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## **COLLECTIVE HOUSINGS DESIGNED FOR SUMMER COMFORT IN NICE: A "HIGH ENVIRONMENTAL QUALITY" OPERATION**

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### **ABSTRACT**

The high environmental quality of the buildings in the south of France requires a good control of the summer thermal comfort. For economical and ecological reasons, this purpose must be reached essentially by architectural design. In the program "Haute Qualité Environnementale" of the "Plan-Construction", 58 collective housings have been built in Nice, in a dense urban zone, with a principal consideration to the summer comfort, specially to allow a good transversal ventilation in the moderate hot and humid climate of this city. Every housing is "transversal", even the most small, thanks to a distribution by external courtyards. The position of the rooms have been chosen in order to avoid a direct exposition of bedrooms to the noise of the street. Endly, a special shutter is used in the living-rooms upon this street, which presents in the same time a great acoustic insulation and an aeraulic permeability for the natural ventilation.

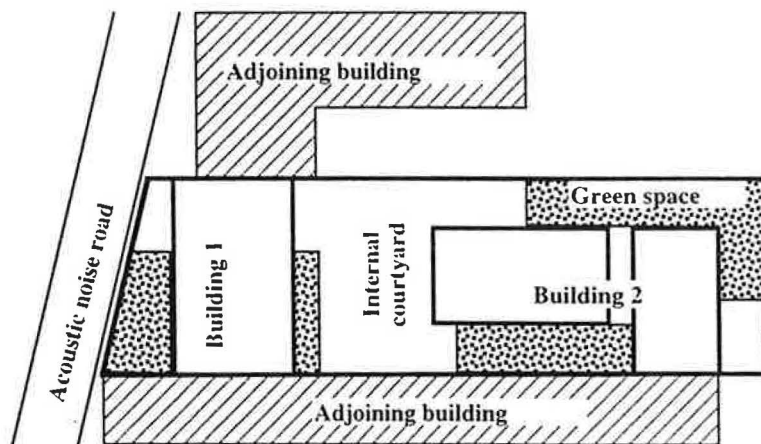
Measurements have been made during the summer 1996 in order to show the thermal performance of these housings according to the occupant behaviour in front of the natural ventilation and to know the real acoustic, thermal and aeraulic effects of the special shutter. The main results of these measurements are presented in this communication.

### **1 - INTRODUCTION**

The French program "HQE" (for "Haute Qualité Environnementale") had for purpose the realization of experimental dwellings with a great ambition in their environmental impact (Ref 1). In the case of Nice, the main problem consists to maintain a good summer comfort, in a dense urban zone, where acoustic noises are frequent.

Unfortunately, the principal required mean in order to conserve comfortable conditions in summer under the climatic conditions of Nice is the "night ventilation", which is also the most effective mean to transmit the noise pollution. Precautions must be take to allow the night ventilation as, for instance, the position of the bedrooms in the opposite calm façade. This principle has been applied in Nice for the building among the noisy road.

The 58 housings are distributed in two buildings: the first one constitutes an acoustic mask for the internal courtyard and the second building. The housings are oriented East-West in the first building and both East-West and North-South in the second. For the East-West housings, the solar protection is ensured for facing west living rooms by loggias with window boxes, which profit by an automatic drop by drop watering. Other openings are protected either by architectural masks, either by shutters. All housing are transversal, even the most small (two-rooms), thanks to a distribution by external courives. The four-rooms housings have three façades with openings. These layouts are also very favourable to the "visual comfort", one of the criteria of the "High Environmental Quality".



*Plan of the operation: position of the two buidings in relation with the acoustic noise road.*

In the building on noisy road, the directly exposed openings are protected by special shutters ("Acoustics shutters"), designed to produce in the same time a great acoustic insulation and a sufficient air permeability. The real efficiency of this shutter is one of the objectives of the measurements.

## 2 - METHODOLOGY

The measurements are submitted to the following principles:

- The measurements have to be made before the arrival of the occupants, in order to control all parameters in the housings;
- the occupant behaviour must be simulated by using windows, doors and shutters, according to a program previously developed;
- these measurements are established for the thermal, aeraulic and acoustic effects of the architectural design under the use conditions;
- the thermal results are obtained by comparison between "experimental housings" and a "reference housing", during a summer period;

The use conditions are exprimed under the form of "use pattern", according to the following table:

