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[1]Centre Scientifique et Technique du Bâtiment (CSTB), Champs sur Marne, France
[2]Agence Française de Sécurité Sanitaire de l'Environnement et du Travail (AFSSET), Maisons Alfort, France

[*]*Corresponding email: Severine.kirchner@cstb.fr*

**SUMMARY**
Set up by the French authorities, the Observatory on Indoor Air Quality (OQAI) aims at collecting data on population exposure to indoor pollutants in various indoor environments. Accordingly, OQAI undertook a national survey in order to assess the air quality inside the French dwellings. A large amount of information has been collected from 567 dwellings (1,612 individuals questioned), representative of dwellings in France. This snapshot of indoor pollution focuses on more than 30 variables (chemical, biological and physical). The first results show differences between indoors and outdoors. Most of the target compounds were found in most of the dwellings surveyed. Pollution in homes is not homogeneous: some homes had indoor pollutant concentrations much higher than the median concentrations observed. Approximately one dwelling in 10 had simultaneous high concentrations of several volatile organic compounds (VOC), while inversely 45% of dwellings had low concentrations of all target VOCs. Attached garages had higher VOC levels than the dwellings themselves. House dust mites constitute the most frequent source of allergens.

**KEYWORDS**
Indoor air exposure, Dwellings, VOC, Allergens, Radon

**INTRODUCTION**
Our lack of understanding of the health risks related to air pollutants exposure in buildings is perceived as a major deficiency, even though 80% of our time is spent indoors. In this context the Observatory on Indoor Air Quality (OQAI) has been set up by the French authorities to collect data on population exposure to indoor pollutants in various indoor environments (dwellings, schools, offices, sports and leisure centers, etc.) to be used for public policies development. Accordingly, OQAI undertook a national survey on indoor air quality in dwellings with a four-fold objective: (1) to compile a descriptive inventory of indoor air quality in dwellings (2) to identify high-risk situations by estimating the exposure of populations occupying these premises (3) to draw up an initial list of parameters influencing the presence of this pollution (sources, type of housing, ventilation, human activities, seasons, geographical situation, etc.) (4) to generate advice and guidelines in order to improve indoor air quality in dwellings.

**METHODS**
The national dwellings survey was carried out between October 1st, 2003 and December 21, 2005 in a sample of occupied, main residences drawn at random and aimed at being representative of the 24,672,135 main residences in mainland France.

The method retained was three-degree sampling which would ultimately ensure that each main residence had the same probability of being drawn at random (Golliot et al. 2003).

Households were recruited on the basis of 6268 addresses drawn at random. Out of the 4165 households contacted, 811 agreed to take part (acceptance rate of 19.5%), and 567 participated in the national survey (participation rate of 13.6%). These rates were linked directly to the characteristics of the survey (random sampling of households and request for considerable involvement from them over the week of the survey). The final sample includes 567 dwellings (1612 individuals) distributed between 74 towns or cities.

So that the final sample would be representative of all main residences in mainland France, adjustments were made. These consisted in restoring to the sample the distribution of variables known for all main residences using a weighting system (for the number of main residences). Seven variables were taken into account: type of dwelling, period of construction, type of occupation of the dwelling, region of town sampling, size of urban unit, climatic zone in winter and comfort zone in summer.

**Data collected**

The pollutants measured in the context of this survey were chosen on the basis of a classification of indoor air pollutants developed by the OQAI and based on short and long-term toxicity criteria as well as the frequency of their presence in dwellings (Mosqueron et al. 2003). Some thirty chemical, physical and microbiological air pollutants were measured (Table 1): carbon monoxide (CO), volatile organic compounds (VOC), particles, radon, dog, cat and dust mite allergens, radon and gamma radiation.

