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"Introduction to Monitored Bioclimatic Buildings in Latisana"

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INTRODUCTION TO MONITORED BIOCLIMATIC BUILDINGS IN LATISANA

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Introduction

This work concerns an experimental research on solarized building . Target of this research is the comparison of energy consumption among flats with different passive solar devices , which were monitored throughout one year.

The building

The experimental building , placed in Latisana (Udine) , is a in-line building (E-W oriented) with 56 flats over 4 floors (fig. 1) . In this building three possible forms of passive solarization have been experimented :

a) **Direct gain** - in reduced degree , to avoid the known problems of : day glare and night reradiation , high night-day thermal excursion and UV radiation damage.

b) **Sunspaces** - thought like external extends of dining rooms , are placed in order to constitute central thermal storages : in this way the sunspace distributes the stored heat to the whole flat (fig. 2) .

c) **Thermal walls** - low heat capacity thermal walls ('Camini Solari Barra-Costantini') have been used in this building to reduce summer overheating and winter heat loss . In this device the thermal storage is placed within the roof (fig. 3) .

The 56 flats of building are divided in 14 columns and 4 floors . Each column is composed of 4 flats of the same area (fig. 4) , so we have :

6 columns of one bedroom apartments (type L1)

6 columns of two bedrooms apartments (type L2)

2 columns of three bedrooms apartments (type L3).

Each floor of the building was built with different passive solar devices :

Ground floor : direct gain only .

First floor : direct gain and sunspaces .

Second and third floor : direct gain , sunspaces and low heat capacity thermal walls .

Our research considers 4 columns of type L2 apartments (16 flats), so we can compare energy consumption of flats of identical area and orientation . Two of these columns (L2X and L2Y) are heated by independent boilers , the other two columns (L2E and L2A) are heated by two central heating plants with water-water heat pumps . The heat pump L2E uses water heated by a solar collector system , the heat pump L2A uses groundwater .

Two kinds of comparisons are possible :

Horizontal comparisons : these are comparisons among flats with different heating system and the same passive solar devices .

Vertical comparisons : these are comparisons among flats with different passive solar devices and the same heating plant.

The monitoring system

The energetic analysis of the building is based on hourly measurements over the period of one year . Each flat was monitored acquiring the following :

Temperature of dining room

Temperature of bedroom 1

Temperature of bedroom 2

Energy consumption for heating .

The two heat pumps were monitored acquiring the following:

Mass flow rate evaporator side

Inlet temperaure evaporator side

Outlet temperature evaporator side

Mass flow rate condenser side

Inlet temperature condenser side

Outlet temperature condenser side

Meteorological data were acquired also :

Temperature

Relative Humidity

Solar Radiation

Windspeed

Results

Figure 5 shows the histogram of mean temperatures of all the flats monitored . It is possible to note that mean temperatures of the occupied flats range within 18.2 °C and 24 °C .

Figure 6 shows histogram of energy consumptions of all the flats . These data are not homogeneus for the reason that monitoring of some flats was reducted because of monitoring system troubles .

An index for taking account of different users behaviour and for homogenizing different data of temperature and consumption was elaborated. This index

(CONSMED) represents the mean specific consumption of each flat . CONSMED is defined as :

$$CONSMED = MQ / (MT_i - MT_e)$$

where :

MQ : mean hourly energy consumption

MT_i: mean indoor temperature

MT_e: mean outdoor temperature

Consequently index CONSMED indicates the hourly energy consumption for one degree of temperature difference between indoor and outdoor .

Figure 7 shows CONSMED of all the monitored flats , star indicates that the correspondent values are not reliable or significant and are not considered in following analysis .

Figure 8 shows a comparison among values of CONSMED calculated like average of the CONSMED values of the flats of each floor . It is a comparison among the passive solar devices . The comparison between floor 1 and floor 2 shows a 12 % difference in terms of CONSMED , but exterior surfaces (and heat losses also) of floor 1 are greater than those of floor 2 .

The comparison between CONSMED value of floor 2 and floor 3 shows that the energy saving due to low heat capacity thermal wall is about 3 % only . This fact is determined by a bad use of the device : many users keep the grids closed (fig. 3) .

Figure 9 represents the comparison between average CONSMED value of the flats with independent heating plant (L2X and L2Y columns) and average CONSMED value of the flats with central heating plant (L2A and L2E columns) . The differences are considerable and are determined , probably , by a better management of the independent plants .

Figure 10 illustrates the measured temperature of second floor L2E type flat , outdoor measured temperature and measured solar radiation . These data were taken when the flat was not occupied and not heated . It is possible to note that mean temperature was about 19 °C and that the peaks of indoor temperature agree with the peaks of solar radiation. Besides it is possible to note that single bedroom , heated by sunspaces and thermal wall , is the hottest . These data show that if the low heat capacity walls were correctly used , the energy saving were significant .