	DAY (8h-20h)	NIGHT (20h-8h)
<b>USE PATTERN 1 &amp; 1bis : NIGHT VENTILATION</b>		
Windows	closed	open
Acoustic Shutter	closed	open
Other shutters	closed	open
<b>USE PATTERN 2: ACOUSTIC NIGHT VENTILATION</b>		
Windows	closed	open
Acoustic Shutter	closed	closed
Other shutters	closed	open
<b>USE PATTERN 3: PERMANENT VENTILATION</b>		
Windows	open	open
Acoustic Shutter	open	open
Other shutters	open	open
<b>USE PATTERN 4: SOLAR PROTECTION DEFAULT</b>		
Windows	closed	closed
Acoustic Shutter	open	closed
Other shutters	open	closed
<b>USE PATTERN 5: DAY VENTILATION</b>		
Windows	open	closed
Acoustic Shutter	open	closed
Other shutters	open	closed

*Table 1: use patterns of the experimental housings*

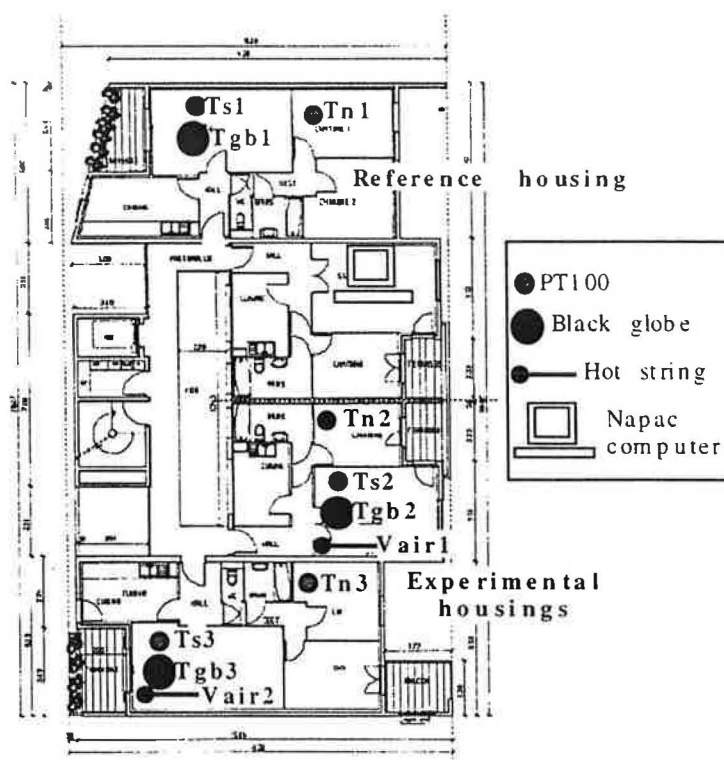
N.B.: The difference between use patterns 1 and 1bis consists to shut the "day-night" door, in order to reduce the acoustic noise. while the "acoustic shutter" is open (or unavailable).

These measurements have been made in the following conditions:

- Thermal measurements: air temperature, radiant temperature, air velocity (11 points) and meteo data (air temperature and air velocity) have been measured every 6 minutes; the hourly average values were stored on napac computer during the period 5 August-8 September 1996; responsible: GENE, Centre d'Etudes Nucléaires de Cadarache (see also the plan of the storey).

- Aeraulic measurements: air change rate (vol/h) have been measured during the period 2-5 September 1996 according to the use patterns, with tracer gas; responsible: CSTB Marne la Vallée; Jacques RIBERON.

- Acoustics measurements: acoustic levels in the different rooms have been measured according to the use patterns; responsible: CETE Méditerranée; Bernard AGLIANY.



