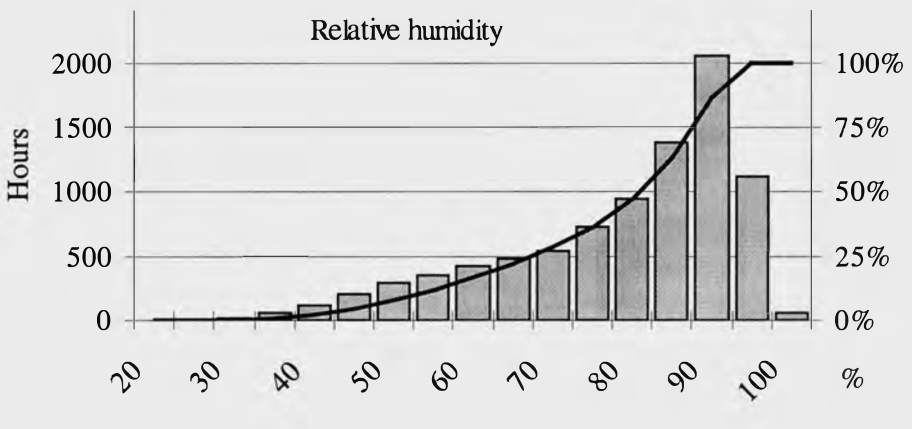


Figure 6: Differential and cumulated frequency distribution of relative humidity.

Outdoor air is humid most of the time (Figure 6), and at any temperature (Figure 7). It can nevertheless be rather dry for temperatures above 0°C.

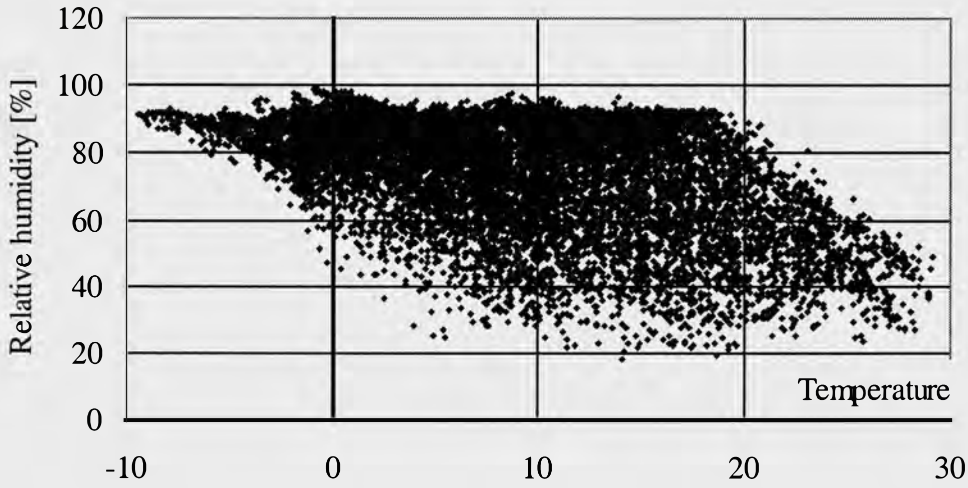


Figure 7: Relative humidity in relation to outdoor air temperature. Each dot represents an hourly measurement.

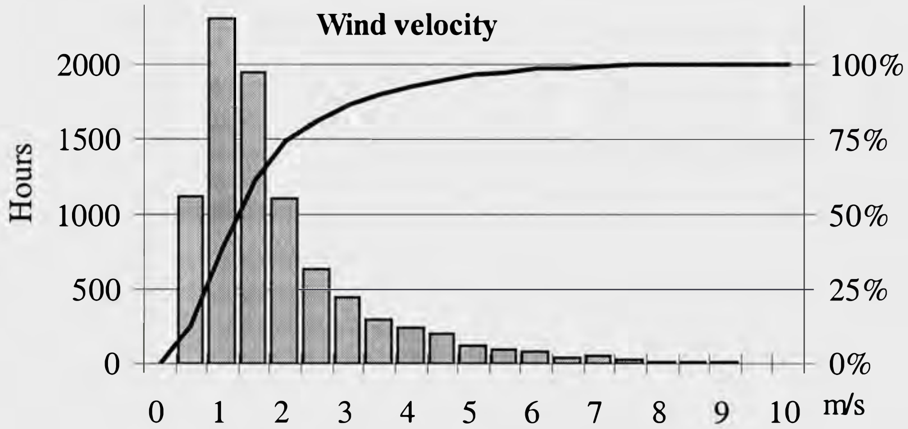
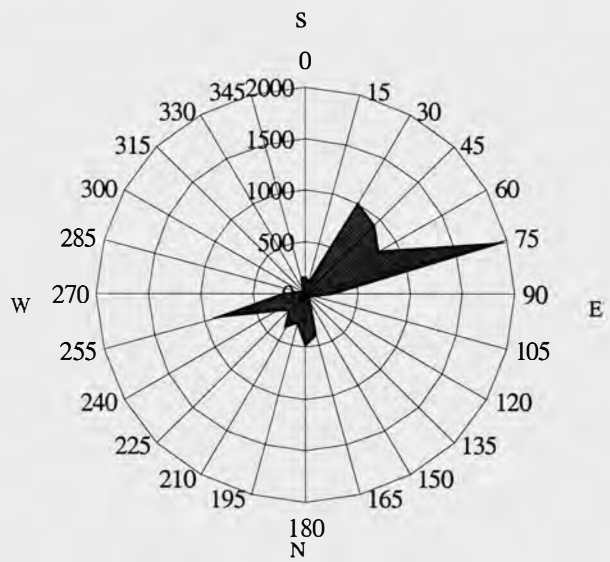


Figure 8: Differential and cumulated frequency distribution of wind velocity



Wind velocity is low (Figure 8) and comes mainly from east-southeast (fronts) and from northwest (cold wind in front of anti-cyclones). These main directions result from the Jura mountains, oriented northeast to southwest.

Figure 9: Wind rose at Bern.

Indoor temperatures

Ambient indoor temperatures were measured at nine locations: four locations in second floor, and five in tenth floor. These measurement points were chosen to assess the differences between facade orientations and between bottom and top floors.

Average temperature in the tower is 22°C. This is measured on one hand in exhaust air, and on the other hand as the average of the nine measurements. These two ways provide very close results: The largest difference is 0,4 K (Figure 10).

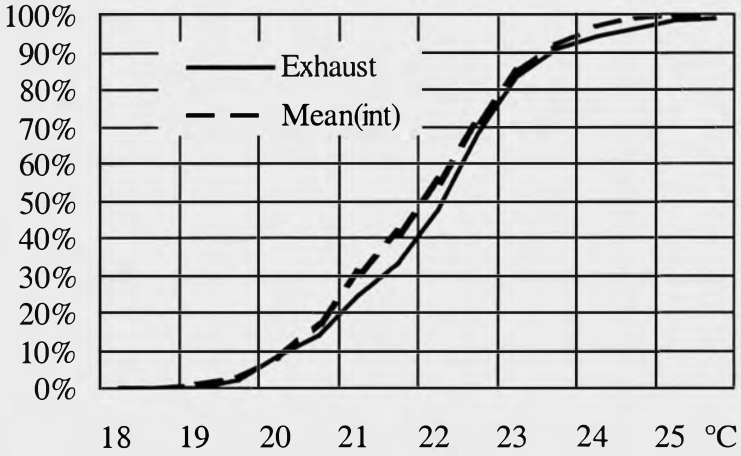


Figure 10: Cumulated frequency distribution of hourly measurements of internal temperature, as measured in exhaust air and as average of nine measurements points.

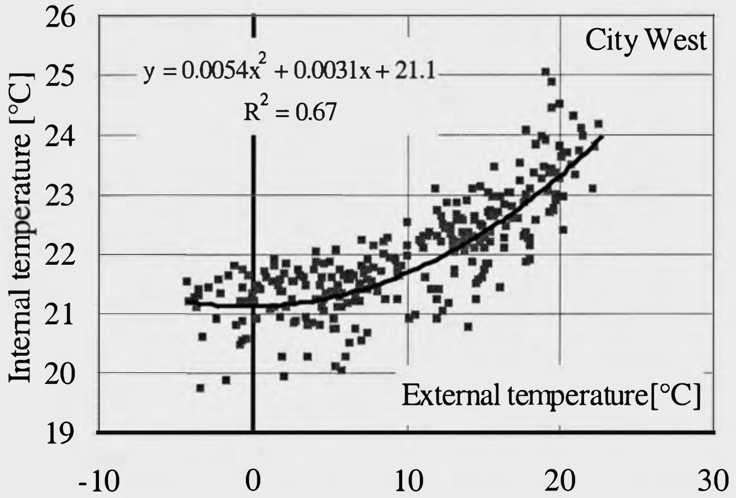


Figure 11: Daily average of indoor temperature in relation to outdoor temperature (working days only).

Internal temperature slightly depends on external temperature, as shown in Figure 11, and this makes sense.

Differences between measurement points are small (Figure 12). The North location at tenth floor and West location at second floor present low minima (open window?), while second floor south presents the largest maximum.

The place at second floor oriented to the north presents the lowest average, 1,2 K below the building average.

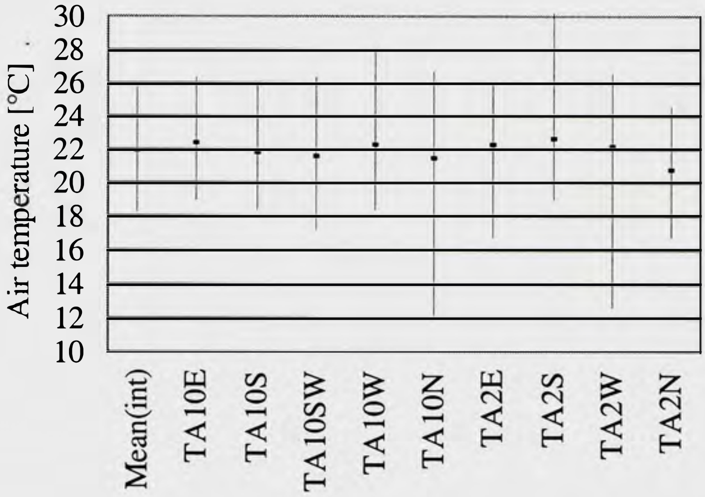


Figure 12: Yearly average of measured temperatures, with mini-max bars. The number indicates the floor, and the letter is for the orientation.

Figure 13: Cumulated frequency distribution of the average internal temperature in two floors.

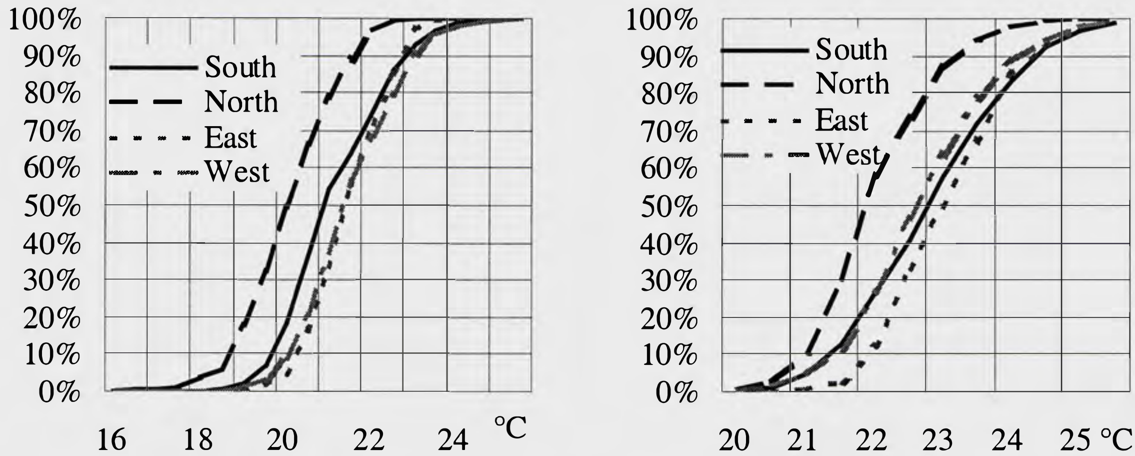


Figure 14: Cumulated frequency distribution of the average internal temperature in the four main orientations. Left: in winter, right, in summer.

There is no significant difference in the average temperature between the two measured floors (Figure 13), but significant differences among the various orientations (Figure 14). The north-oriented locations are systematically 1 K colder than the other places, in winter as well as in summer.

The temperature at a southwest location on tenth floor was recorded on request of the house-keeper, who reported complaints from occupants. In fact, the temperature at this location is close to the building average, and the reasons for complaints should be looked for elsewhere (draughts?) or may result from usual individual differences.

According to EN ISO 7730, the building average temperature is most of the time within the comfort range for office work in winter. Indeed, the internal temperature is between 20 and 24 °C during 92% of the time. The coldest temperatures may even occur during holidays.

Still according to EN ISO 7730, the building may be a bit cold in summer. Recommended temperatures are between 23 and 26 °C in summer, and the indoor air temperature is within this range only 35% of the time, and below this range for the remaining. It should however be noted that EN ISO 7730 address the operative temperature, which combines air- and radiant temperatures, while the tiny thermocouples measure mainly air temperature. Therefore, the occupants may prefer a lower air temperature when close to a warm surface, such as a facade heated by the sun.