Table 1. Parameters measured during the national dwellings survey.

| Parameters measured during the national dwellings survey | |
|---|---|
| **Animal allergens:** | Cat (*Feld 1)* and dog (*Can f1*) allergens in the air |
| **Dust mite allergens:** | (*Derp1, Derf 1*) in mattress dust |
| **Carbon monoxide (CO):** | In the environment and in expired air (for occupants aged 6 years or over). |
| **Volatile organic compounds** | One week passive sampling |
| *Aromatic hydrocarbons:* | *Benzene, toluene, m/p xylene, o-xylene, 1,2,4-trimethylbenzene, ethylbenzene, styrene.* |
| *Aliphatic hydrocarbons (n-C6 to n-16):* | *n-decane, n-undecane,* |
| *Halogenic hydrocarbons:* | *trichloroethylene, tetrachloroethylene, 1,4-dichlorobenzene* |
| *Glycol ethers:* | *2PG1ME (1-methoxy 2-propanol) and its acetate, EGBE (2 butoxyethanols) and its acetate* |
| *Aldehydes:* | *Formaldehyde, acetaldehyde, hexaldehyde, acrolein* |
| **Inert particles**: $PM_{10}$, $PM_{2.5}$. | One week sampling |
| **Radon** | 2 months sampling |
| **Gamma radiation** | One hour sampling |

All data were collected in most cases over a period of one week and according to a specific sampling strategy (materials, application, sampling and analytical protocols) (Ramalho et al. 2006). Active or passive samples were collected continuously during this one-week period. Some parameters, such as allergens or gamma radiation, were examined on an occasional basis. The radon detection badge was left in place for two months. Finally, alongside air measurements, levels of CO in exhaled air were also measured.

Pollutants were measured inside dwellings, in attached or integrated garages (when they existed) (VOC not including aldehydes) and outside the dwellings (CO, VOC).

Other data were also collected during this survey for future exploitation; they are not described in this article. These concerned comfort/confinement parameters (carbon dioxide, temperature, relative humidity) and detailed descriptive data on the construction characteristics of the dwellings and their environment, as well as on households and their activities (including the space-time-activities budget) (Derbez, 2006).

**Statistical analyses of descriptive data**

Data were processed on the basis of descriptive statistics in order to present the breakdown of dwellings as a function of the concentrations or levels measured for each pollutant.

Multidimensional statistical analyses were also performed on the data; firstly on the chemical pollutants detected in the 532 dwellings surveyed (10 volatile organic compounds, or all those measured (Table 1) except for 1-methoxy-2 propyl acetate and 2-butoxy ethyl acetate, levels of which were below the limits of detection in more than 90% of dwellings). The aim of these analyses was to determine groups of dwellings where the levels were highest for several pollutants at the same time. The approach was as follows: use of Kohonen self-organizing maps (Kohonen, 2001), which enabled an initial grouping of dwellings with similar or very homogeneous concentrations, taking simultaneous account of the 18 chemical pollutants, with an ascending hierarchical classification based on these initial sub-groups, and then weighting of the results to achieve an estimate at a national scale.

## RESULTS

The characteristics of the distributions of the levels of each pollutant (percentage of data lower than the limit of detection, median, 95 percentile and, for VOC, ratio of indoor concentrations to outdoor concentrations) are shown in Table 2. They are presented in detail in the OQAI report available on www.air-interieur.org.

As a general rule, the pollutants targeted by the national survey were present at quantifiable levels in most French dwellings, reflecting the presence of the numerous sources of indoor pollution from which they arose, and the ventilation conditions. However, the breakdown of pollution was not homogeneous in French housing stock. The distributions of the number of dwellings as a function of pollutant concentrations were usually markedly asymmetric, with some dwellings exhibiting levels much higher than the median observed in the housing stock (for example, see the case of tetratchloroethylene shown in Figure 1).

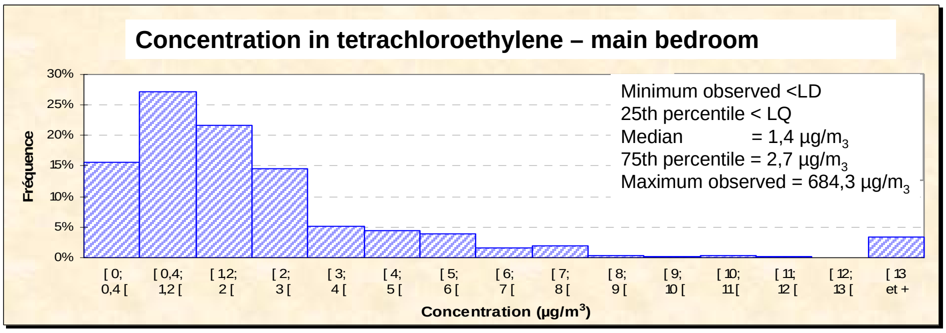


Figure 1. Distribution of dwellings as a function of indoor levels of 1,4-dichlorobenzene ($\mu g/m^3$) Concentration in 1,4-dichlorobenzene – main bedroom or similar.