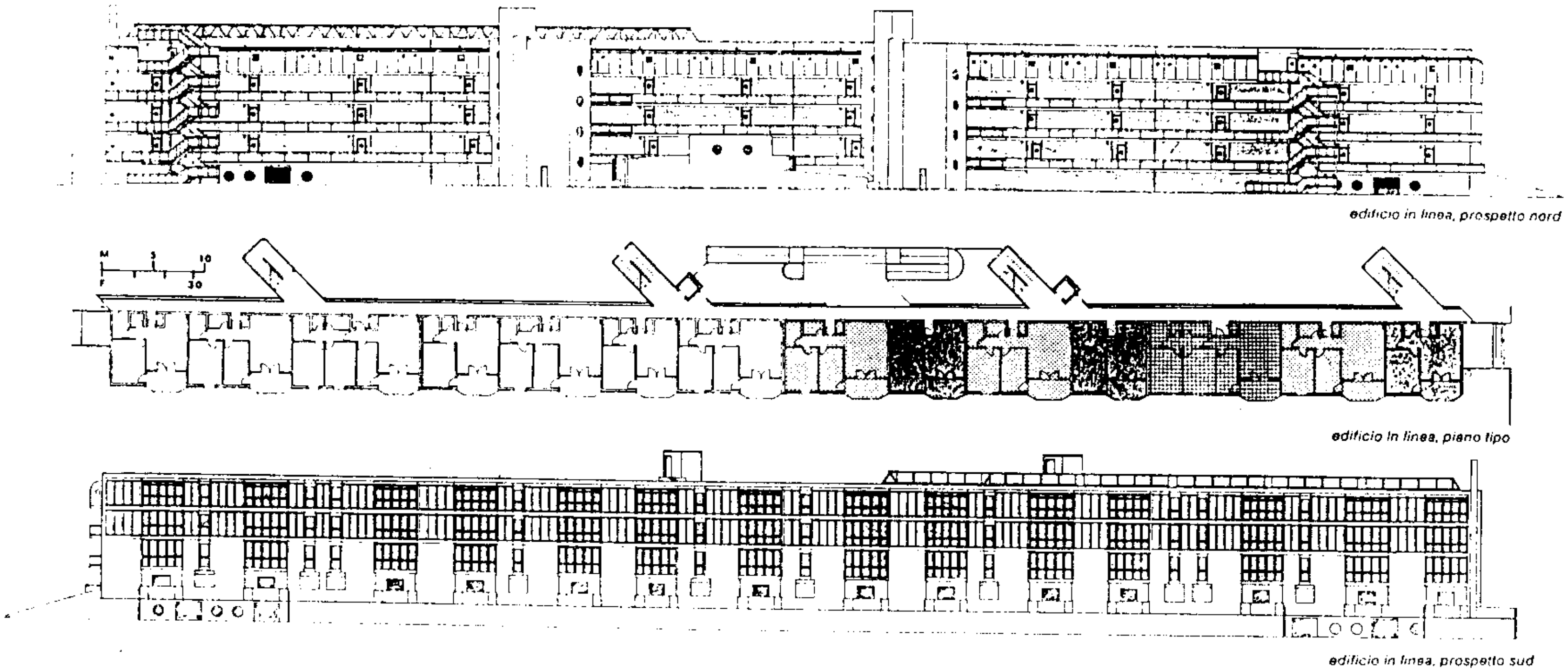
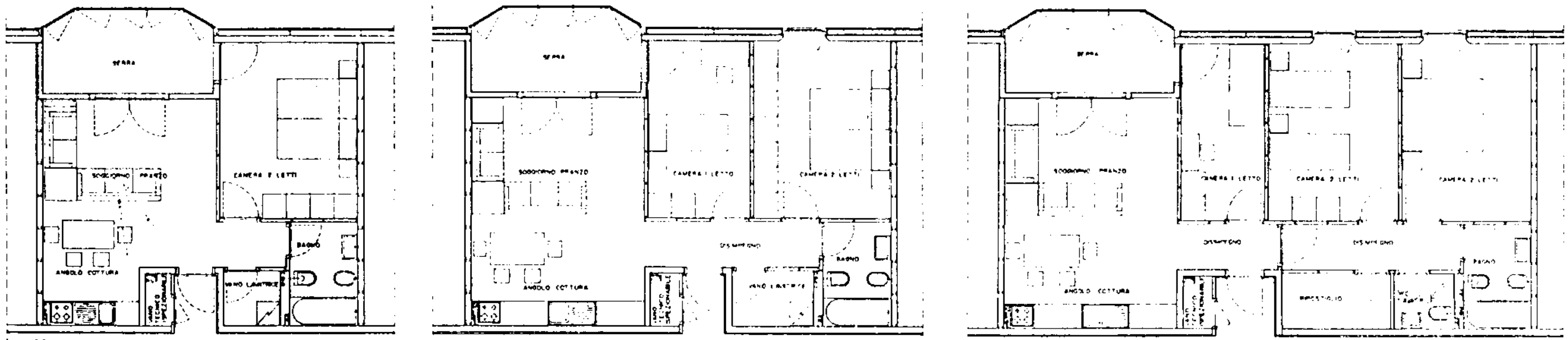

edificio in linea, prospetto nord
M 5 10
F 30
edificio in linea, piano tipo
edificio in linea, prospetto sud