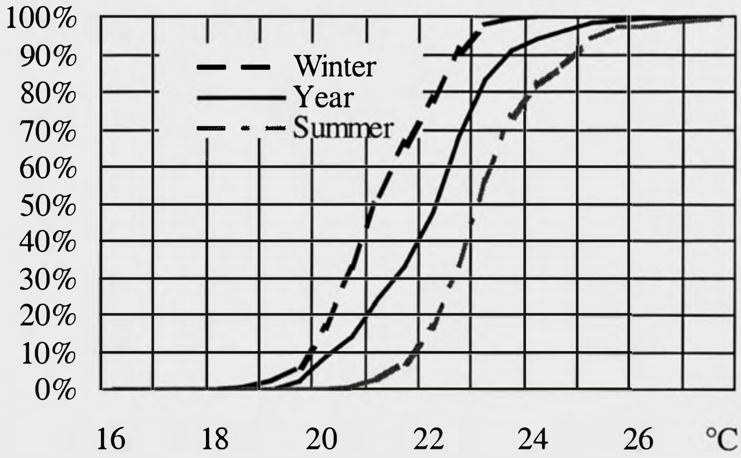


Figure 15: Cumulated frequency distribution of the average internal temperature.

Energy use

The monthly energy use for the whole building is shown in Figure 16, together with the external temperature. It can readily be seen that the largest part is for heating. Note that heating in summer is for hot water only. It can be seen, however, that heating and cooling are both used in May and September. Monthly energy use for ventilation and other appliance does not vary much with time, the exception being an unexplained peak in June

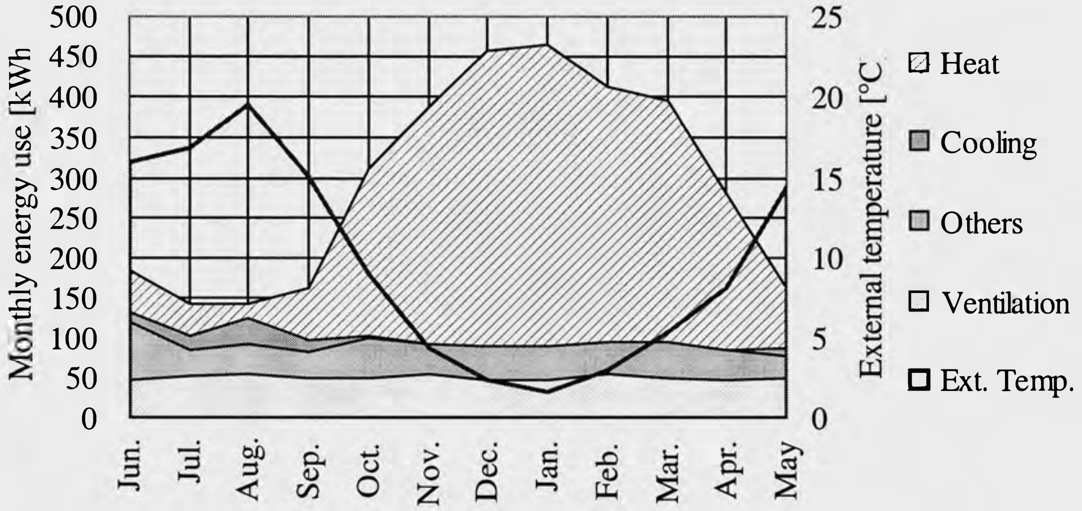


Figure 16: Monthly energy use for the whole building and external temperature.

Partition of energy among the various uses is in Table 1 and Figure 17. While most of the energy use is for heating, most of electricity is for the ventilation systems. Cooling uses only a small part of the energy. "Other" uses include lighting and office appliances as well as the computer centre, some machines and phase compensation units.

The annual bill for electricity is CHF 180'800.- (about 110'000.- ECU), that is less than 0,1 ECU/kWh.

Table 1: Partition of energy uses.

	MWh	kWh/m²	Part
Heat	2'310	339.5	65.2%
Lifts	36	5.3	1.0%
Cooling	91	13.4	2.6%
Ventilation	612	89.9	17.3%
Others	495	72.8	14.0%
Total Elect.	1'234	181.3	34.8%
Total energy	3'544	520.9	100.0%

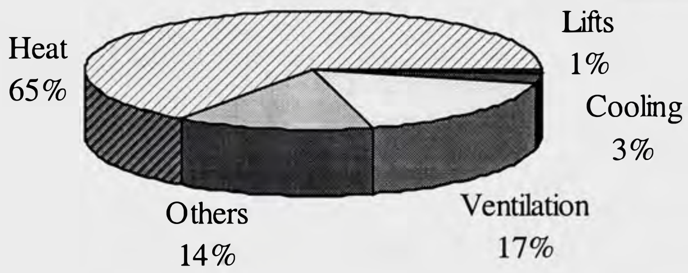


Figure 17: Partition of energy uses.

Energy signature

Energy signature is the relationship between heating power, averaged over a given period of time, and external temperature, averaged over the same period of time.

Monthly basis

Heating and cooling energy signatures on a monthly basis are given in Figure 18.

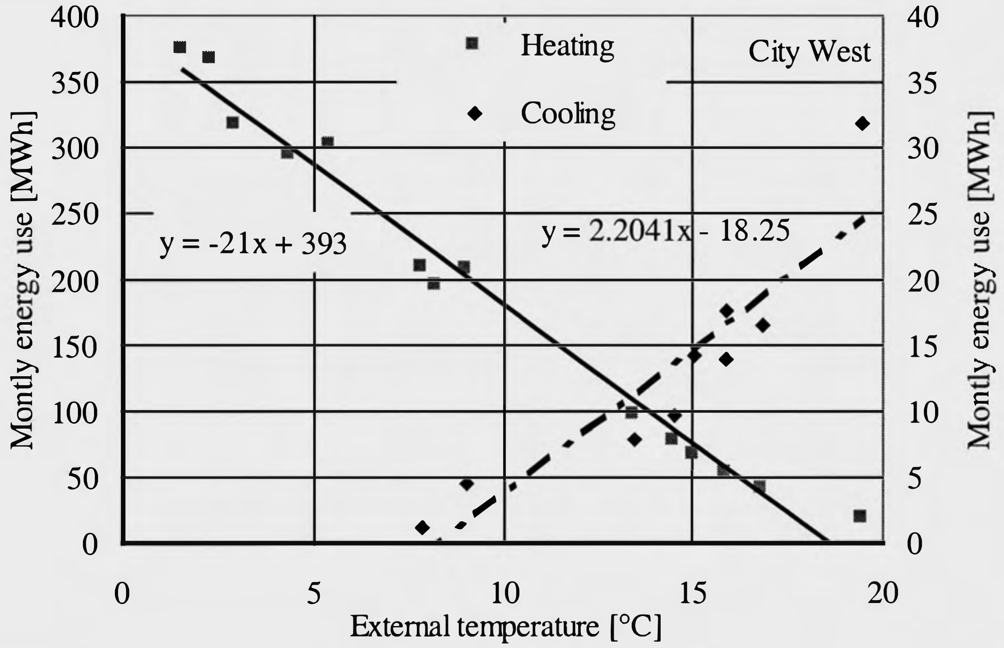


Figure 18: Heating and cooling energy signatures on a monthly basis

Heating energy signature has the following parameters:

Heating power à 0°C	393 MW/month =	540 kW
Slope	21 MWh/(month.K) =	30 kW/K
No heating above	16,7 °C, assuming 40 kW base power (hot water etc)	

The slope can be compared to the heat loss coefficient of the tower, which is 20 kW/K (4,3 kW/K by transmission and 15,7 kW/K by ventilation). The difference may come from uncertainties of input data for calculations and of measurements, and from building delimitation used to compute the heat loss coefficient, which may not be exactly the same as the boundaries of the space heated by metered district heating. There may also be some small losses in the heat distribution.

Theoretical heat requirement at minimum temperature (i.e. –10 °C) would be 840 kW. This figure can be compared with the nominal power of the district heating connection, which is 2400 kW! It should be mentioned that such kind of over-sizing was of common use in 1970, when this building was erected.

Cooling energy signature has the following parameters:

Slope	2.2 MWh/(month·K) = 3 kW/K
No cooling below	8.3 °C

So this building is ten times less sensitive to external temperature for cooling than for heating. In fact, cooling is used mostly for extracting internal and solar heat gains, and not for compensating transmission heat gains through the walls. It is therefore rather astonishing to find a significant correlation (R^2=0.84) between cooling power and external temperature. Even more surprising is the lack of correlation between cooling energy and solar radiation (Figure 19).

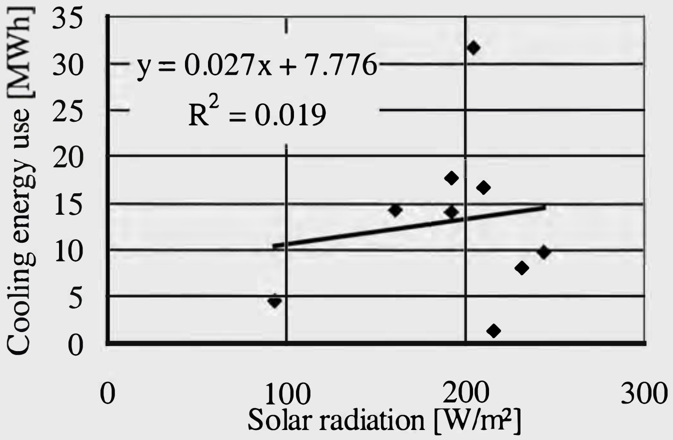


Figure 19: Monthly cooling energy and average solar radiation.

What is also astonishing is that cooling and heating occur in months with average temperature between 8,3 and 18,7 °C.

Daily basis

Heating power is monitored on a daily basis. Therefore, the energy signature can also be drawn on this basis. This shows clearly two clouds of dots, which were easily identified as working days and holidays (Figure 20). Ventilation is off during holidays and the heat loss coefficient is then reduced. Parameters of both signatures are listed in

Table 2: Parameters of signatures drawn on a daily basis

	Working days	Holidays	
Heating power à 0°C	613	330	kW
Slope	32.3	18.2	kW/K
No heating above	17.7	15.9	°C

Heat load can be calculated form the working day's parameters. It is close to 1 MW. It is larger than the load calculated on a monthly basis, but it is still less than half the installed power!

The difference between the two slopes is 13 kW/K, which is close to the ventilation heat loss coefficient (about 15 kW/K).

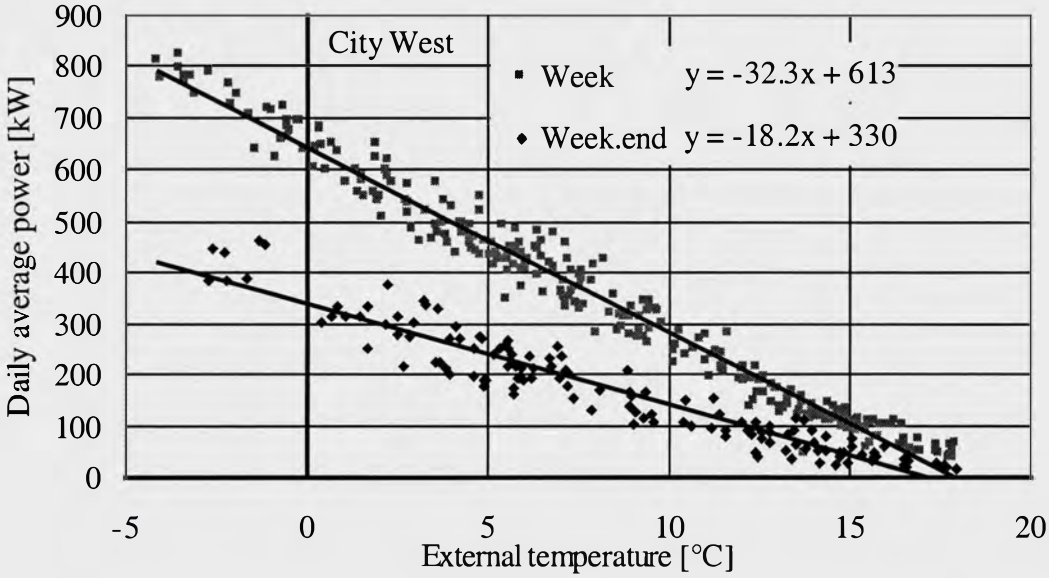


Figure 20: Heating energy signatures on daily basis

The H-m method *[Gay et al, 1995]* is useful to identify the sensitivity of the building to solar radiation, or its ability to make use of solar gains. It is an identification method based on a slight rearrangement of the building hat balance:

$$\frac{P - P_b}{\theta_i - \theta_e} = H - \frac{\eta\left(q_s A_e + \Phi_i\right)}{\theta_i \quad \theta_e} \tag{1}$$

where:

- P is the heating power, averaged, in watts,
- P_b is a base power corresponding mainly to other heat consumers such as hot water, and heat loss of the heating system, taken as 40 kW from average during summer months,
- H is the heat loss coefficient, including transmission and ventilation heat loss, in W/K
- θ_i is the internal set-point temperature, in °C
- θ_e is the external temperature, averaged over the same time period than that for P
- η is the utilisation factor for heat gains
- q_s is the solar radiation on a reference (e.g. horizontal) plane in W/m²
- A_e is the effective solar collecting area, and
- Φ_i is for the internal heat gains from occupants metabolism and appliances.