### Volatile organic compounds

With the exception of two glycol ethers (EGBEA and 2PG1MEA), all the volatile organic compounds measured were present in 80% to 100% of dwellings, the most widespread compounds being formaldehyde, acetaldehyde, hexaldehyde, toluene and m/p-xylenes.

A search for groups of dwellings with multiple pollution by volatile organic compounds revealed that around 10% of dwellings presented simultaneously with three to eight compounds at very high concentrations (in these dwellings, the median levels of these compounds were 2 to 20-fold higher than those in the overall sample), only one compound were found at high or very high levels in 24% of dwellings (5 to 400-fold higher), 40% of dwellings presented with significantly lower than median levels in the global sample for practically all compounds and the last 26% of dwellings contained levels of several compounds that were slightly higher than the median of the global sample.

Furthermore, indoor air quality in dwellings differed specifically from outdoor air quality, as illustrated in Figure 2, which shows the distribution of median values (in µg/m$^3$) for 20 volatile organic compounds, as measured inside and outside dwellings.

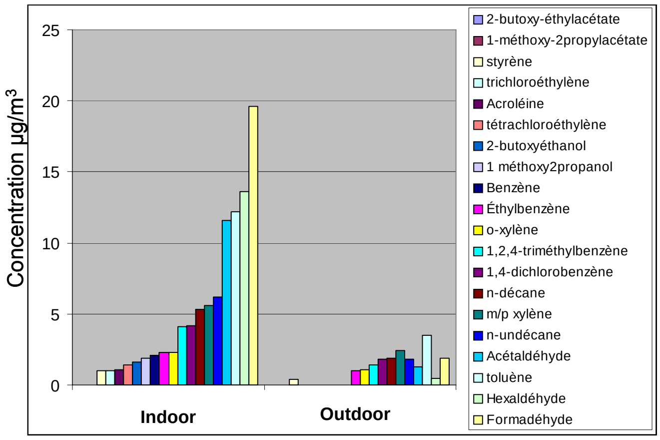


Figure 2. Distribution of median values (in µg/m$^3$) of concentrations of the 20 volatile organic compounds measured inside and outside dwellings.

It was seen that median levels were markedly higher indoors than outdoors with respect to the majority of compounds (18 out of 20). For some compounds (trichloroethylene, acrolein, tetrachloroethylene, 2-butoxyethanol, 1-methoxy-2 propanol, benzene), median outdoor levels were even lower than the limit of detection. The percentage of French dwellings with volatile organic compound levels (not including glycol ethers) that were higher indoors than outdoors ranged from 68.4% (trichlorethylene) to 100% (formaldehyde and hexaldehyde). In attached or integrated garages, median levels of several volatile organic compounds were higher than those measured in all dwellings.

Table 2. Characteristics of the distributions of pollutants inside and outside French dwellings.

**A) Volatile organic compounds (VOC)**

| | **Site** | **% weighted data <limit of detection** | **Median[a] (µg/m$^3$)** | **P95[b] (*g/m$^3$)** | **% ratios $C_{int}/C_{ext}$[c] ≥1** |
|---|---|---|---|---|---|
| **Acetaldehyde** | Indoors | 0.0 | 11.6 [10.8 – 12.3 | 30.0 [26.7 -35.1] | 99.6 |
| | Outdoors | 1.1 | 1.3 [1.2 – 1.3[ | 3.0 [2.6 – 3.1] | |
| **Acrolein** | Indoors | 0.6 | 1.1 [1.0 – 1.2] | 3.4 [2.9 – 3.8] | 98.1 |
| | Outdoors | 18.1 | <LQ [= 0.3] | 0.5 [0.4 – 0.6] | |