FIG. 1



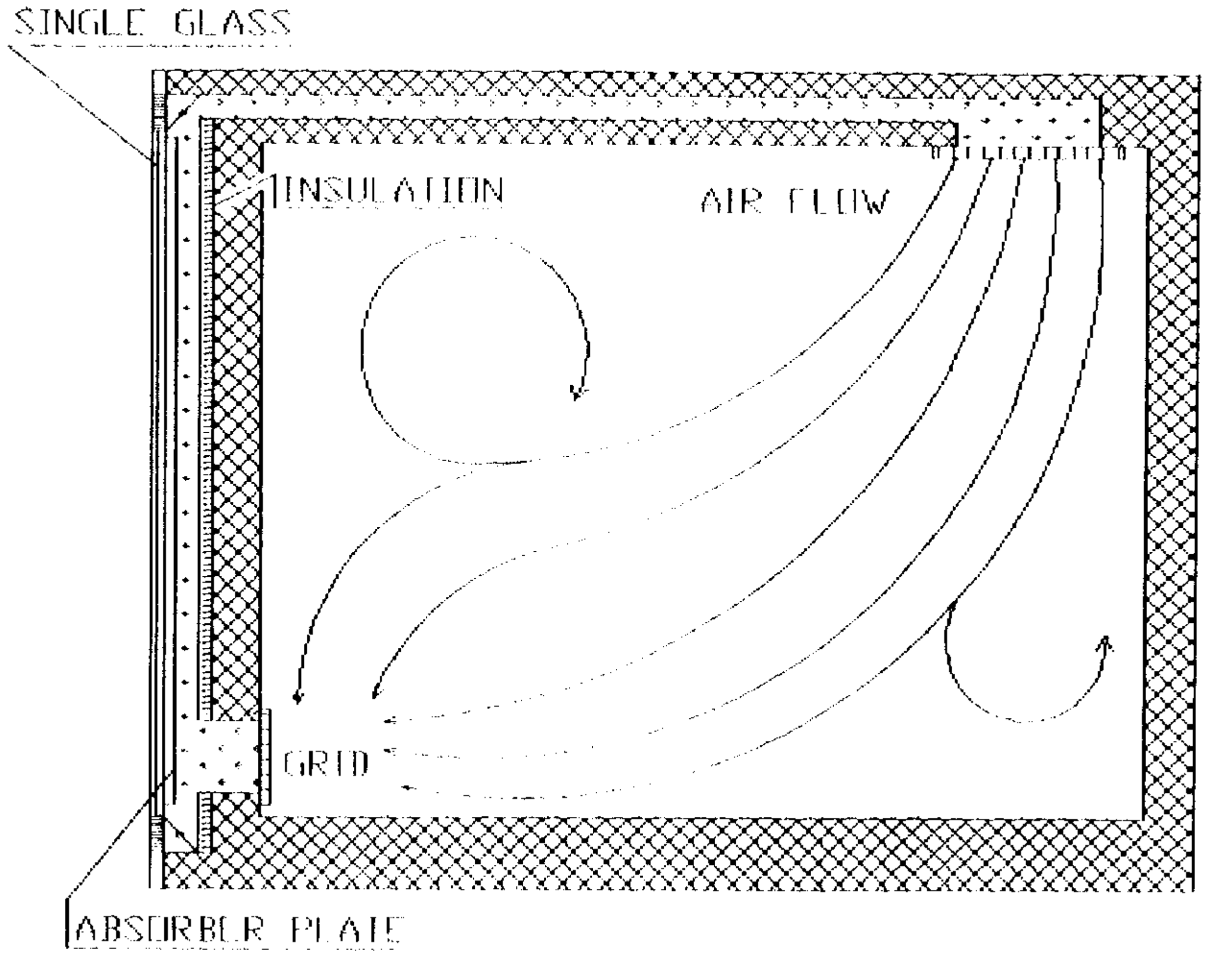
M 3 F 10

edificio in linea, tipo L_1 (mq 45.39), pianta

tipo L_2 (mq 63.44), pianta

tipo L_3 (mq 80.64) pianta

FIG. 2



WINTER CIRCULATION

FIG. 3

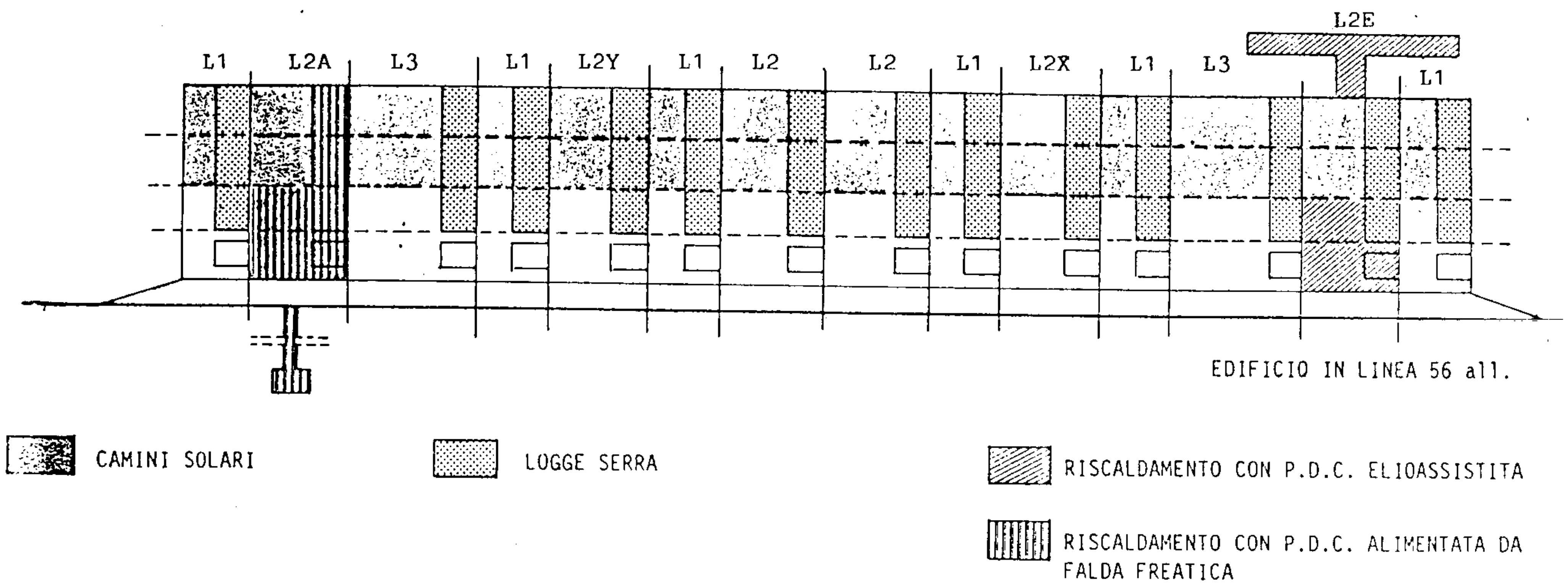

L1
L2A
L3
L1
L2Y
L1
L2
L2
L1
L2X
L1
L3
L2E
L1
EDIFICIO IN LINEA 56 all.
CAMINI SOLARI
LOGGE SERRA
RISCALDAMENTO CON P.D.C. ELIOASSISTITA