When the internal heat gains can be neglected, this becomes:

$$H = \frac{P - P_b}{\theta_i - \theta_e} = H_0 - \eta A_e \frac{q_s}{\theta_i - \theta_e} = H_0 - \eta A_e\, m \tag{2}$$

where the heat loss coefficient is renamed H_0, H being now an apparent heat loss coefficient, which varies with solar radiation. m is a variable depending mainly on meteorological conditions:

$$m = \frac{q_s}{\theta_i - \theta_e} \tag{3}$$

This relationship is shown on Figure 21. The parameters H_0 and ηA_e of the H-m equation are identified using a linear least square fit. These are:

H_0 = 27 W/K, close to the slope of the signature

ηA_e = 540 m², effective solar radiation collecting area, to be compared to 1423 m² windows, or 700 m² equivalent area calculated according to prEN 832. Note that ηA_e is related to global solar irradiance on a horizontal plane, while prEN 832 looks at each orientation separately. This, together with the fact that utilisation factor is included in ηA_e easily explains the difference between ηA_e and 700 m².

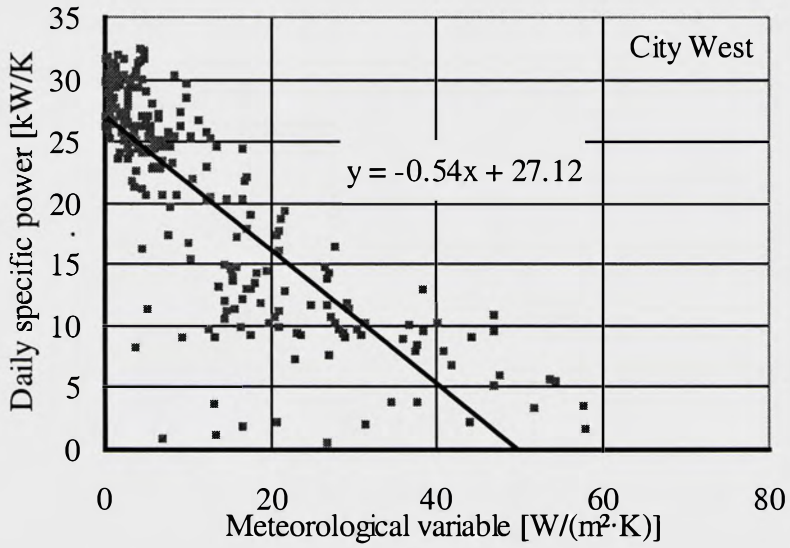


Figure 21: H-m diagram of the City West building, working days.

Note that heating is no more necessary when m = 50 W/(m²·K), or in other words, when the global solar radiation intensity on an horizontal plane, in W/m² is 50 times the indoor-outdoor temperature difference. This shows that the City West tower makes some uses of the passive solar gains (they cover 28% of the heating requirement) but not as well as a passive solar building.

Air flow rates in air handling units

The main air-handling unit, used to ventilate the tower, was measured to assess the real air-flow rates.

Measurement method

The measurement procedure is based on tracer gas dilution at constant injection rate. Tracer gas is injected at known, constant rate in a duct, upstream enough from a location where the air in the duct is analysed. At steady state, the measured concentration, C, is linked to the tracer source rate, S, and to the air flow rate in the duct, Q, by:

$$C - C_o = \frac{S}{Q} \quad hence \quad Q = \frac{S}{C - C_o} \tag{4}$$

where C_o is the tracer concentration upstream the injection port. Noting ε_Q and ε_C for measurement errors of tracer flow rate and concentrations, the error for airflow rate is:

$$\varepsilon_Q^2 = \frac{1}{(C - C_0)^2}\left[\varepsilon_S^2 + \frac{2S^2}{(C - C_0)^2}\varepsilon_C^2\right] \qquad (5)$$

In a typical ventilation system, as illustrated on Figure 22, there could be recirculation, short-circuits, mixing tees, etc.

In order to obtain all the airflow rates, either several tracers should be injected at the same time, or the experiment should be repeated several times, injecting the tracer at various locations. These procedures are planned in order to get, from air- and tracer gas mass balance, at least as much flow equations as air flow rates to be measured. Proper tracer gas injection and analysis locations for the system are shown on Figure 22 and Table 1. These measurements provide all airflows in the installation. In many cases, it can be safely assumed that some airflow rates are negligible or non-existent, and the planning of the experiment can be greatly simplified.

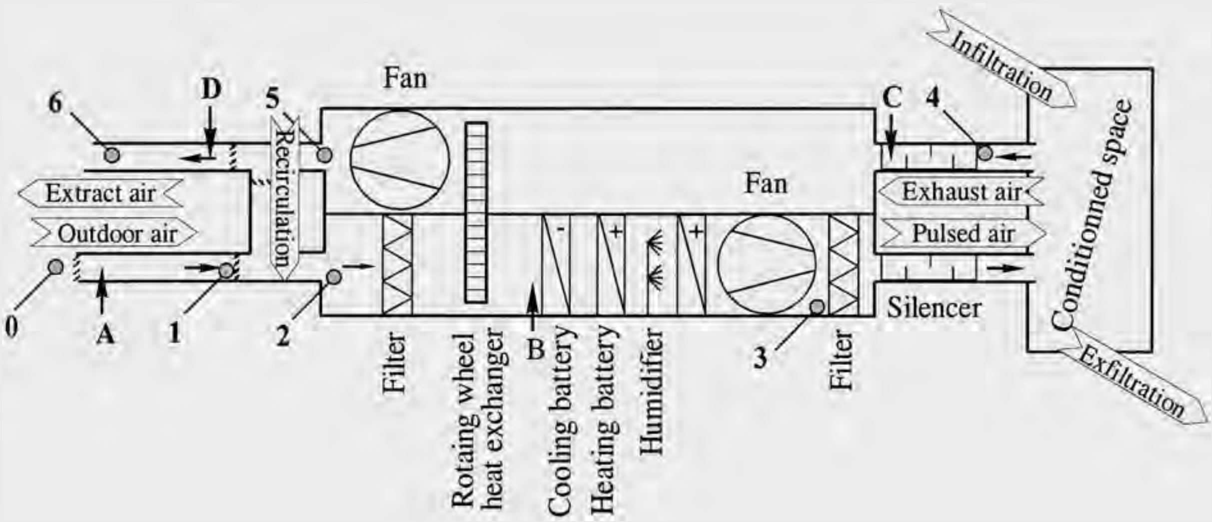


Figure 22: Schematics of a typical ventilation system. A, B, C, D: possible tracer gas injection points; 0, 1, 2, 3, 4, 5, 6: concentration analysis locations.

Table 1: Examples of injection and analysis locations for measurement of airflow rates in ventilation system.

Injection location	Analysis port	To measure		Equation used
A	0 and 1	Q_o	outdoor air flow rate	$Q_o(C_1-C_o) = S_A$
B	2 and 3	Q_p	pulsed air flow rate	$Q_p(C_3-C_2) = S_B$
C	4 and 5	Q_{ex}	exhaust flow rate	$Q_{ex}(C_5-C_4) = S_C$
	0, 3 and 5	Q_r	recirculation flow rate	$Q_r = (Q_pC_3-Q_oC_0)/C_5$
D	5 and 6	Q_e	extract air flow rate	$Q_e(C_6-C_5) = S_D$
B	0, 3 and 4	Q_i	infiltration flow rate.	$Q_i = Q_x+Q_{ex}-Q_p$
		Q_x	exfiltration flow rate.	$(C_0-C_3)Q_x=(C_0-C_3)Q_p + (C_4-C_0)Q_{ex}$

Other experimental designs are possible, allowing measurement of many airflow rates with fewer experiments. They lead however to more complex equations (Roulet an Vandaele [*1991*]). The most important condition is that the tracer is perfectly mixed to the air at the concentration measurement location. This requires either a very long straight duct, or some flow perturbing elements such as bends or fans between the injection and the analysis locations. The most convenient experimental plan should be chosen after taking account of the practical possibilities for injection and analysis, and of the tracer mixing elements.

The tracer gas mixing should be verified by checking the concentration variation along a traverse in the duct or upon time. If the concentration remains steady, the mixing is likely to be good. If not, mixing can be improved by multiplying the injection ports in the section of the duct, or by mixing air samples taken at several locations in a traverse.

Results

Figure 23 shows the measured air-handling unit. Since only few airflow rates should be measured in this simple system (no heat recovery, no expected short cuts), only two injection points and three sampling points are required.

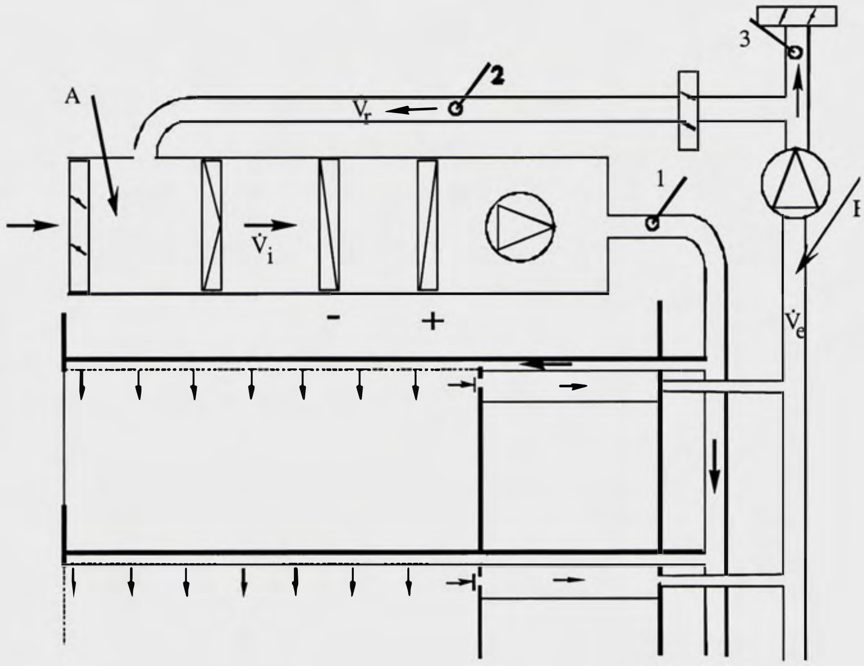


Figure 23: Schematics of the measured air-handling unit. A and B are successive injection locations. Sampling locations are numerated 1 to 3.

Injection of sulphur hexafluoride at 3,72 l/minute was first performed in air inlet (point A), and tracer gas was analysed in inlet and return air (points 1 and 2.) A mass flow controller controls the injection rate. Concentrations were monitored using a BINOS infrared absorption analyser, calibrated with pure nitrogen and a calibrating gas at 150 ppm SF6.

The total pulsed airflow rate was obtained first from steady state concentration at location 1. Then the recirculation rate was assessed from the concentration ratio C_1/C_2 after having stopped the injection. From these, the outdoor and recirculation airflow rates can be deduced.

Then, sulphur hexafluoride was injected at point B, upwind of exhaust fan. Tracer gas concentrations at points 2 and 3 were very close each other, indicating a good mixing. From these, exhaust airflow rate can be readily calculated.

Results are summarised in Table 3. These are not significantly different from the planned values.

Note that the building is under pressure, and that exhaust airflow rate is only 40% of pulsed airflow rate, the remaining air being likely lost through envelope cracks and other leaks.

Table 3: Airflow rates in air handling unit as measured using tracer gas dilution method.

Exhaust air flow rate	36 800	±	4 100 m³/h
Pulsed air flow rate	93 000	±	13 000 m³/h
Outdoor air flow rate	48 000	±	13 000 m³/h
Recirculation air flow rate	45 000	±	12 000 m³/h
Exfiltration flow rate	57 000	±	17 000 m³/h
Recirculation rate	50%	±	6%

Leakage characteristics of a window

Measurement method

The air permeability characteristics of a window were measured according to ISO 9972. A plastic foil was sealed on the internal side of the metallic wall around the window using strong adhesive tape. A small fan equipped with a nozzle was used to pressurise the air layer enclosed between this foil and the window.

Pressure differential was measured using an electronic digital manometer having a sensitivity of 1 Pa and 2000 Pa maximum range. The air velocity at the centre of the nozzle was measured using a hot sphere anemometer.

The relation between airflow rate, $\dot{V}$, and pressure differential, Δp, is interpreted according to the empirical law:

$$\dot{V} = D\Delta p^n \quad (1)$$

where D is the flow coefficient (that is the airflow rate at 1 Pa pressure differential) and n an exponent ($0{,}5 \leq n \leq 1$).

Results

The measured window is 1.1 by 1,5 m and cannot be opened. It includes a metallic frame and a double pane glazing.

After checking that there was zero pressure differential without fan, the pressure was increased step by step up to 50 Pa.

Pressure differential and air velocity at the centre of the nozzle attached to the fan were measured at each step, once the steady state was reached. Air tightness of the seals on the plastic foil was checked using fume probe.