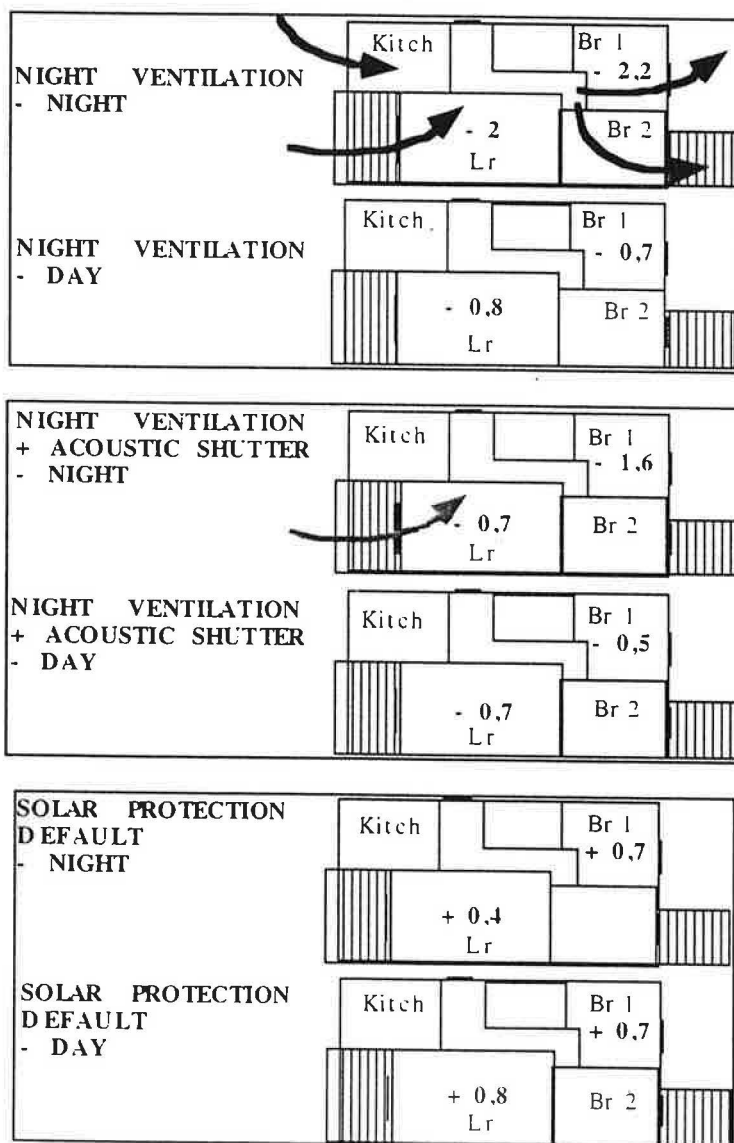
Position of the measurement points on the third storey of the building N°1

### 3 - MAIN RESULTS

The results are presented under the form of a housing schema. In this way, the effects of the "use patterns" are more easy readable.

#### 3-1. Thermal results

The following drawing presents the average temperature differences between experimental housings and the reference one.



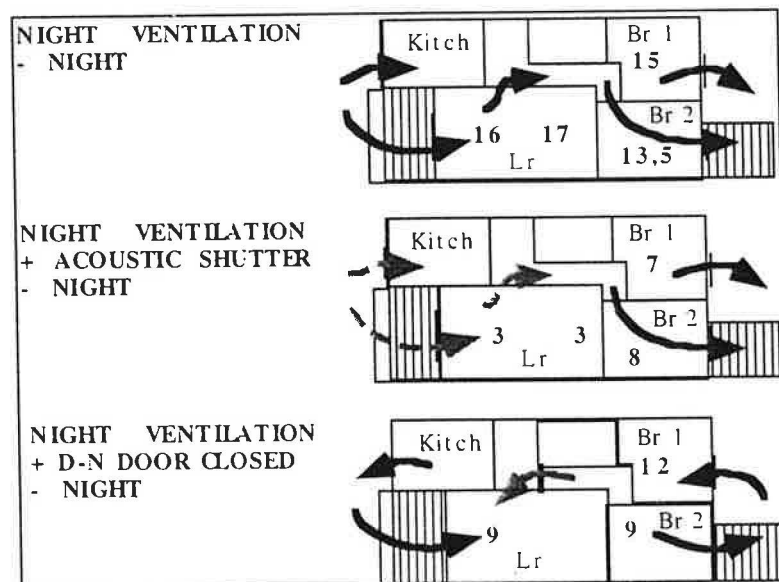
It can be seen that the effect of the acoustic shutter is negative on the summer comfort for the living room: during the night the temperature is 1,3°C higher. In the bedroom, this difference is equal to 0.6°C.

For the "Solar protection default", the temperatures in the "experimental housing" are higher than in the reference one.

These results confirm the thermal performance of a transversal night ventilation, and show that the closing of the acoustic shutter is defavourable to this ventilation, essentially for the living room. Therefore, the closing of the day-night door allows to preserve a large part of the transversal ventilation performance: these results are not presented because of the bad representativeness of measurement sequence for this use pattern.

### 3-2. Aeraulic measurements (Ref 4)

The following drawings give the Air change rate (vol/h) for each room for three night use patterns: "transversal ventilation", "acoustic shutter closed" and "day-night door closed".