RISCALDAMENTO CON P.D.C. ALIMENTATA DA FALDA FREATICA

FIG. 4

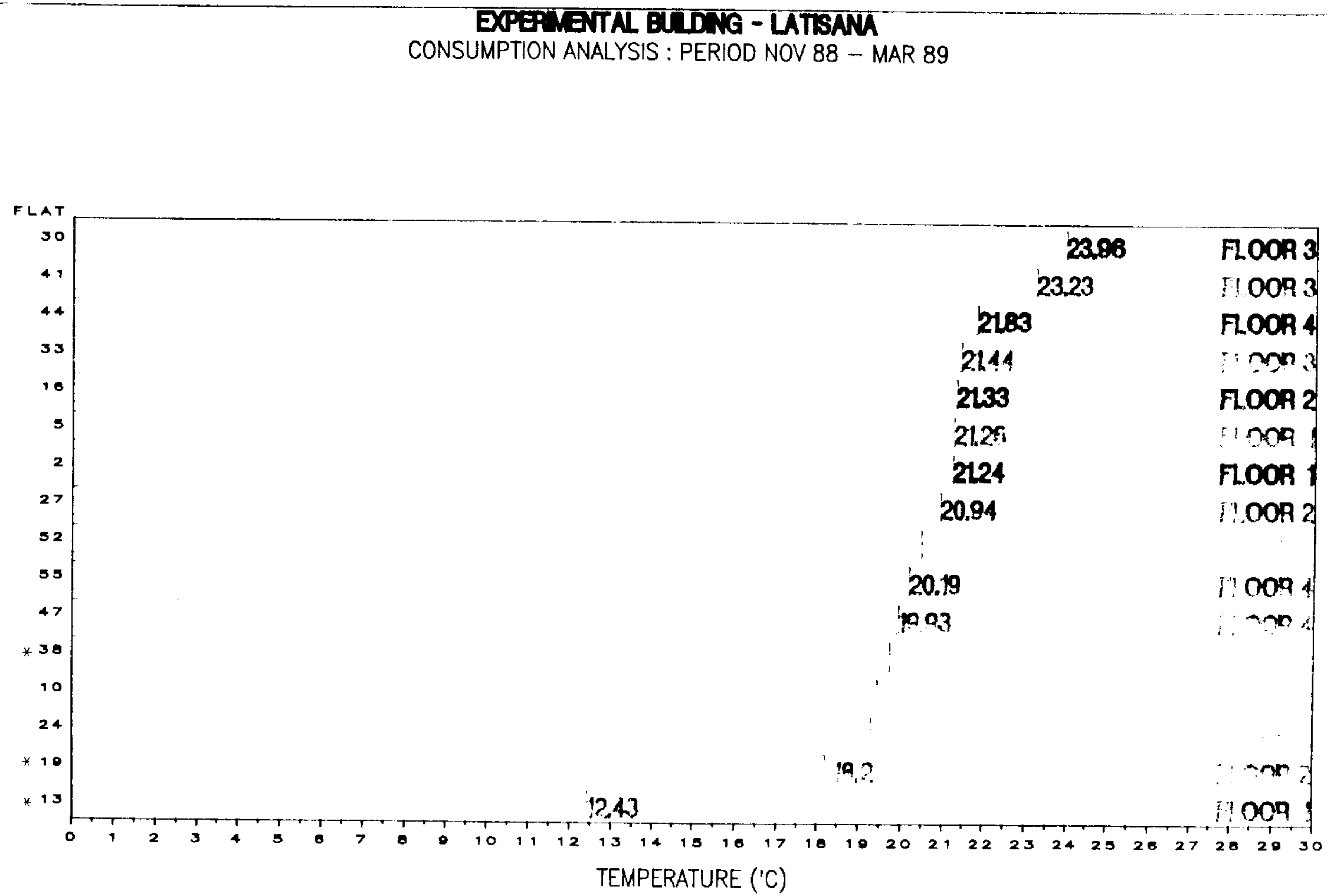

EXPERIMENTAL BUILDING - LATISANA
CONSUMPTION ANALYSIS : PERIOD NOV 88 — MAR 89
FLAT
30
41
44
33
16
5
2
27
52
55
47
* 38
10
24
* 19
* 13
23.96
23.23
21.83
21.44
21.33
21.26
21.24
20.94
20.19
12.43
FLOOR 3
FLOOR 4
FLOOR 2
FLOOR 1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
TEMPERATURE ('C)