A leak was observed when measuring the last two measured points (empty dots on Figure 24). These points are not included in the regression. A regression line according to

$$\dot{V} = D\Delta p^n$$

where D is the flow coefficient and n an exponent, was adjusted to the remaining points.

Results are:

D = 1,6±1 [l/s] and n = 0,50 ±0,04

Equivalent leakage area @ 4 Pa = 0,0013 m²

Leakage rate @ 50 Pa: 11±0,5 l/s.

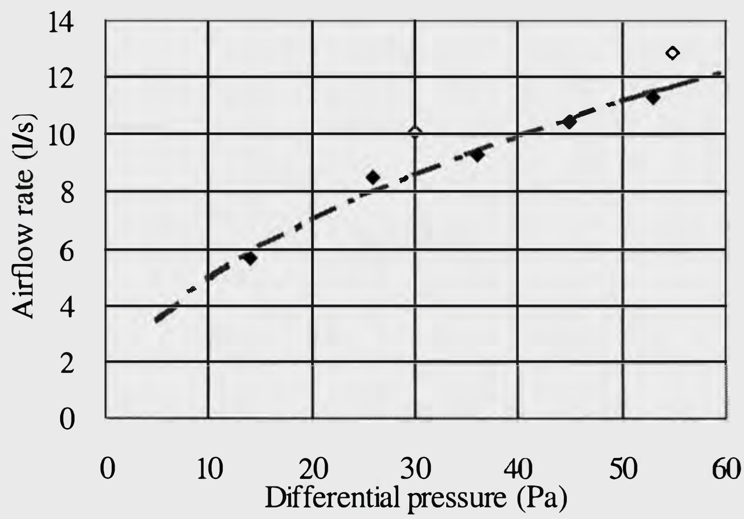


Figure 24: Airflow rate versus pressure. Dots are measured points, and the curve is the regression line.

There are 416 such windows on the tower. The exfiltration rate (57'000 m^3/h or 16'000 l/s) cannot be explained by the leakage of such windows only. This would mean that the average leakage flow rate through one window is 38 l/s, that is much more than can be expected at less than 50 Pa pressure differential. Under common conditions, the airflow rate through such a window is about 5 to 8 l/s, that is 2000 to 3200 l/s for the whole building.

If the leakage were concentrated in the frame of this window, which length is 5,4 m the width of the crack should be 0,24 mm.

It can be concluded that this window is reasonably airtight.

Age of air and ventilation efficiency

Measurement method

Parameters, which are of greatest interest in assessing the ventilation performance of a building are, among others:

The fresh air exchange rate, *n* (or specific flow rate), which may be expressed as the nominal time constant τ_n:

$$\tau_n = \frac{1}{n} = \frac{V}{Q_o} \qquad (2)$$

The room or building mean age of the air, τ, which is the mean time spend indoors by the air since it entered the room or the building

The air change efficiency, which is related to the above two quantities and indicates the type of air distribution (piston ventilation, full mixing or poor distribution with dead zones and shortcuts).

$$\eta_a = \frac{\tau_n}{2\tau} \qquad (3)$$

Definitions of these parameters may be found in Sutcliffe [*1990*], Brouns and Waters [*1991*], and Liddament [*1993*]. Measurement is most easily accomplished by tracer gas methods. Roulet and Vandaele [1991] describe the theory and practice of which in detail.

The basic principle is to mark the air to be measured by injecting and mixing a tracer gas into it, to detect the passage of this air by measuring the tracer gas concentration, and to measure the airflow rate by tracer dilution. Two basic procedures are used to assess the age of the air: The tracer step-up method and the tracer decay method. We used both successively.

The tracer step-up method can be applied when all the air supplied to the building passes through controllable ways (such as an inlet duct). From a given time on, tracer gas is injected into the supply air in the inlet duct at a constant rate. It is assumed that the tracer and the air are fully mixed in the supply duct to produce a homogeneous concentration, C_s, at the inlet. As high order transients die out quickly, the concentration at all points tends towards a simple exponential of the form:

$$C_p(t) = C_p(\infty)\left(1 - e^{-t/t_c}\right) \qquad (4)$$

Ignoring the first part of the measured data, the rest may be fitted to this equation to give an estimate of both $C_p(\infty)$ and the dominant time constant, τ_c, which is needed for the end correction terms.

The room mean age of air is deduced from the evolution of the tracer concentration at the exhaust:

$$\tau = \frac{\int_0^\infty t\left(1 - \frac{C_e(t)}{C_s}\right)dt}{\int_0^\infty \left(1 - \frac{C_e(t)}{C_s}\right)dt} \qquad (5)$$

In the tracer decay method, tracer gas is injected into the enclosure and mixed to a uniform concentration. At a given time, the tracer gas concentration is allowed to decay, and is monitored at a convenient point. The decay is exponential, with a time constant equal to the required nominal time constant of the enclosure.

Results

Determination of the age of air was performed simultaneously to the airflow rate measurements, using successively a step-up and a decay experiment. The tracer gas concentration was continuously monitored and recorded at locations 1 and 2. Figure 25 shows the recorded concentrations.

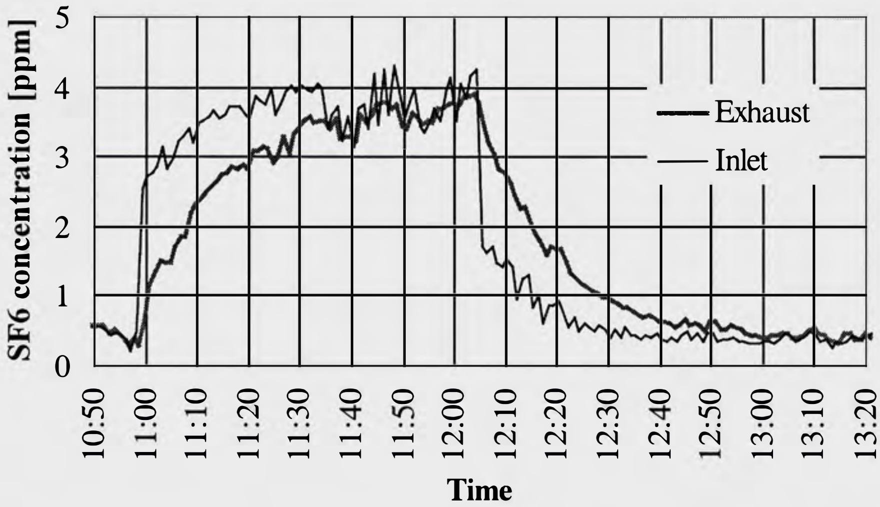


Figure 25: Evolution of tracer gas concentrations at building air inlet and exhaust.

Concentrations normalised to steady state value (step up) and to initial value (decay) are shown on Figure 26, together with an exponential fit. The good fit shows that ventilation distribution is fully mixed. This is confirmed by the ages of air shown on Table 4.

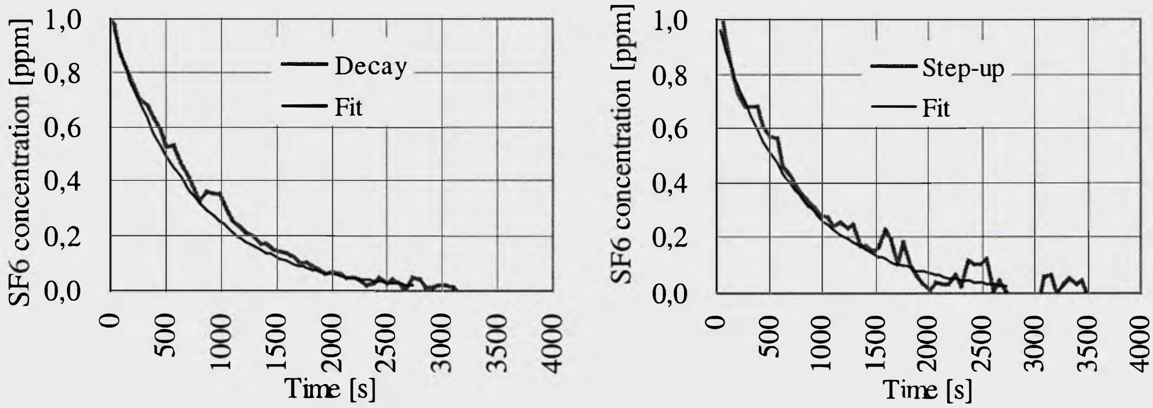


Figure 26: Normalised concentration and exponential fit for step-up and decay experiments.

Table 4: Results of age of air measurements

	Step-up measurement	Decay measurement	
Air change rate	4,8 ± 0,2	5,1 ± 0,1	/h
Nominal time constant (fit)	750 ± 30	710 ± 20	s
Building mean age	740 ± 65	700 ± 35	s
Air age @ exhaust	892 ± 9	858 ± 8	s

Ages of the air from decay experiment are a little smaller than those from step-up experiment, but the difference is not significant. Nominal time constant from fit and building mean age are very close together. The ventilation effectiveness using these data in equation 3 is then 50%. If the age of the air at exhaust is taken for the building time constant, then the efficiency would be 60%, indicating a small piston effect. Note that a part of this apparent piston effect is in the ducts themselves.

The ventilated volume deduced from the fresh airflow rate and the air change rate is 10'000 m³. This cannot be compared to the volume that should be ventilated by this air-handling unit, i.e. 18'500 m³. There is no explanation of this discrepancy for the moment.

Fan efficiency

Measurement method

The mechanical power delivered by a fan is the product of the mass air flow rate by the pressure differential:

$$P_m = Q_m \Delta p \qquad (6)$$

Airflow rate was known from tracer measurements. A differential manometer is used to measure the pressure differential. For this, the fittings of the manometer are connected to two thin tubes, each being itself fitted into the main duct, upwind and downwind the fan. Care should be taken to install both tube ends in the same position with respect to the main airflow, to avoid that the dynamic pressure perturb the measurement.

If the electrical power consumed by the fan motor, P_e, is known, the fan efficiency is calculated by:

$$\eta = \frac{P_m}{P_e} = \frac{Q_m \Delta p}{P_e} \qquad (7)$$

Actual fan electric power was not measured, because connecting wires were not easily accessible. Results given on Table 5 are based on equations 6 and 7, in which nominal power indicated on the motor labels was introduced. Since the actual electric power is generally smaller than the nominal power, these results are pessimistic.

Table 5: Assessment of the efficiencies of fans.

	Inlet fan	Exhaust fan	
Nominal power	45	15	kW @ 380 V Δ
Pressure drop	830 ± 30	100 ± 10	Pa
Airflow rate	93000 ± 13000	36800 ± 4100	m³/h
Mechanical power	26 ± 4	1,3 ± 0,2	kW
"Nominal" efficiency	58% ± 8%	8% ± 1%	

The pressure drop at the exhaust fan is rather small. For this reason, the mechanical power delivered by the fan is also small and the "nominal" efficiency is then ridiculous. It is however very likely that the electric consumption of the motor be smaller than the nominal power.

More measurements should be performed to clarify this point.

Exhaust air monitoring

Much information can be gathered from exhaust air monitoring, since this air is representative of a building average.

This air was simply monitored by introducing a Q-trak® logging air analyser in the exhaust duct, just upwind the exhaust fan. This instrument records air temperature and relative humidity, as well as carbon monoxide and dioxide concentrations. It was first put in the air inlet for 15 minutes, in order to get the characteristics of the outdoor air. The average and standard deviations of these are given in Table 6.

Table 6: Some characteristics of the outdoor air, monitored between 9:45 and 10:00.

	Carbon Dioxide ppm	Temperature °C	Relative humidity [%]	Vapour pressure [Pa]
Average in inlet air	376	6,0	33,5	313
Standard deviation	4	0,5	1,4	3

Figure 27 shows the recorded data. Vapour pressure is deduced from relative humidity and temperature. Carbon monoxide is not shown, because the concentration was very low, close to the detection limit (1 ppm).

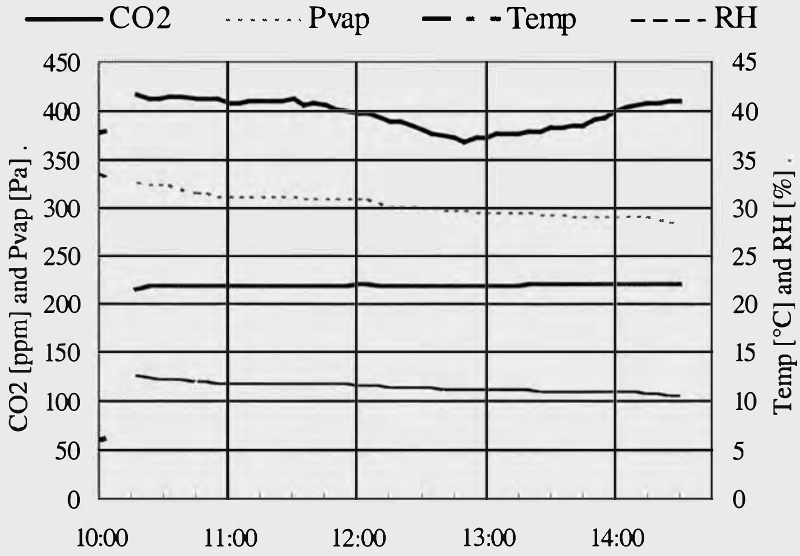


Figure 27: Recordings of exhaust air characteristics.