| | | | | | |
|---|---|---|---|---|---|
| **Formaldehyde** | Indoors | 0.0 | 19.5 [18.4 – 21.0] | 46.6 [40.8 – 55.1] | 100.0 |
| | Outdoors | 0.5 | 1.9 [1.8 – 2.0] | 3.6 [3.4 – 4.2] | |
| **Hexaldehyde** | Indoors | 0.0 | 13.6 [12.6 – 14.7] | 50.1 [37.6 – 55.4] | 100.0 |
| | Outdoors | 18.6 | 0.5 [0.4 – 0.5] | 1.4 [1.1 – 1.7] | |
| **Benzene** | Indoors | 1.4 | 2.1 [1.9 – 2.2] | 7.2 [6.3 – 9.4] | 90.9 |
| | Outdoors | 6.5 | <LQ [= 1.1] | 2.9 [2.5 – 3.4] | |
| | Garage | 0.8 | 4.4 [3.5 – 6.4] | 18.6 [12.6 – 21.6] | |
| **1,4-dichlorobenzene** | Indoors | 1.9 | 4.2 [3.7 – 4.8] | 150 [96.5 – 341.0] | 95.6 |
| | Outdoors | 5.7 | 1.8 [1.6 – 1.9] | 4.3 [3.5 – 5.5] | |
| | Garage | 6.9 | 2.2 [1.8 – 2.5] | 18.1 [8.0 – 40.0] | |
| **Ethylbenzene** | Indoors | 0.3 | 2.3 [2.1 – 2.5] | 15.0 [9.2 – 18.2] | 95.5 |
| | Outdoors | 6.2 | 1.0 [1.0 – 1.1] | 2.6 [2.3 – 3.0] | |
| | Garage | 1.2 | 18.0 [13.9 – 26.4] | 137 [109 – 155] | |
| **n-Decane** | Indoors | 0.7 | 5.3 [4.8 – 6.2] | 53.0 [38.6 – 83.9] | 94.4 |
| | Outdoors | 4.1 | 1.9 [1.9 – 2.1] | 6.4 [5.3 – 9.8] | |
| | Garage | 0.0 | 10.8 [7.3 – 14.0] | 213 [88.3 – 257] | |
| **n-Undecane** | Indoors | 0.6 | 6.2 [5 – 7.1] | 72.4 [45.2 – 93.2] | 94.1 |
| | Outdoors | 12.5 | 1.8 [1.6 – 2.0] | 7.0 [5.5 – 9.5] | |
| | Garage | 1.0 | 8.6 [ 5 – 11] | 106 [65.7 – 115.0] | |
| **Styrene** | Indoors | 1.9 | 1.0 [0.9 – 10] | 2.7 [2.2 – 3.1] | 95.2 |
| | Outdoors | 8.6 | 0.4 [0.3 – 0.4] | 0.7 [0.7 – 0.8] | |
| | Garage | 2.8 | 1.2 [0.9 – 1.6] | 9.3 [4.6 – 11.4] | |
| **Tetrachloro ethylene** | Indoors | 15.7 | 1.4 [1.2 – 1.6] | 7.3 [6.0 – 11.5] | 77.1 |
| | Outdoors | 21.4 | <LQ (=1.2) | 3.9 [2.7 – 4.3] | |
| | Garage | 41.0 | <LQ (= 1.2) | 2.5 [1.5 – 4.9] | |
| **Toluene** | Indoors | 0.0 | 12.2 [11.4 – 13.7] | 82.9 [57.7 – 115] | 96.2 |
| | Outdoors | 0.5 | 3.5 [3.3 – 3.8] | 12.9 [10.8 – 14.8] | |
| | Garage | 0.0 | 110.4[67.6-157] | 677 [426 – 789] | |
| **Trichloroethylene** | Indoors | 17.1 | 1.0 [<LQ-1.1] | 7.3 [5.1 – 16.1] | 68.4 |
| | Outdoors | 23.0 | <LQ (=1.0) | 2.3 [1.8 – 2.8] | |
| | Garage | 38.8 | <LQ (=1.0) | 12.8 [1.7 – 29.3] | |
| **1,2,4-trimethylbenzene** | Indoors | 0.5 | 4.1 [3.7 – 4.4] | 21.2 [15.7 – 25.7] | 95.9 |
| | Outdoors | 1.9 | 1.4 [1.3 – 1.4] | 4.1 [3.6 – 5.3] | |
| | Garage | 0.0 | 18.7 [13.2 – 29.2] | 149 [110 – 164] | |
| **m/p-Xylene** | Indoors | 0.0 | 5.6 [5.1 – 6.0] | 39.7 [27.1 – 56.4] | 92.5 |
| | Outdoors | 3.7 | 2.4 [2.3 – 2.7] | 7.1 [6.1 – 8.3] | |
| | Garage | 1.2 | 58.9 [38.5 – 81.2] | 454 [321 – 530] | |
| **o-Xylene** | Indoors | 0.1 | 2.3 [2.1 – 2.5] | 14.6 [10.5 – 19.5] | 92.1 |
| | Outdoors | 4.6 | 1.1 [1.0 – 1.2] | 2.7 [2.4 – 3.2] | |
| | Garage | 1.2 | 20.8 [14.2 – 27.9] | 166 [121 – 188] | |
| **2-butoxyethanol** | Indoors | 17.0 | 1.6 [<LQ – 1.8] | 10.3 [7.0 – 12.7] | 82.6 |
| | Outdoors | 91.3 | < LD (=0.4) | <LQ (=1.5) | |
| | Garage | 58.2 | <LD (=0.4) | 2.7 [2.0 – 4.5] | |
| **2-butoxy-ethylacetate** | Indoors | 97.7 | <LD (=0.3) | <LD (=0.3) | 2.5 |
| | Outdoors | 97.9 | <LD (=0.3) | <LD (=0.3) | |
| | Garage | 98.3 | <LD (=0.3) | <LD (=0.3) | |
| **1-methoxy-2-propanol** | Indoors | 15.1 | 1.9 [<LQ – 2.3] | 17.5 [13.1 – 20.4] | 84.4 |
| | Outdoors | 94.3 | <LD (=0.5) | <LQ (=1.8) | |
| | Garage | 51.2 | <LD (=0.5) | 9.1 [2.4 – 13.0] | |
| **1-methoxy-2-propylacetate** | Indoors | 77.3 | <LD (=0.7) | 2.3 [<LQ-2.8] | 22.1 |
| | Outdoors | 97.0 | <LD (=0.7) | <LD (=0.7) | |
| | Garage | 90.6 | <LD (=0.7) | <LQ (=2.2) | |