FIG. 5

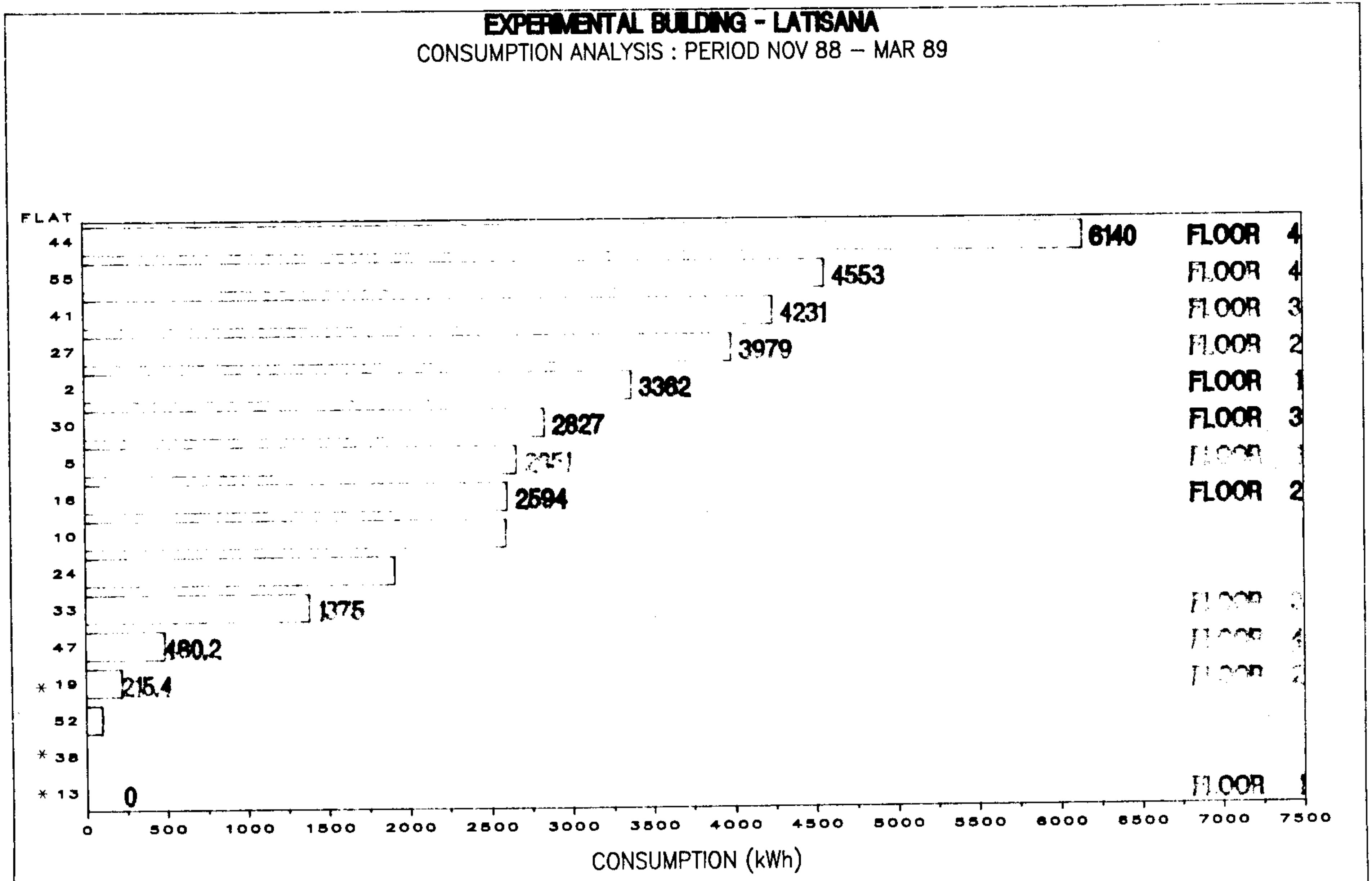

EXPERIMENTAL BUILDING - LATISANA
CONSUMPTION ANALYSIS : PERIOD NOV 88 – MAR 89
FLAT
44
55
41
27
2
30
5
16
10
24
33
47
* 19
52
* 38
* 13
6140
4553
4231
3979
3362
2827
2594
1375
480,2
215,4
0
FLOOR 4
FLOOR 4
FLOOR 3
FLOOR 2
FLOOR 1
FLOOR 3
FLOOR 2
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
CONSUMPTION (kWh)