Table 7 summarises the recorded data. It can be first noticed that concentrations of carbon dioxide and water vapour pressure indoors are very close to the corresponding values outdoors: the building is over-ventilated with respect to these contaminants.

Table 7: Summary of characteristics of exhaust air from recordings at 5-minute interval between 10:15 and 14:30

	Carbon Dioxide ppm	Temperature °C	Relative Humidity %	Vapour pressure [Pa]	CO_2 source [Persons Eq.]
Average	397	21,9	11,5	304	57
Standard deviation	15	0,1	0,5	11	38
Minimum:	361	21,9	10,7	11	0
Time of Minimum:	12:50	12:48	14:18	14:18	14:18
Maximum:	421	22,1	12,1	12	108
Time of Maximum:	14:28	14:17	10:40	10:40	10:40

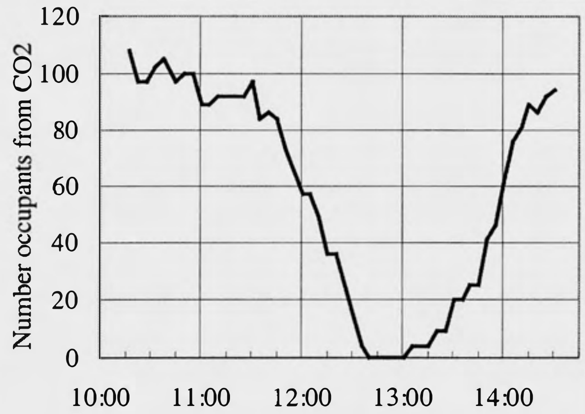


Figure 28: Occupancy in buildings as deduced from CO_2 concentration and airflow rate.

The internal temperature is very stable. Indoor air is exceptionally dry, resulting form very dry weather and slight overheating. The installed humidifying system is disconnected since several years for energy saving.

Assuming that the occupants are the only source of carbon dioxide, at a rate of 18 l/(person·h), a theoretical occupancy can be calculated form CO_2 concentration and outdoor airflow rate. This occupancy is shown on Figure 28. Lunch break is clearly visible, with a slight delay resulting from CO_2 concentration decay. The number of 100 occupants is close to the number of occupants known from the building management

Another way to interpret CO_2 concentration is to divide the CO_2 generation rate of one person (18 l/h) by the concentration, thus obtaining the airflow rate per person. At the time of maximum concentration, this airflow rate is 39 m³/(h·person).

Questionnaire

Method

A questionnaire similar to the one prepared by Gary Raw for the European Indoor Air Quality Audit *[Bluyssen et al, 1995]*. It provides the occupant's judgement on his environment, and an indication on the health or sickness in the building. This questionnaire is provided in Annex 2 in three languages, since both French and German were used for that building.

A contact person distributed the questionnaire to all the employees of the building owner. The filled questionnaire were returned within fifteen days. They are interpreted so as to obtain the information listed in annex 2. More information on the interpretation method is provided below.

For all questions, the number N of replies are counted, this mean that empty replies are not.

In many cases, the reply is a number, say x. For these questions, the mean μ and the standard deviation s are estimated by

$$\mu = \frac{\sum_{i=1}^{N} x_i}{N} \qquad \text{and} \qquad s = \sqrt{\frac{\sum_{i=1}^{N} (x_i - \mu)^2}{N-1}} \qquad 8$$

In a few cases, it is interesting to know the histogram of the replies, that is the number of replies for each value of the number, e.g. the number of people having voted –3, -2, -1. 0, 1, 2, or 3 for thermal comfort.

Finally, the BSI's (Building Symptom Index) should be calculated. The procedure is as follows [Clausen et al, 1993]:

Calculate the personal symptom index for each person:

> For each symptom, determine if the symptom is present and building related. For this, the three figures provided for each symptom are coded:

D_a determines whether the symptom is currently present. D_a = 1 if "yes" or 2 if "no"

D_b determines whether the symptom gets worse in the building: D_b = 1 if "better", 2 if "no change", or 3 if "worse"

D_c gives the severity of the symptom, and a limit should be defined. It is proposed to take all symptoms having a severity of 1 or more.

Then, a variable *D* is defined, which takes the values 1 (symptom present and building related) or 0 (symptom absent or not building related. If there are no replies to the questions, D will have the value "missing". The following conditional statements define *D*:

LET D = missing

IF(((Da<>2) AND (Db=3)) OR ((Da=1) AND (Db=2)) OR ((DA<>2) AND (Db=2) AND (Dc >=1)) THEN D = 1

IF (Da=2) OR Db=1) THEN D =0

Define the PSI or personal symptom index by the sum of building related symptoms (sum of D-values) over all 11 symptoms:

PSI1 = SUM(D1:D7), but PSI1 missing if D1 to D7 are all missing

PSI2 = SUM(D8:D11) but PSI2 missing if D8 to D11 are all missing

PSI = PSI1 + PSI2, but PSI missing of PSI1 or PSI2 is missing.

The building symptom index is the mean PSI score over the building, that is the sum of all PSI's divided by the number of PSI's (missing PSI's are not taken into account)

The results of questionnaires distributed into 56 buildings within the IAQ audit project have shown that the PSI score is strongly affected by gender and, in a much smaller proportion, by job type. Males managers tend to have the least symptoms, while female clerical tend to have a larger PSI. Therefore, to compare several buildings, correction factors can be applied to PSI's before adding them to calculate the BSI.

Correction factors depend on the reference used. Since male managers present the smallest PSI, one is tempted to use this as a reference. Unfortunately, there are very few questionnaires, if any, filled by male managers, and the reference would have a poor statistical basis. Therefore, it is proposed to use the female clerical, who often represent the largest population in office buildings as a reference.

Questionnaires were distributed in June 1998 and returned back on July 21, 1998.

Results from questionnaires

	Winter 1994				Summer 1998			
General	Nr	Mean	Stdev	%	Nr	Mean	Stdev	%
Questionnaires distributed	100				150			
Questionnaires returned	77			77%	142			95%
Age	77	44.2	9.8		138	47.8	10.2	
Number of female occupants	61			79%	111			79%
Number of male occupants	16			21%	29			21%
Managerial work	15			19%	15			12%
Specialist skill	44			57%	69			53%
Clerical	17			22%	30			23%
Other	1			1%	16			12%
Hours per day at the desk	74	6.9	1.5		141	7.1	4.2	
Paid hours per week	76	41.9	6.1		142	40.4	8.0	
Hours at VDU per week	75	13.8	10.6		139	17.9	11.1	
Days per month in the building	72	16.6	4.6		136	18.0	5.7	
Number of people in the room	76	8.2	7.0		136	5.3	4.8	
Rooms with windows	74			95%	136			97%
Rooms without windows	4			5%	4			3%
Distance from the window	75	1.2	0.5		134	1.4	1.1	
People opening the window	5			7%	17			12%
People not opening the window	70			93%	121			88%

Between winter 1994 and summer 1998, the following changes occurred:

- The mean age increased by 3,6 years, that is slightly less than elapsed time.
- The percentage of managers and specialists decreased, while the "others" incresased
- Occupants are more often at their desk and in front of a screen
- The density of occupants was reduced
- Occupants open the windows a little more.

Frequency of building related symptoms

Only symptoms that disappear out of building are taken into account in this table. For each symptom, the frequency is the ratio of the number of person presenting the symptom to the total number of answers.

The most frequent symptoms are listed first. Dry throat, stuffy nose, dry skin and dry eyes are the most frequent. Average air humidity on the audit day in winter was 34%. This may explain the symptoms related to dryness. 22 displays out of 23 have glare, and this may explain dry eyes. All dryness related syxmptoms are slightly less frequent in summer.

Lethargy increased, maybe because increased temperature in summer.

Health now	Symptom present 1994	Symptom present 1998	% worse in bldg. 1994	% worse in bldg. 1998
Dry throat	47%	31%	59%	44%
Stuffy nose	42%	41%	44%	46%
Dry skin	35%	21%	32%	29%
Dry eyes	24%	21%	50%	42%
Lethargy	19%	24%	55%	48%
Flu-like symptoms	18%	16%	33%	30%
Chest tightness	12%	8%	29%	23%
Headaches	12%	11%	38%	48%
Runny nose	9%	10%	11%	32%
Rash or irritated skin	6%	4%	20%	22%
Other symptoms	5%	4%	75%	75%
Watering eyes	3%	4%	0%	29%

Environmental conditions

Level of thermal comfort are on a -3 to+3 scale, Indoor air acceptability is on a -5 to+5 scale, while other votes are on a 1 to 7 scale.

	Winter '94		Summer '98		
Environmental conditions now	Mean	Stdev	Mean	Stdev	Conclusions
Thermal comfort (-3 to +3)	-0.42	0.71	-0.06	0.99	Comfortable
Indoor air quality (-5 to +5)	2.13	2.22	2.21	2.55	Unacceptable
1 to 7 scale, best 4					
Air movement	4.29	1.23	4.09	1.29	Nice
Air humidity	2.71	1.09	3.03	1.06	A bit dry
Light distribution	4.13	0.91	3.95	0.67	Excellent
1 to 7 scale, best 1, worse 7	Mean	Stdev	Mean	Stdev	
Comfort temperature	2.39	1.46	2.51	1.56	Comfortable
Air stuffiness	2.78	1.75	3.45	1.72	Acceptable
Air odor	1.95	1.24	2.38	1.52	Faint smell
Light flickering	1.48	1.03	2.15	4.87	Very stable
Glare	1.78	1.32	1.72	1.16	No glare
Lighting satisfactory	1.95	1.46	1.80	1.32	Excellent
Noise from ventilation	2.42	1.54	3.11	1.84	No noise
Other noise	3.57	1.92	3.09	1.62	No noise
Noise satisfactory	3.10	1.87	2.70	1.65	Good

Temperature was a bit cold in winter 94, and is close to perfection in summer. Most indicators present similar values in both periods.

Health and direct environment

	1'994	1'998
Percent having smoking neighbours	21%	21%
Percent smokers	16%	27%
If yes: Do you smoke in this room?	22%	16%
If no: did you ever smoke?	16%	32%
I had asthmatic problems	10%	11%
I have suffered from eczema	24%	19%
I have suffered with hay fever	19%	25%

Percentage of smokers increased slightly, but is still below the Swiss average. Hay fever also increased.

Estimation of occupant's influence on indoor conditions
Given are the average vote on a 1 (no influence, unsatisfactory) to 7 (total influence, satisfactory) scale, and standard deviation of the votes within the population.

	1'994		1'998		
	Mean	Stdev	Mean	Stdev	**Conclusions**
Control on temperature (1 to 7)	2.55	1.72	2.06	1.57	Weak influence
Control on ventilation	1.12	0.58	1.22	0.65	No influence
Control on lighting	4.91	1.98	4.38	6.40	Acceptable influence
Cleanliness of room	6.42	1.18	5.67	1.63	Very clean

No significant change.

Building symptom indices

	1'994		1'998	
	Mean	Stdev	Mean	Stdev
BSI all occupants	2.00	1.93	1.78	2.16
BSI sf Male	1.75	1.68	1.54	1.86
BSI sf Female	2.94	2.57	2.71	3.00

Building symptom index is the average number of symptoms presented per person, out of the list of 12 symptoms given above, but only symptoms that disappear out of building are taken into account.

The situation is slightly better in summer 98 than in winter 94.

CONCLUSIONS

Monitoring of internal temperatures has shown that indoor air temperatures are within the comfort except during very few hours. Temperatures on top and bottom of building are the same. Northern part of the building is nevertheless one degree colder than the other parts.

The main part of energy consumption is for heating. Half of electrical energy use is for air handling units. Energy signatures have shown that heating and cooling both occur in May and

September, and that the district heating terminal is oversized. Cooling energy is correlated to outdoor temperature, but not to solar radiation. Another regression applied to heat use gave an equivalent solar collecting area in good agreement with that provided by calculations according to prEN 832.

Energy index of the tower is not very high when compared to similar buildings, but this seems to be the result of a good management, not of a good building. In fact, the building is poorly insulated, HVAC systems are oversized and not always efficient.

Measurements performed on the main air-handling unit of the tower at Bern City West have given the following results:

- Pulsed airflow rate and recirculation rates are close to the planned values.
- Exhaust airflow rate is only 40% of pulsed airflow rate, putting the building under pressure. However, since the building is rather leaky, the pressure is not that high, but the exfiltration rate is large.
- The measured window, sealed, was reasonably airtight. The total building leakage (about 60'000 m^3/h) cannot be explained by this leakage path only.
- Air is fully mixed indoors. The age of air in the building is about 12 minutes.
- The pulsing fan has an overall efficiency larger than 58%, while that of the exhaust fan is very low. This results from the large difference between inlet and exhaust airflow rates and lack of balance between pressure drops at both fans.
- Carbon dioxide concentration is very low, showing that the airflow rate per person is large. Internal temperature is very stable, at 22°C. On the day of measurement, indoor air was exceptionally dry because of exceptionally dry weather before and during this day.

The results from the questionnaires were similar in winter 94 and summer 98. The indoor environment quality is fairly good. The dryness related symptoms may result from dry or dusty air.