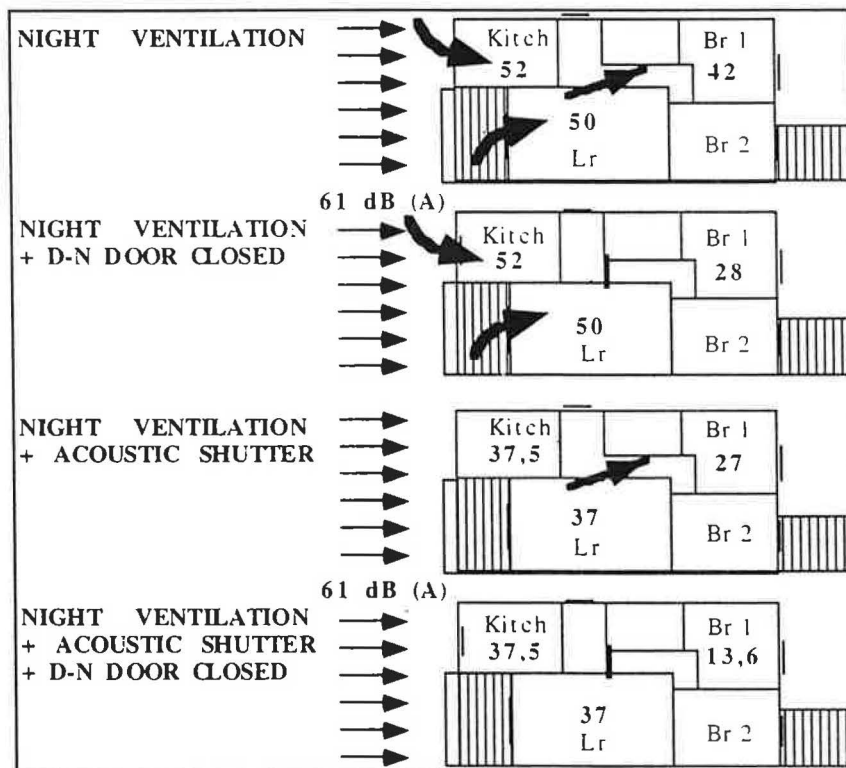


When the acoustic shutter is closed, the air change rate in the living room decreases (from 16 to 3 vol/h), while the value of this rate is 9 vol/h with the day-night door closed. In the bedroom, the decrease is lower: from 15 to 7 vol/h, and 12 vol/h for the day-night door closed.

It is possible to conclude that, in a transversal housing, when the reduction of acoustic noises is needed, the "day-night door closed" pattern is more appropriate to ensure a good night ventilation than the closing of the acoustic shutter.

### 3-3. Acoustic measurements (Ref 2&3)

The results are presented under the form of global weighted levels (expressed in dB"A") in front of the real traffic noise, according to each use pattern, for the night period. These values have been extrapolated from the measurements made with a "rose noise" for every third octave and rectified to take in account the real reverberation time (the housing are not occupied).



The closing of the acoustic shutter and the day-night door have approximately the same acoustic performance (28 to 27 dB"A"). The difference of 1 dB"A" is a little value, and, as the night ventilation pattern assumes that the window of the bedroom remains open, the direct external noise (not measured) exceeds certainly the one which is arising from the other façade, across the housing. For this reason, the value of 13,6 dB(A) in the bedroom is not significant.

The recent french regulation specifies that the internal level do not exceed 30 dB(A) during the night in the habitable rooms. Both solutions satisfy this condition.



*From left to right: East façade, West façade and small courtyard of the building 1.*

#### 4 - CONCLUSIONS

These results show that the environmental objectives of this High Environmental Quality operation are globally reached. It is possible to maintain summer comfort conditions in urban zones with acoustic noises, if some precautions are taken in the architectural design, such as position of the bedrooms in calm façades, transversal form of the housing, use of the building as an acoustic mask, solar protections by architectural shapes or plants, and if the occupants are conscious of the possibilities of their housing.

The acoustic shutter performance is not perfect, especially from the aeraulic point of view. It would be preferable to improve the air permeability of this shutter, even if the acoustic performance is lower.

The real occupant behaviour will be measured by a special investigation after the summer 1997.



## 5 - REFERENCES

1 - "Bâtiment et environnement; vers une filière de construction durable?" Revue PCA Actualités, n°57, Octobre 1996.

2 - B. AGLIANY, "Résidence "La Provençale" à Nice, 58 logements P.L.A. Le Logis Familial, opération REX HQE; interprétation des mesures acoustiques dans le bâtiment A". Rapport de mesures: CETE Méditerranée, DHACE, Service Energie Construction; Déc 1996.

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