| **B) Carbon monoxide** | | | |
|---|---|---|---|
| | **Site** | **Median (ppm)** | **P95 (ppm)** |
| **Cumulated mean over 15 minutes** | Main rooms | 2.9 [1.9 – 2.9] | 15.3 [12.4 – 22.0] |
| | Other rooms | 6.0 [4.8 – 7.0] | 37.2 [22.3 – 54.4] |
| | Annexes | 3.8 [1.7 – 5.3] | 53.1 [28.2 – 94.4] |
| **Cumulated mean over 30 minutes** | Main rooms | 2.7 [2.1 – 3.0] | 14.3 [11.4 – 19.1] |
| | Other rooms | 4.9 [3.9 – 5.9] | 27.4 [18.3 – 49.2] |
| | Annexes | 3.3 [1.5 – 4.9] | 36.2 [21.7 – 78.0] |
| **Cumulated mean over 1 hour** | Main rooms | 2.0 [1.6 – 15.2] | 13.1 [9.5 – 15.2] |
| | Other rooms | 3.9 [3.0 – 4.7] | 21.1 [14.4 – 36.3] |
| | Annexes | 3.0 [0.9 – 3.8] | 30.2 [18.0 – 67.4] |

| | | | |
|---|---|---|---|
| **Cumulated mean over 8 hours** | Main rooms | 0.5 [0.4 – 0.9] | 6.3 [4.8 – 8.1] |
| | Other rooms | 1.3 [0.9 – 1.9] | 9.5 [5.0 – 19.2] |
| | Annexes | 0.7 [0.1 – 1.3] | 10.5 [5.2 – 13.9] |

| **C) Biological compounds** | | | | | |
|---|---|---|---|---|---|
| | **Limit of quantification (LQ)** | **Site** | **% weighted data <LQ** | **Median** | **P95** |
| **Fel d 1 cat allergens** | 0.18 ng/m$^3$ | living room | 74.6 | <LQ | 2.7 ng/m$^3$ [1.3 – 5.8] |
| **Can f 1 dog allergens** | 1.02 ng/m$^3$ | living room | 90.7 | <LQ | 1.6 ng/m$^3$ [1.1 – 2.5] |
| **Der f 1 mite allergens** | 0.01 µg/g | mattress | 3.1 | 2.2 µg/g [1.3 – 3.7] | 83.6 µg/g [46.4 – 103.0] |
| **Der p 1 mite allergens** | 0K02 µg/g | mattress | 7.9 | 1.6 µg/g [1.2 – 2.1] | 36.2 µg/g [23.1 – 41.5] |