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ANNEX 1: INFORMATION ON MONITORED DATA FILES

Monitored data are provided for the OFFICE monitoring year, that is from June 1st, 1997 to May 31, 1998. Monitoring actually began by the end of April 1997 and ended at the beginning of June 1998.

Monitored data are stored in comma-separated-variable (csv) format files. Such files can easily be read either as text files, or by spreadsheet software such as Excel. In addition, they are much smaller than Excel files. In this format, each line corresponds to a given time. In each line, the variables are written one after the other, separated by a semicolon.

The first line contains the variable names, listed below with explanations.

CityWest_hourly file

This file contains hourly averages of climatic data and internal temperatures. There are three heading lines, containing the variable names, its unit, and comments

Variable	Unit	Comment
Date and time		Date and time in format j.mm.yy hh:mm
TE	°C	External air temperature
IR radiation	W/m²	Infrared radiative exchange of an horizontal surface with the environment
HE	%	Relative humidity of outdoor air
SG. Hor.	W/m²	Global solar radiation on horizontal surface
SD. Hor.	W/m²	Diffuse solar radiation on horizontal plane
SGV. E	W/m²	Global solar radiation on East vertical surface
SGV. S	W/m²	Global solar radiation on South vertical surface
SGV. W	W/m²	Global solar radiation on West vertical surface
SGV. N	W/m²	Global solar radiation on North vertical surface
Wv	m/s	Wind velocity
Wd (N=0)	degree	Wind direction, North = 0, East = 90°
TA(exh.)	°C	Exhaust air temperature. Note that when fans are off, this temperature may drift toowards that of outdoor air.
TA10E	°C	Indoor air temperature, 10th floor, East
TA10S	°C	Indoor air temperature, 10th floor, South
TA10W	°C	Indoor air temperature, 10th floor, West
TA10N	°C	Indoor air temperature, 10th floor, North
TA2E	°C	Indoor air temperature, 2nd floor, East
TA2S	°C	Indoor air temperature, 2nd floor, South
TA2W	°C	Indoor air temperature, 2nd floor, West
TA2N	°C	Indoor air temperature, 2nd floor, North
TA10SW	°C	Indoor air temperature, 10th floor, South-West

CityWest_daily file

This file contains daily averages of climatic data and district heat use for each day

Heading	Comment
Holiday	H if the day is holiday, blank otherwise.
Date	Date of the day, in dd.mm.yy format
Ext. Temp	Outdoor temperature from meteorological service
Solar [kWh/m²]	Global solar radiation received on horizontal plane within the day
Wind [m/s]	Average wind velocity
RH [%]	Average relative humidity in outdoor air
Int. Temp.	Average internal temperature in the building (office tower only)
Heat [kWh]	District heat used within the day.

CityWest_monthly file

This file contains monthly averages of climatic data, district heat and electricity use for each month

Heading	Comment
Month	Name of the month
Ext. Temp [°C]	Outdoor temperature from meteorological service
Sun [kWh/m²]	Global solar radiation received on horizontal plane within the month
Wind [m/s]	Average wind velocity
RH [%]	Average relative humidity in outdoor air
Heat [kWh]	District heat used within the month.
E Lifts	Electricity use for elevators
E Cooling	Electricity use for cooling plant
E Ventilation	Electricity use for several air handling units
E Others	Electricity use for anything that is not the three above.
Total Elect.	Total electricity use of building
Total energy	Sum of heat and total electricity.

All energy uses are in kWh for each month.

ANNEX 2: INDOOR ENVIRONMENT QUALITY QUESTIONNAIRE

Information provided by interpreting IEQ questionnaires.

For each item, results for the whole building are provided in one or more of the following forms:

- Count: number of replies to this question
- Mean mean value, averaged over the number of replies
- Stdev estimate of the standard deviation of the distribution of the replies
- Histo when appropriate, histogram of the replies. E.g. for sex: number of males and number of females. For work type: number of persons for each work type.

Note that some statistics, especially histograms, can be available only if a large number of questionnaire is returned.

	Joule -Thermie OFFICE - Questionnaire	Count	Mean	Stdev	Histo
	Age	✓	✓	✓	
	Sex (male= 1, female = 2)				✓
	Level				✓
	Orientation N, E, S or West?				✓
A1	Time at desk before filling questionnaire	✓	✓	✓	
A2	Work type: Manager 1; Specialist 2; Clerical 3; other 4				✓
	Secondary work type				✓
A3	Time spent in the building years	✓	✓	✓	
A4	Time spent in the room years	✓	✓	✓	
A5	Hours per day at the desk	✓	✓	✓	
A6	Paid hours per week	✓	✓	✓	
A7	Hours at VDU per week	✓	✓	✓	
A8	Days per month in the building	✓	✓	✓	
A9	Number of people in the room	✓	✓	✓	
A10	Window in the room (yes=1 no = 2)	✓			✓
A11	Distance from the window	✓	✓	✓	
A12	Do you open the window (yes=1 no = 2)	✓			✓
	Health now				
D1	Dry eyes: Yes = 1, no = 2	✓			✓
	Better = 1, no change = 2 worse = 3	✓			✓
	Severity scale (1 to 7)	✓	✓	✓	✓
D2	Watering eyes: Yes = 1, no = 2	✓			✓
	Better = 1, no change = 2 worse = 3	✓			✓
	Severity scale (1 to 7)	✓	✓	✓	✓
D3	Stuffy nose: Yes = 1, no = 2	✓			✓
	Better = 1, no change = 2 worse = 3	✓			✓
	Severity scale (1 to 7)	✓	✓	✓	✓
D4	Runny nose: Yes = 1, no = 2	✓			✓
	Better = 1, no change = 2 worse = 3	✓			✓
	Severity scale (1 to 7)	✓	✓	✓	✓
D5	Dry throat: Yes = 1, no = 2	✓			✓
	Better = 1, no change = 2 worse = 3	✓			✓
	Severity scale (1 to 7)	✓	✓	✓	✓
D6	Chest tightness: Yes = 1, no = 2	✓			✓
	Better = 1, no change = 2 worse = 3	✓			✓
	Severity scale (1 to 7)	✓	✓	✓	✓
D7	Flu-like symptoms: Yes = 1, no = 2	✓			✓
	Better = 1, no change = 2 worse = 3	✓			✓
	Severity scale (1 to 7)	✓	✓	✓	✓
D8	Dry skin : Yes = 1, no = 2	✓			✓
	Better = 1, no change = 2 worse = 3	✓			✓
	Severity scale (1 to 7)	✓	✓	✓	✓

	Joule -Thermie OFFICE - Questionnaire	Count	Mean	Stdev	Histo
D9	Rash or irritated skin : Yes = 1, no = 2	✓			✓
	Better = 1, no change = 2 worse = 3	✓			✓
	Severity scale (1 to 7)	✓	✓	✓	✓
D10	Headaches: Yes = 1, no = 2	✓			✓
	Better = 1, no change = 2 worse = 3	✓			✓
	Severity scale (1 to 7)	✓	✓	✓	✓
D11	Lethargy: Yes = 1, no = 2	✓			✓
	Better = 1, no change = 2 worse = 3	✓			✓
	Severity scale (1 to 7)	✓	✓	✓	✓
D12	Other symptoms: Yes = 1, no = 2	✓			✓
	Better = 1, no change = 2 worse = 3	✓			✓
	Severity scale (1 to 7)	✓	✓	✓	✓
	Type of symptoms (list)	✓			
E1	Level of thermal comfort (-3 to +3)	✓	✓	✓	✓
E2	Indoor air acceptability (-5 to +5)	✓	✓	✓	✓
E3a	Comfort temperature (1 to 7)	✓	✓	✓	
b	Air movement	✓	✓	✓	
c	Air humidity	✓	✓	✓	
d	Air Stuffyness	✓	✓	✓	
e	Air odour	✓	✓	✓	
f	Light brightness	✓	✓	✓	
g	Light flickering	✓	✓	✓	
h	Glare	✓	✓	✓	
i	Light uneven	✓	✓	✓	
j	Lighting satisfatory	✓	✓	✓	
k	Noise from ventilation	✓	✓	✓	
l	Other noise	✓	✓	✓	
m	Noise satisfactory	✓	✓	✓	
F1	Control on temperature (1 to 7)	✓	✓	✓	
F2	Control on ventilation	✓	✓	✓	
F3	Control on lighting	✓	✓	✓	
F4	Cleanliness	✓	✓	✓	
F5	Smoking neigbours	✓			✓
F6	Other aspect (Yes = 1; No = 2)	✓			✓
	Other aspect: list of comments	✓			
G1	Asthma	✓			✓
G2	Eczema	✓			✓
G3	Hay fever	✓			✓
G4	Do you smoke? (Yes = 1; No = 2)	✓			✓
	If yes: Do you smoke in this room?	✓			✓
	If no: did you ever smoke?	✓			✓
	Building related symptom				
D1	Dry eyes	✓	✓	✓	
D2	Watering eyes	✓	✓	✓	
D3	Stuffy nose	✓	✓	✓	
D4	Runny nose	✓	✓	✓	
D5	Dry throat	✓	✓	✓	
D6	Chest tightness	✓	✓	✓	
D7	Flu-like symptoms	✓	✓	✓	
D8	Dry skin	✓	✓	✓	
D9	Rash or irritated skin	✓	✓	✓	
D10	Headaches	✓	✓	✓	
D11	Lethargy	✓	✓	✓	
D12	Other	✓	✓	✓	

	Personal symptom indices	Count	Mean	Stdev	Histo
	PSI ss1	✓	✓	✓	
	PSI ss2	✓	✓	✓	
	BSI ss	✓	✓	✓	
	PSI sf1	✓	✓	✓	
	PSI sf2	✓	✓	✓	
	BSI sf	✓	✓	✓	
	BSI ss Male Managers	✓	✓	✓	
	BSI ss Male Specialists	✓	✓	✓	
	BSI ss Male Clerical	✓	✓	✓	
	BSI ss Male Others	✓	✓	✓	
	BSI ss Male	✓	✓	✓	
	BSI ss Female Managers	✓	✓	✓	
	BSI ss Female Specialists	✓	✓	✓	
	BSI ss Female Clerical	✓	✓	✓	
	BSI ss Female Others	✓	✓	✓	
	BSI ss Female	✓	✓	✓	
	BSI sf Male Managers	✓	✓	✓	
	BSI sf Male Specialists	✓	✓	✓	
	BSI sf Male Clerical	✓	✓	✓	
	BSI sf Male Others	✓	✓	✓	
	BSI sf Male	✓	✓	✓	
	BSI sf Female Managers	✓	✓	✓	
	BSI sf Female Specialists	✓	✓	✓	
	BSI sf Female Clerical	✓	✓	✓	
	BSI sf Female Others	✓	✓	✓	
	BSI sf Female	✓	✓	✓	

Deutsche Fassung

Fragebogen-Nummer [ ]   Uhrzeit [|] [|]
(in 24 Stundenangabe)

Alter [|]   Geschlecht: männlich [ ]   weiblich [ ]

Arbeitsplatz im Gebäude: Stockwerk [ ]   Raumnummer [ ]

Haupt-Fenster-Richtung

Nord	Ost	Süd	West

1 Wie lange sind Sie heute ungefähr an ihrem Schreibtisch gesessen, bevor Sie mit dem Ausfüllen des Fragebogens begonnen haben? (ohne kurze Pausen). [|] Stunden

2 Mit welcher Art von Arbeit beschäftigen Sie sich vor allem? (Bitte nur einmal ankreuzen)

Mit Arbeitsorganisation oder mit Finanzen [ ]

Mit der Anwendung von Fachwissen (z. Bsp. Jurist, Arzt, Ingenieur) [ ]

Mit der Ausführung von administrativen Arbeiten (Büro, Sekretariat) [ ]

Mit anderen Arbeiten, wie .... [ ]

	Jahre	Monate*
3 Seit wie langer Zeit arbeiten Sie schon in diesem Gebäude?	[|]	[|]
4 Seit wie langer Zeit arbeiten	[|]	[|]

* Monatsangabe ist überflüssig, falls länger als 2 Jahre

Die folgenden Fragen beziehen sich auf den **vergangenen Monat**. Durchnittliche Angaben genügen:

5 Wieviel Zeit verbrachten Sie an Ihrem Schreibtisch pro Arbeitstag? [|] Stunden

6 Wieviele bezahlte Arbeitsstunden leisten Sie pro Woche? [|] Stunden
(Einschliesslich Arbeitszeit ausserhalb dieses Gebäudes)

7 Wieviele Stunden pro Woche haben Sie an einem Bildschirm gearbeitet? [|] Stunden

8 Wieviele Tage, während der letzten 30 Tage, haben Sie in diesem Gebäude gearbeitet? [|] Tage

9 Wieviele andere Personen arbeiten normalerweise im gleichen Raum wie Sie? [|] Personen

10 Gibt est in Ihrem Raum ein Fenster? [Ja] [Nein] Wenn nein, fahren Sie mit der nächsten Seite fort.

11 Wie weit ist Ihr Schreibtisch ungefähr vom nächsten Fenster entfernt? [|] Meter

12 Öffnen Sie in Ihrem Raum je ein Fenster? [Ja] [Nein]

1 Verspüren Sie im Moment **gereizte oder brennende Augen**? [Ja] [Nein]
Falls ja: hat sich das Symptom verbessert oder verschlimmert seit Sie heute in dieses Gebäude gekommen sind?