FIG. 6

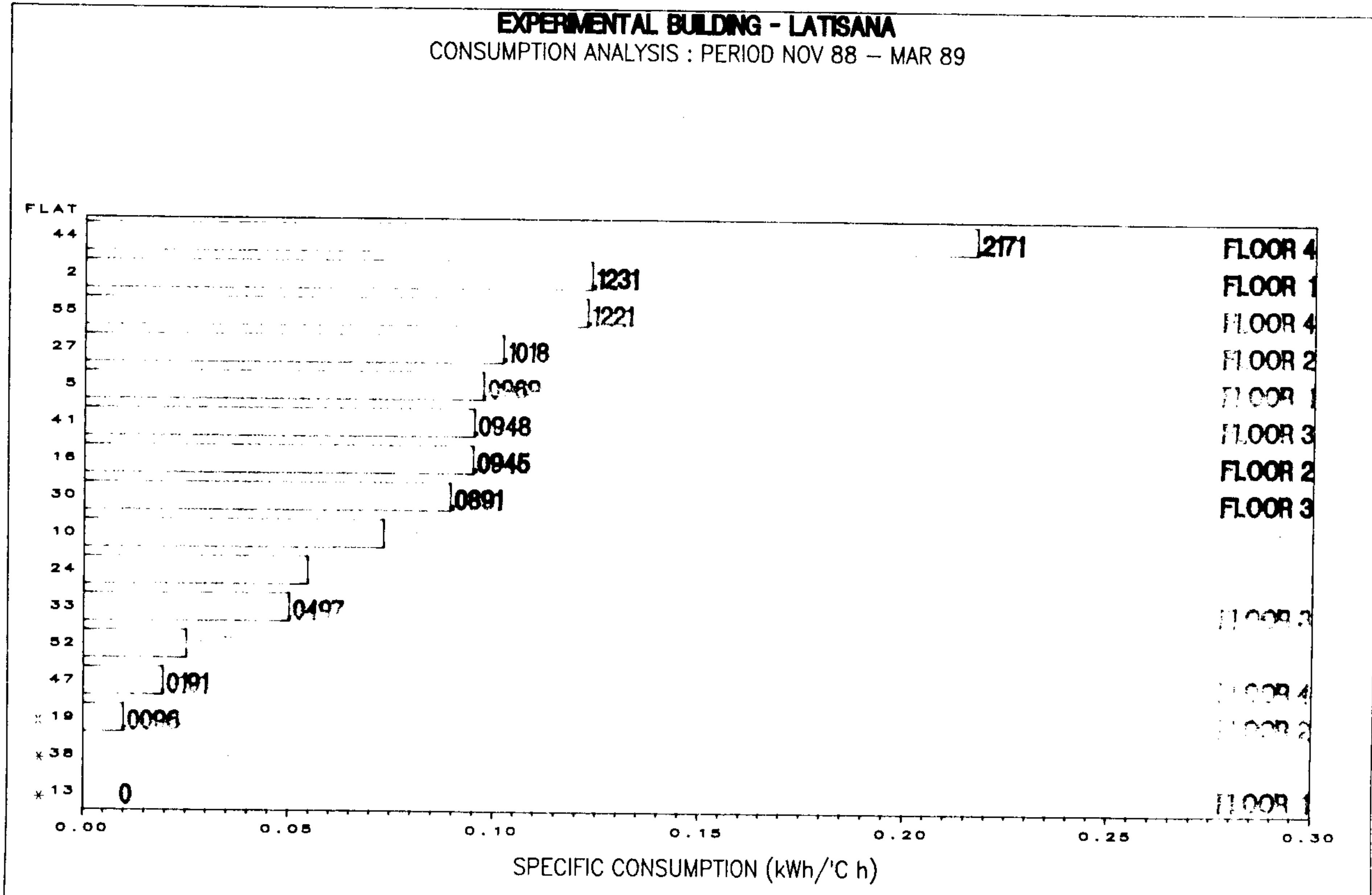

EXPERIMENTAL BUILDING - LATISANA
CONSUMPTION ANALYSIS : PERIOD NOV 88 – MAR 89
FLAT
44
2
55
27
5
41
16
30
10
24
33
52
47
* 19
* 38
* 13
2171
1231
1221
1018
0948
0945
0891
0497
0191
0
FLOOR 4
FLOOR 1
FLOOR 4
FLOOR 2
FLOOR 3
FLOOR 2
FLOOR 3
0.00
0.05
0.10
0.15
0.20
0.25
0.30
SPECIFIC CONSUMPTION (kWh/'C h)