| **D) Physical parameters** | | | | |
|---|---|---|---|---|
| | **Unit** | **Site** | **Median** | **P95** |
| **$PM_{10}$** | µg/m$^3$ | Living room | 31.3 [28.2 – 34.4] | 182.0 [119.0 – 214.0] |
| **$PM_{2.5}$** | µg/m$^3$ | Living room | 19.1 [17.2 – 20.7] | 132.0 [88.3 – 174.0] |
| **Radon** | Bq/m$^3$ | Bedrooms | 31.0 (with and without correction for seasonal variations) | 220 with correction for seasonal variations (225 without correction) |
| | | Other rooms | 33.0 (with and without correction for seasonal variations) | 194 with correction for seasonal variations (214 without correction) |
| **Gamma** | µS/h | Living room | 0.062 [0.058 – 0.064] | 0.122 [0.109 – 0.125] |

Main rooms: bedroom, sitting room, living room, study, open-plan kitchen; other rooms: kitchen, bathroom, WC, indoor circulation areas. Annexes: cellar, boiler room, storage areas, veranda, laundry, garage communicating with living areas.

[a] 50% of dwellings with levels lower or higher than this value.

[b] 95% of dwellings with levels lower than this value.

[c] $C_{int}/C_{ext}$ ratio: ratio between indoor and outdoor concentrations

### *Carbon monoxide*

The great majority of carbon monoxide levels were close to zero in the different rooms of dwellings, whatever the duration of measurement (15 minutes, 30 minutes, 1 hour, 8 hours). However, higher values were observed occasionally. Depending on the rooms considered, the maximum values observed ranged from 130 to 233 ppm (over 15 minutes), 90 to 174 ppm (over 30 minutes), 53 to 120 ppm (over 1 hour) and 31 to 36 ppm (over 8 hours), with service areas (kitchens, bathrooms, WCs) presenting the highest maxima over 15 minutes, 30 minutes and 1 hour. Comparison of WHO guidelines and the carbon monoxide levels found shows that 0.7% to 9.4% of French dwellings exceeded guideline values for 15 minutes (87 ppm), 30 minutes (52 ppm), 1 hour (26 ppm) and 8 hours (9 ppm) (Table 4). Excessive levels mainly affected service areas (kitchens, bathrooms, WCs, etc.) and annexes (cellars, lofts, garages, etc.).

Table 3. Percentage of dwellings with CO concentrations higher than WHO guidelines.

| **Exposure time** | **Guideline value (WHO)** | **Main room** *(bedroom, living room, office, open kitchen, etc.)* | **Other rooms** *(kitchen, bathroom, toilet, corridor)* | **Annexes** *(cellar, garage, loft, ,…)* |
|---|---|---|---|---|
| 15 minutes | 87 ppm | 0% - 0,8% | 0,2% - 6,8% | 1,5% - 10,5% |
| 30 minutes | 52 ppm | 0,1% - 1,2% | 0,4% - 6,5% | 1,9% - 11,1% |
| 1 hour | 26 ppm | 0,6% - 3.2% | 1,6% - 8,2% | 2,8% - 12,9% |
| 8 hours | 9 ppm | 2% - 5,6% | 3,4% - 12,9% | 3,3% - 11,5% |

**Biological pollutants**

***Dog and cat allergens***

Dog and cat allergens were not very common in the indoor air of dwellings (quantification in 9% and 25% of dwellings, respectively, even though 54% of households declared they owned or kept domestic animals). The respective median values were lower than the limit of quantification. Five per cent of dwellings exhibited levels higher than 2.7 ng/m$^3$ for cat allergens (*Fel d1*) and higher than 1.6 ng/m$^3$ for dog allergens (*Can f 1*).