Verbessert [1] Unverändert [2] Verschlimmert [3]

Wie stark ist dieses Symptom im Moment? Sehr schwach [1] [2] [3] [4] [5] [6] [7] Sehr stark

2 Haben Sie im Moment **tränende Augen**? [Ja] [Nein]
Falls ja: hat sich dieses Symptom verbessert oder verschlimmert seit Sie heute in dieses Gebäude gekommen sind?

Verbessert [1] Unverändert [2] Verschlimmert [3]

Wie stark ist dieses Symptom im Moment? Sehr schwach [1] [2] [3] [4] [5] [6] [7] Sehr stark

3 Verspüren Sie im Moment eine **leicht verstopfte** oder **blockierte Nase**? [Ja] [Nein]
Falls ja: hat sich dieses Symptom verbessert oder verschlimmert seit Sie heute in dieses Gebäude gekommen sind?

Verbessert [1] Unverändert [2] Verschlimmert [3]

Wie stark ist dieses Symptom im Moment? Sehr schwach [1] [2] [3] [4] [5] [6] [7] Sehr stark

4 Haben Sie im Moment eine **laufende Nase**? [Ja] [Nein]
Falls ja: hat sich dieses Symptom verbessert oder verschlimmert seit Sie heute in dieses Gebäude gekommen sind?

Verbessert [1] Unverändert [2] Verschlimmert [3]

Wie stark ist dieses Symptom im Moment? Sehr schwach [1] [2] [3] [4] [5] [6] [7] Sehr stark

5 Haben Sie im Moment einen **trockenen oder gereizten Hals**? [Ja] [Nein]
Falls ja: hat sich dieses Symptom verbessert oder verschlimmert seit Sie heute in dieses Gebäude gekommen sind?

Verbessert [1] Unverändert [2] Verschlimmert [3]

Wie stark ist dieses Symptom im Moment? Sehr schwach [1] [2] [3] [4] [5] [6] [7] Sehr stark

6 Verspüren Sie im Moment **beengende Gefühle in der Brustgegend** oder **Atmungsbeschwerden**? [Ja] [Nein]
Falls ja: hat sich dieses Symptom verbessert oder verschlimmert seit Sie heute in dieses Gebäude gekommen sind?

Verbessert [1] Unverändert [2] Verschlimmert [3]

Wie stark ist dieses Symptom im Moment? Sehr schwach [1] [2] [3] [4] [5] [6] [7] Sehr stark

7 Haben Sie im Moment **erkältungsähnliche Symptome**? Ja / Nein
Falls ja: hat sich dieses Symptom verbessert oder verschlimmert seit Sie heute in dieses Gebäude gekommen sind?
Verbessert 1 / Unverändert 2 / Verschlimmert 3
Wie stark ist dieses Symptom im Moment? Sehr schwach 1 2 3 4 5 6 7 Sehr stark

8 Haben Sie im Moment eine **trockene Haut**? Ja / Nein
Falls ja: hat sich dieses Symptom verbessert oder verschlimmert seit Sie heute in dieses Gebäude gekommen sind?
Verbessert 1 / Unverändert 2 / Verschlimmert 3
Wie stark ist dieses Symptom im Moment? Sehr schwach 1 2 3 4 5 6 7 Sehr stark

9 Haben Sie im Moment einen **Hautausschlag** oder eine **gereizte Haut**? Ja / Nein
Falls ja: hat sich dieses Symptom verbessert oder verschlimmert seit Sie heute in dieses Gebäude gekommen sind?
Verbessert 1 / Unverändert 2 / Verschlimmert 3
Wie stark ist dieses Symptom im Moment? Sehr schwach 1 2 3 4 5 6 7 Sehr stark

10 Verspüren Sie im Moment **Kopfschmerzen**? Ja / Nein
Falls ja: hat sich dieses Symptom verbessert oder verschlimmert seit Sie heute in dieses Gebäude gekommen sind?
Verbessert 1 / Unverändert 2 / Verschlimmert 3
Wie stark ist dieses Symptom im Moment? Sehr schwach 1 2 3 4 5 6 7 Sehr stark

11 Verspüren Sie im Moment **Müdigkeit oder Schlaffheit**? Ja / Nein
Falls ja: hat sich dieses Symptom verbessert oder verschlimmert seit Sie heute in dieses Gebäude gekommen sind?
Verbessert 1 / Unverändert 2 / Verschlimmert 3
Wie stark ist dieses Symptom im Moment? Sehr schwach 1 2 3 4 5 6 7 Sehr stark

12 Verspüren Sie im Moment irgendwelche **andere Symptome**? Ja / Nein

Beschreibung: ....

Falls ja: hat sich dieses Symptom verbessert oder verschlimmert seit Sie heute in dieses Gebäude gekommen sind?
Verbessert 1 / Unverändert 2 / Verschlimmert 3
Wie stark ist dieses Symptom im Moment? Sehr schwach 1 2 3 4 5 6 7 Sehr stark

1 Wie empfinden Sie die Temperatur in Ihrem Büro zum jetzigen Zeitpunkt?

sehr kalt	etwas kalt	kühl	angenehm	warm	etwas heiss	sehr heiss
1	2	3	4	5	6	7

2 Wie würden Sie die Innenraumluftqualität in Ihrem Büro zum jetzigen Zeitpunkt beurteilen?
Bitte kreuzen Sie ein Feld an

5	klar akzeptabel
☐	
☐	
☐	
1	gerade noch akzeptabel
-1	gerade nicht mehr akzeptabel
☐	
☐	
☐	
-5	klar nicht akzeptabel

3 Wie würden sie die Innenraumbedingungen in Ihrem Büro zum jetzigen Zeitpunkt bezeichnen?
Bitte ein Feld pro Skala ankreuzen.
Die fett umrahmten Felder markieren den Idealzustand.

Temperatur	angenehm	**1**	2	3	4	5	6	7	unangenehm
Luftbewegung	zu ruhig	1	2	3	**4**	5	6	7	zu starker Luftzug
Luftqualität	troc	1	2	3	**4**	5	6	7	feucht
	frisch	**1**	2	3	4	5	6	7	abgestanden
	geruchlos	**1**	2	3	4	5	6	7	übelriechend
Licht	zu dunkel	1	2	3	**4**	5	6	7	zu hell
	konstant	**1**	2	3	4	5	6	7	flimmernd
	nicht grell	**1**	2	3	4	5	6	7	viel zu grell
	zu einheitlich	1	2	3	**4**	5	6	7	zu unterschiedlich
	allg. befriedigend	**1**	2	3	4	5	6	7	allg. unbefriedigend
Lärm	keine Ventilationsgeräusche	**1**	2	3	4	5	6	7	zuviele Ventilationsgeräusche
	kein anderer Lärm	**1**	2	3	4	5	6	7	zuviel anderer Lärm
	allg. befriedigend	**1**	2	3	4	5	6	7	allg. unbefriedigend

Können Sie in Ihrem Büro Einfluss nehmen auf folgende Faktoren?
Bitte kreuzen Sie jeweils ein Feld an

1 Temperatur	überhaupt keinen	1	2	3	4	5	6	7	beliebigen Einfluss
2 Luftbewegung	überhaupt keinen	1	2	3	4	5	6	7	beliebigen Einfluss
3 Beleuchtung	überhaupt keinen	1	2	3	4	5	6	7	beliebigen Einfluss

4 Wie würden Sie die Sauberkeit in Ihrem Büro bewerten?

unbefriedigend [1] [2] [3] [4] [5] [6] [7] befriedigend

5 Rauchen andere Leute in Ihrer unmittelbaren Umgebung während der Arbeit? [Ja] [Nein]

6 Gibt es andere Raum- oder Klimabedingungen Ihres Büros, über die Sie sich äussern möchten? [Ja] [Nein]

Falls ja, beschreiben Sie sie bitte:

....

....

....

....

....

G Fragen zu Ihrer Person

1 Hatten Sie schon einmal Asthma? [Ja] [Nein]

2 Hatten Sie schon einmal Ekzeme? [Ja] [Nein]

3 Hatten Sie schon einmal Heuschnupfen? [Ja] [Nein]

4 Rauchen Sie? [ja] ➨ Rauchen Sie in diesem Zimmer? [Ja] [Nein]

[nein] ➨ Haben Sie früher regelmässig geraucht? [Ja] [Nein]

Name

....

Es steht Ihnen frei, keinen Namen anzugeben. Ihr Name würde uns jedoch ermöglichen, festzustellen, ob alle Fragebogenzurückgekommen sind. Wir könnten ausserdem auf auffällige Kommentare Ihrerseits näher eingeben. Auf jeden Fall werden Ihre Inforamtionen vertraulich behandelt und an keine Drittperson weitergegeben.

SIE SIND AM ENDE DES FRAGEBOGENS ANGELANGT.
WIR DANKEN IHNEN FÜR IHRE BEMÜHUNGEN.

Version française

Questionnaire No ☐ Heure ☐☐ ☐☐
(Horloge 24 Heures)

Age ☐☐ Homme ☐ Femme ☐

Position de votre place de travail: Etage ☐ No de pièce ☐

Orientation de la façade principale (fenêtre) | Nord | Est | Sud | Ouest |

1 Depuis combien de temps, approximativement, étiez vous assis(e) à ce bureau avant de commencer à remplir ce questionnaire? ☐☐ heures
Ne tenez pas compte des interruptions de courte durée.

2 A quoi consacrez vous la majeure partie de votre travail? (cochez une case)
- Tâches de direction, d'organisation ☐
- Tâche de spécialiste (telle que ingénieur, médecin, juriste, informaticien) ☐
- Tâches de secrétariat et d'administration ☐
- Autre tâche ☐ (précisez)

	Années	Mois*	
3 Depuis combien de temps travaillez vous dans ce bâtiment?	☐☐	☐☐	*Ne notez pas les mois si plus de 2 ans
4 Depuis combien de temps travaillez vous dans cette pièce?	☐☐	☐☐	

En moyenne, sur la base des derniers 30 jours:

5 combien de temps passez vous à votre bureau, par jour ouvrable? ☐☐ heures

6 Combien d'heures par semaine effectuez vous un travail rémunéré? ☐☐ heures
(y compris le temps passé en dehors de ce bâtiment)

7 Combien d'heures par semaine passez vous devant un écran ? ☐☐ heures

8 Durant les derniers 30 jours, combien de jours avez vous passé dans ce bâtiment? ☐☐ jours

9 Pendant votre travail, combien d'autres personnes occupent votre bureau? ☐☐ personnes

10 Il y a-t-il une fenêtre dans votre bureau? Oui Non Si NON, passez à la page suivante

11 A quelle distance, approximativement, est la plus proche fenêtre? ☐☐ mètres

12 Ouvrez vous parfois une fenêtre de votre bureau? Oui Non

1 En cet instant précis, avez-vous **les yeux secs**? [Oui] [Non]
Si oui, ce symptôme a-t-il diminué ou empiré depuis que vous êtes dans ce bâtiment? Diminué [1] Inchangé [2] Empiré [3]
Cochez la case correspondant à la sévérité de ce symptôme: Très faible [1] [2] [3] [4] [5] [6] [7] Très sévère

2 En cet instant précis, avez-vous **les yeux larmoyants**? [Oui] [Non]
Si oui, ce symptôme a-t-il diminué ou empiré depuis que vous êtes dans ce bâtiment? Diminué [1] Inchangé [2] Empiré [3]
Cochez la case correspondant à la sévérité de ce symptôme: Très faible [1] [2] [3] [4] [5] [6] [7] Très sévère

3 En cet instant précis, avez-vous **le nez bouché**? [Oui] [Non]
Si oui, ce symptôme a-t-il diminué ou empiré depuis que vous êtes dans ce bâtiment? Diminué [1] Inchangé [2] Empiré [3]
Cochez la case correspondant à la sévérité de ce symptôme: Très faible [1] [2] [3] [4] [5] [6] [7] Très sévère

4 En cet instant précis, avez-vous l**e nez qui coule?** [Oui] [Non]
Si oui, ce symptôme a-t-il diminué ou empiré depuis que vous êtes dans ce bâtiment? Diminué [1] Inchangé [2] Empiré [3]
Cochez la case correspondant à la sévérité de ce symptôme: Très faible [1] [2] [3] [4] [5] [6] [7] Très sévère

5 En cet instant précis, avez-vous **la gorge sèche ou irritée**? [Oui] [Non]
Si oui, ce symptôme a-t-il diminué ou empiré depuis que vous êtes dans ce bâtiment? Diminué [1] Inchangé [2] Empiré [3]
Cochez la case correspondant à la sévérité de ce symptôme: Très faible [1] [2] [3] [4] [5] [6] [7] Très sévère

6 En cet instant précis, avez-vous **la poitrine oppressée ou des difficultés respiratoires**? [Oui] [Non]
Si oui, ce symptôme a-t-il diminué ou empiré depuis que vous êtes dans ce bâtiment? Diminué [1] Inchangé [2] Empiré [3]
Cochez la case correspondant à la sévérité de ce symptôme: Très faible [1] [2] [3] [4] [5] [6] [7] Très sévère