FIG. 7

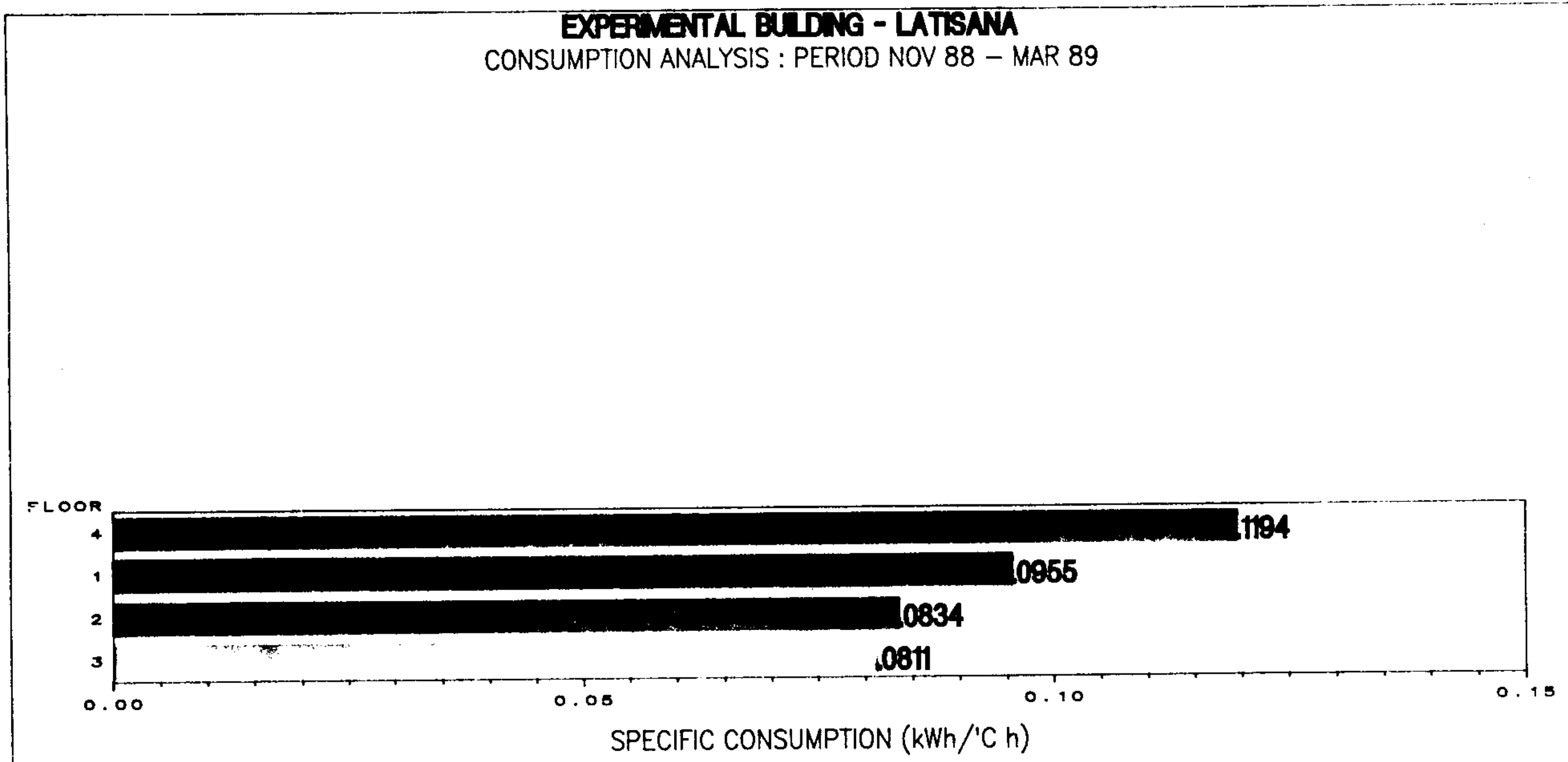
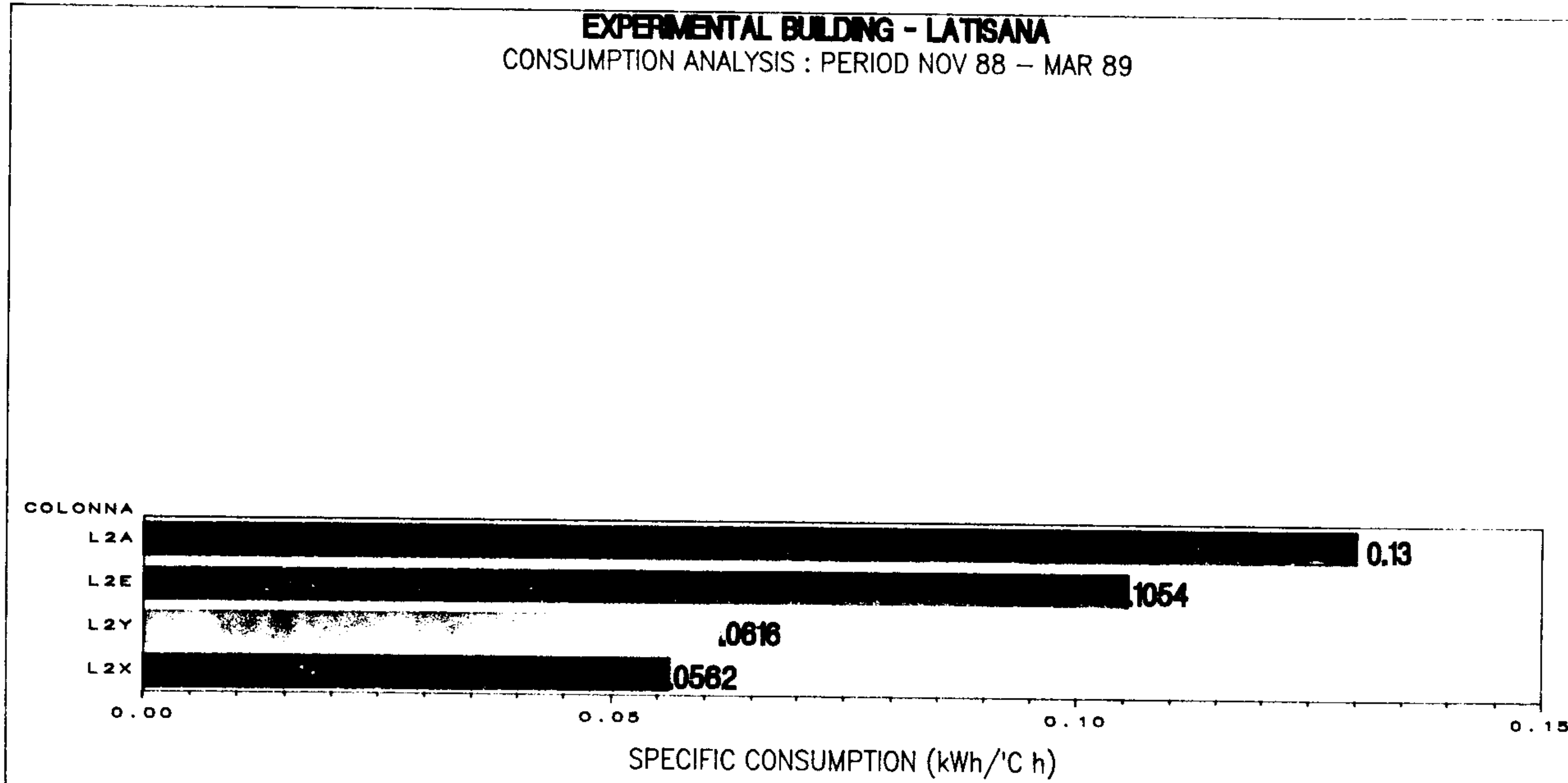