***Mite allergens***

Mite allergens were observed in mattress dust in more than 90% of dwellings, with levels exceeding 83.6 µg/g for *Der f 1* and 36.2 µg/g for *Der p 1* in 5% of dwellings (median values of 1.6 µg/g and 2.2 µg/g respectively for *Der p 1* and *Der f 1*).

**Physical pollutants**

Fifty per cent of dwellings contained *particle* levels higher than 19.1 µg/m$^3$ for particles with a diameter smaller than 2.5 µm ($PM_{2.5}$) and 31.3 µg/m$^3$ for particles with a diameter smaller than 10 µm ($PM_{10}$). Five per cent of dwellings had concentrations higher than 133 µg/m$^3$ ($PM_{2.5}$) and 182 µg/m$^3$ ($PM_{10}$).

Median concentrations of *radon* were 31 Bq/m$^3$ in bedrooms and 33 Bq/m$^3$ in other rooms. Maximum values (1215 Bq/m$^3$ in a bedroom and 2161 Bq/m$^3$ in another room) were measured in the same dwelling. These levels were slightly lower than those measured by the Directorate General for Health (DGS) and the Institute for Radioprotection and Nuclear Safety (IRSN) in France between 1982 and 2000 at nearly 13,000 measurement points (median value: 50 Bq/m$^3$) (IRSN, 2000). This difference was certainly linked to the sampling methods employed in dwellings during the two campaigns. Based on voluntary participation, and with a number of measurements available in different regions that did not correspond to the density of residential housing, the DGS-IRSN campaign focused particularly on non-collective residential buildings and configurations and periods which were in principle "risky" (individual residential buildings, ground floor, measurements performed in winter).

Gamma radiation was found to be present at levels lower than 0.062 µSv/h in 50% of French dwellings, and only exceeded 0.1 µSv/h in 5% of dwellings.

## CONCLUSIONS

This first national campaign carried out by the OQAI in French dwellings enabled an inventory of air quality that targeted some thirty chemical, physical and microbiological pollutants. These findings will be supplemented by data on the levels of fungal contamination and the presence of damp in dwellings (to be published).

Indoor pollution is different from outdoor pollution, particularly in terms of the presence of some substances that are not observed outdoors, or by markedly higher concentrations indoors. The pollutants targeted were present at quantifiable levels in most French dwellings. However, the distribution of organic chemical pollution was not homogeneous throughout the housing stock. Only a minority of dwellings (around 10%) exhibited very high levels of several pollutants at the same time; by contrast, 45% of dwellings presented very low levels of all the pollutants measured. Furthermore, the distributions of the number of dwellings as a function of pollutant levels were usually highly asymmetric, with some dwellings presenting values that were markedly higher than the median levels observed throughout the housing stock.

This study constitutes the first reference available on the quality of indoor air in French housing stock and cannot be compared with any previous situations because of its originality. Nevertheless, it generated levels similar to those already demonstrated during occasional studies in France and in the context of major international surveys. These findings are currently being analyzed by the health authorities in order to better evaluate the health risk to populations. These values are crucial to situating the measurements established in the context of claims or emergencies where the quality of indoor air is called into question.

This overview of pollution at the level of the French housing stock now constitutes a reference to establish a context for policies concerning the prevention and reduction of health risks. In this respect, the data are currently being used for studies by the AFSSET (French Agency for the Health Safety of the Environment and Working Conditions) in order to draw up guidelines for the quality of indoor air. This state of pollution has also led the authorities to recommend the display of information relative to chemical substances emitted by all types of products (household cleaning agents, construction materials, furniture, etc.).

The detailed information collected in parallel on the construction characteristics of dwellings and their environment, as well as on households, their activities and the time spent in dwellings, are currently being processed. The long-term aim is to draw up a typical profile of the most polluted dwellings and to search for the factors incriminated so that measures can be taken to protect the population. Pollution tracers and indicators are also being developed in order to provide different actors in the construction industry with the tools they need to manage and communicate on indoor air pollution.

**ACKNOWLEDGEMENT**
This work was carried out thanks to the collaboration of OQAI partners, comprising some one hundred experts (50 agencies) who compiled the survey protocols and organized the survey, eighteen teams of technical surveyors spread throughout 12 geographical regions who were involved in carrying out the survey and five laboratories in France and other countries which analyzed the samples.

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