7 En cet instant précis, avez-vous **des symptômes grippaux**? [Oui] [Non]
Si oui, ce symptôme a-t-il diminué ou empiré depuis que vous êtes dans ce bâtiment? Diminué [1] Inchangé [2] Empiré [3]
Cochez la case correspondant à la sévérité de ce symptôme: Très faible [1] [2] [3] [4] [5] [6] [7] Très sévère

8 En cet instant précis, avez-vous **la peau sèche**? [Oui] [Non]
Si oui, ce symptôme a-t-il diminué ou empiré depuis que vous êtes dans ce bâtiment? Diminué [1] Inchangé [2] Empiré [3]
Cochez la case correspondant à la sévérité de ce symptôme: Très faible [1] [2] [3] [4] [5] [6] [7] Très sévère

9 En cet instant précis, avez-vous **la peau irritée ou des éruptions**? [Oui] [Non]
Si oui, ce symptôme a-t-il diminué ou empiré depuis que vous êtes dans ce bâtiment? Diminué [1] Inchangé [2] Empiré [3]
Cochez la case correspondant à la sévérité de ce symptôme: Très faible [1] [2] [3] [4] [5] [6] [7] Très sévère

10 En cet instant précis, avez-vous **mal à la tête**? [Oui] [Non]
Si oui, ce symptôme a-t-il diminué ou empiré depuis que vous êtes dans ce bâtiment? Diminué [1] Inchangé [2] Empiré [3]
Cochez la case correspondant à la sévérité de ce symptôme: Très faible [1] [2] [3] [4] [5] [6] [7] Très sévère

11 En cet instant précis, êtes vous **fatigué ou apathique**? [Oui] [Non]
Si oui, ce symptôme a-t-il diminué ou empiré depuis que vous êtes dans ce bâtiment? Diminué [1] Inchangé [2] Empiré [3]
Cochez la case correspondant à la sévérité de ce symptôme: Très faible [1] [2] [3] [4] [5] [6] [7] Très sévère

12 En cet instant précis, ressentez vous un **symptôme non mentionné** ci-dessus? [Oui] [Non]

Si oui, décrivez le: ....

....

Si oui, ce symptôme a-t-il diminué ou empiré depuis que vous êtes dans ce bâtiment? Diminué [1] Inchangé [2] Empiré [3]
Cochez la case correspondant à la sévérité de ce symptôme: Très faible [1] [2] [3] [4] [5] [6] [7] Très sévère

1 Comment qualifiez-vous le confort thermique dans votre bureau en ce moment?

Froid	Frais	A peine frais	Neutre	A peine chaud	Chaud	Trop chaud
1	2	3	4	5	6	7

2 Comment jugez vous la qualité de l'air dans votre bureau en ce moment?
Veuillez cochez une case

- 5 Tout à fait acceptable
- ☐
- ☐
- ☐
- 1 Juste acceptable
- -1 Juste inacceptable
- ☐
- ☐
- ☐
- -5 Tout à fait inacceptable

3 Comment qualifiez vous le climat intérieur et les conditions de travail régnant actuellement dans votre bureau?
Veuillez cocher une case par ligne.
Les cases encadrées représentent, sur chaque échelle, la valeur idéale.

Température	Confortable	1	2	3	4	5	6	7	Inconfortable
Mouvements d'air	Air stagnant	1	2	3	4	5	6	7	Courants d'air
Sécheresse, humidité de l'air	Sec	1	2	3	4	5	6	7	Humide
Qualité de l'air	Frais	1	2	3	4	5	6	7	Etouffant
Odeur dans l'air	Insignifiante	1	2	3	4	5	6	7	Horrible
Eclairage	Trop sombre	1	2	3	4	5	6	7	Trop clair
Eclairage	Stable	1	2	3	4	5	6	7	Clignotant
Eclairage	Sans éblouissement	1	2	3	4	5	6	7	Eblouissant
Eclairage	Trop uniforme	1	2	3	4	5	6	7	Trop irrégulier
Eclairage, en général	Satisfaisant	1	2	3	4	5	6	7	Insatisfaisant
Bruit de la ventilation	Aucun bruit	1	2	3	4	5	6	7	Trop de bruit
Autres bruits	Pas d'autres bruits	1	2	3	4	5	6	7	Trop de bruits
Bruit en général	Satisfaisant	1	2	3	4	5	6	7	Insatisfaisant

F Autres aspects de votre environnement de travail

Dans votre bureau, dans quelle mesure pouvez vous influencer les fonctions suivantes?

Cochez une case par ligne

1 Température	Aucune influence	1	2	3	4	5	6	7	Contrôle total
2 Ventilation, aération	Aucune influence	1	2	3	4	5	6	7	Contrôle total
3 Eclairage	Aucune influence	1	2	3	4	5	6	7	Contrôle total
4 Comment qualifiez-vous la propreté dans votre bureau?	Insatisfaisante	1	2	3	4	5	6	7	Satisfaisante

5 Il y a-t-il des fumeurs dans votre environnement in

Oui Non

6 Il y a-t-il d'autres aspects de votre environnement de travail que vous désireriez commenter? Oui Non

Si oui, faites le ci-dessous

....

....

....

....

....

....

G Quelques questions personnelles

1 Avez vous souffert d'asthme? Oui Non

2 Avez vous souffert d'eczéma? Oui Non

3 Avez vous souffert du rhume des foins? Oui Non

4 Etes vous fumeur, maintenant?

Oui ➨ Fumez-vous dans cette pièce? Oui Non

Non ➨ Fumiez vous régulièrement par le passé? Oui Non

Nom (facultatif)

....

....

Votre nom n'est pas indispensable, et vous êtes libre de le mettre ou non. Il nous aiderait à mieux tenir compte des remarques importantes.

VOICI LA FIN DU QUESTIONNAIRE. MERCI POUR VOTRE PEINE ET VOTRE TEMPS.

English version

Survey Number [ ] Time [ ][ ] [ ][ ] (24 Hour clock)

Age [ ][ ] Sex [ ] Male [ ] Female

Your work place: Floor [ ] Room no. [ ]

Orientation of the main facade (window) | North | East | South | West |

1 Approximately how long were you sitting at your desk before you started this questionnaire (excluding short breaks)? [ ][ ] Hours

2 What is the biggest part of the work you do? *(please tick a box)*

Managing people or resources [ ]

Using specialist skills (e.g. legal, medical, engineering, scientific) [ ]

Doing clerical, secretarial or administrative work [ ]

Other [ ] (Please specifiy)

	Years	Months*
3 How long have you been working in this building?	[ ][ ]	[ ][ ]
4 How long have you been working in this room?	[ ][ ]	[ ][ ]

*Months not needed if more than two years

On average, during the past month -

5 How long did you spend at your desk per working day?? [ ][ ] Hours

6 How many hours did you spend doing paid work per week? (Include any time you may have spent working away from this building) [ ][ ] Hours

7 How many hours per week did you operate a VDU at work ? [ ][ ] Hours

8 How many days did you come to this building? [ ][ ] Days

9 How many other people normally share the room where you normally work? [ ][ ] People

10 Is there a window in your room? Yes No If NO: please go the next page

11 Approximately how far is your desk from the nearest window? [ ][ ] Meters

12 Do you ever open a window in your room? Yes No

1 At this moment, are you experiencing **dry eyes** at all? Yes No
If yes: has this symptom got better or worse since you arrived in this building today? Better 1 No Change 2 Worse 3

How severe is this symptom now? Please tick one box on the scale. Very mild 1 2 3 4 5 6 7 Very severe

2 At this moment, are you experiencing **watering eyes** at all? Yes No
If yes: has this symptom got better or worse since you arrived in this building today? Better 1 No change 2 Worse 3

How severe is this symptom now? Please tick one box on the scale. Very mild 1 2 3 4 5 6 7 Very severe

3 At this moment, are you experiencing **a blocked or stuffy nose** at all? Yes No
If yes: has this symptom got better or worse since you arrived in this building today? Better 1 No change 2 Worse 3

How severe is this symptom now? Please tick one box on the scale. Very mild 1 2 3 4 5 6 7 Very severe

4 At this moment, are you experiencing **a runny nose** at all? Yes No
If yes: has this symptom got better or worse since you arrived in this building today? Better 1 No change 2 Worse 3

How severe is this symptom now? Please tick one box on the scale. Very mild 1 2 3 4 5 6 7 Very severe

5 At this moment, are you experiencing **dry or irritated throat** at all? Yes No
If yes: has this symptom got better or worse since you arrived in this building today? Better 1 No change 2 Worse 3

How severe is this symptom now? Please tick one box on the scale. Very mild 1 2 3 4 5 6 7 Very severe

6 At this moment, are you experiencing **chest tightness or breathing difficulties** at all? Yes No
If yes: has this symptom got better or worse since you arrived in this building today? Better 1 No change 2 Worse 3

How severe is this symptom now? Please tick one box on the scale. Very mild 1 2 3 4 5 6 7 Very severe

7 At this moment, are you experiencing **flu-like symptons** at all? Yes No
If yes: has this symptom got better or worse since you arrived in this building today? Better 1 No change 2 Worse 3

How severe is this symptom now? Please tick one box on the scale. Very mild 1 2 3 4 5 6 7 Very severe

8 At this moment, are you experiencing **dry skin** at all? Yes No
If yes: has this symptom got better or worse since you arrived in this building today? Better 1 No change 2 Worse 3

How severe is this symptom now? Please tick one box on the scale. Very mild 1 2 3 4 5 6 7 Very severe

9 At this moment, are you experiencing **a rash or irritated skin** at all? Yes No
If yes: has this symptom got better or worse since you arrived in this building today? Better 1 No change 2 Worse 3

How severe is this symptom now? Please tick one box on the scale. Very mild 1 2 3 4 5 6 7 Very severe

10 At this moment, are you experiencing **headaches** at all? Yes No
If yes: has this symptom got better or worse since you arrived in this building today? Better 1 No change 2 Worse 3

How severe is this symptom now? Please tick one box on the scale. Very mild 1 2 3 4 5 6 7 Very severe

11 At this moment, are you experiencing **lethargy or tiredness** at all? Yes No
If yes: has this symptom got better or worse since you arrived in this building today? Better 1 No change 2 Worse 3

How severe is this symptom now? Please tick one box on the scale. Very mild 1 2 3 4 5 6 7 Very severe

12 At this moment, are you experiencing **any other symptoms** at all? Yes No

Please describe the symptoms: ....

....

If yes: have these symptoms got better or worse since you arrived in this building today? Better 1 No change 2 Worse 3

How severe are these symptoms now? Please tick one box on the scale. Very mild 1 2 3 4 5 6 7 Very severe

1 How would you describe your level of thermal comfort at this moment?
Please tick one box

Cold	Cool	Slightly cool	Neutral	Slightly warm	Warm	Hot
1	2	3	4	5	6	7

2 How would you rate the overall acceptability of the indoor air quality in this office at the moment?
Please tick one box

5	Clearly acceptable
1	Just acceptable
-1	Just not acceptable
-5	Clearly not acceptable

3 How would you describe the indoor conditions in this office at this moment?
Please tick one box per scale
The boxes with bold edges represent the ideal point on each scale

Temperature	Comfortable	1	2	3	4	5	6	7	Uncomfortable
Air movement	Still	1	2	3	4	5	6	7	Draughty
Air quality	D	1	2	3	4	5	6	7	Humid
	Fresh	1	2	3	4	5	6	7	Stuffy
	Odourless	1	2	3	4	5	6	7	Smelly
Light	Too dark	1	2	3	4	5	6	7	Too bright
	Steady	1	2	3	4	5	6	7	Flickering
	No glare at all	1	2	3	4	5	6	7	Too much glare
	Very uniform	1	2	3	4	5	6	7	Very uneven
	Satisfactory overall	1	2	3	4	5	6	7	Unsatisfactory overall
Noise	No noise from ventilation system	1	2	3	4	5	6	7	Too much noise from ventilation system
	No other noise	1	2	3	4	5	6	7	Too much other noise
	Satisfactory overall	1	2	3	4	5	6	7	Unsatisfactory overall

In your office, how much control do you have over the following?

Please tick one box per scale

1 Temperature	None at all	1	2	3	4	5	6	7	Full control
2 Ventilation	None at all	1	2	3	4	5	6	7	Full control
3 Lighting	None at all	1	2	3	4	5	6	7	Full control
4 How would you describe the cleanliness of your office?	Unsatisfactory	1	2	3	4	5	6	7	Satisfactory

5 Do other people smoke in your immediate working environr

Yes No

6 Is there any other aspect of your office environment you would like to comment on? Yes No

If yes, please describe below

....

....

....

....

....

....

G ABOUT YOURSELF

1 Have you ever had asthmatic problems? Yes No

2 Have you ever suffered from eczema? Yes No

3 Have you ever suffered with hay fever? Yes No

4 Are you currently a smoker?

Yes ➨ Do you smoke in this room? Yes No

No ➨ Did you ever smoke regularly in the past? Yes No

Name (optional)

....

....

It is optional to enter your name but it would help us to keep track of which questionnaires have been collected and to follow up any important comments..

THAT IS THE END OF THE QUESTIONNAIRE. THANK YOU FOR YOUR TIME.