EXPERIMENTAL BUILDING - LATISANA
CONSUMPTION ANALYSIS : PERIOD NOV 88 – MAR 89
FLOOR
4
1
2
3
.1194
.0955
.0834
.0811
0.00
0.05
0.10
0.15
SPECIFIC CONSUMPTION (kWh/'C h)

FIG. 8



EXPERIMENTAL BUILDING - LATISANA
CONSUMPTION ANALYSIS : PERIOD NOV 88 – MAR 89
COLONNA
L2A
L2E
L2Y
L2X
0.13
.1054
.0616
.0562
0.00
0.05
0.10
0.15
SPECIFIC CONSUMPTION (kWh/'C h)

FIG. 9

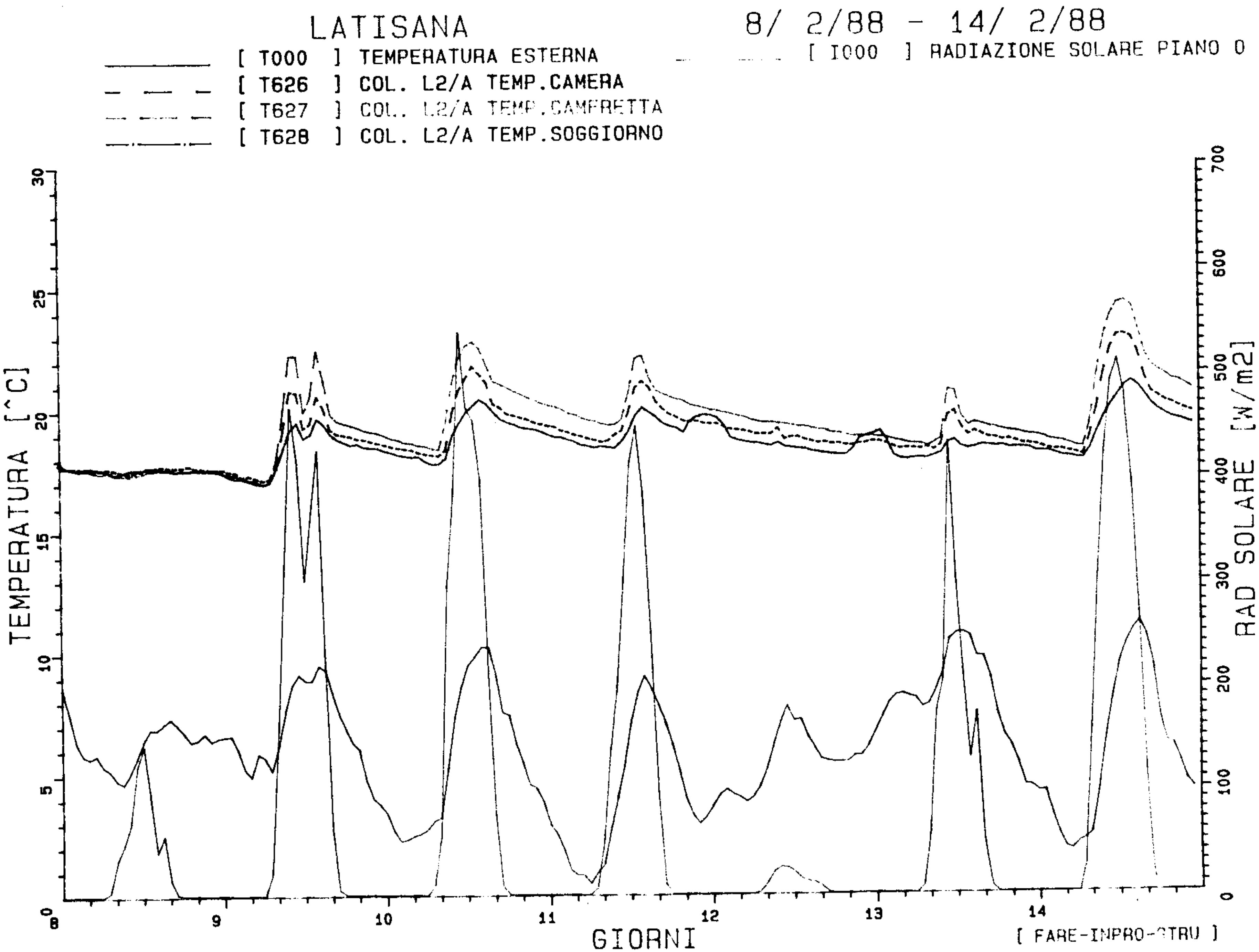

LATISANA
8/ 2/88 - 14/ 2/88
[T000] TEMPERATURA ESTERNA
[T626] COL. L2/A TEMP.CAMERA
[T627] COL. L2/A TEMP.CAMERETTA
[T628] COL. L2/A TEMP.SOGGIORNO
[I000] RADIAZIONE SOLARE PIANO 0
TEMPERATURA [°C]
RAD SOLARE [W/m2]
0
5
10
15
20
25
30
100
200
300
400
500
600
700
8
9
10
11
12
13
14
GIORNI
[FARE-INPRO-?TRU]

FIG. 10