LONG-TERM MONITORING OF A BALANCED VENTILATION SYSTEM WITH HEAT RECOVERY FOR MULTISTOREY BLOCK - BUILDINGS

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1. Introduction

A five-year research and development project was launched in 1980 in Hungary-financed by the Ministry for Building and Urban Development-to develop a new energy saving ventilation system for multistorey blockbuildings. The presently widely used ventilation systems are of suction type, outlets positioned in the kitchens bathrooms and lavatories and fresh air supply are realized through the cracks of the windows. Due to the official measures to install and use airtight windows for the sake of energy saving, problems with the decreased ventilation rate had arisen.

The need for a balanced ventilation originated from this and beside the demands of necessary and enough air change rate, proper flow patterns inside the flat and low noise level, the system had to meet the requirements of the energy saving operation as well.
The system had to be conform to the characteristics of the prefabricated building technology. The five-year R and D activity realized through the following steps: system analysis, choice of the most suitable one, draft then detailed design into an experimental house /in that time under construction/, manufacturing and installing, experimental running and comprehensive monitoring during a year, evaluation of the experiments and proposal for wide utilization. Beyond the system analysis, indoor air quality measurements and the examination of the effects of several occupants' activities were also aimed.

2. System description, operation, monitoring

The experimental object was a section of an 11 storey blockbuilding made of prefabricated wall-panels and of other prefabricated elements. The section consisted of 3 flats /average floor area about 60 m2 each/. Among the 33 dwellings, each ventilated by the system, 6 of them in 3 storeys were instrumented with sensors for measurements.

For the sake of comparison a neighboring similar section of the building was also measured as reference. In this section the traditional suction-type ventilation system was operated. The main unit of the experimental system was a roof-top ventilation unit. The Fig.1. shows the plan view of the roof of the section, the ventilation box and the distributing duct network. The pipes were connected to the vertical ducts placed in the ventilation shafts.

The fresh heated air was supplied into the rooms above the doors, through adjustable inlet grids. The suction outlets for exhausting were placed in the kitchen, bathroom and lavatory. For the sake of proper inside flow pattern the inner doors were equipped with permeable opening-grids.

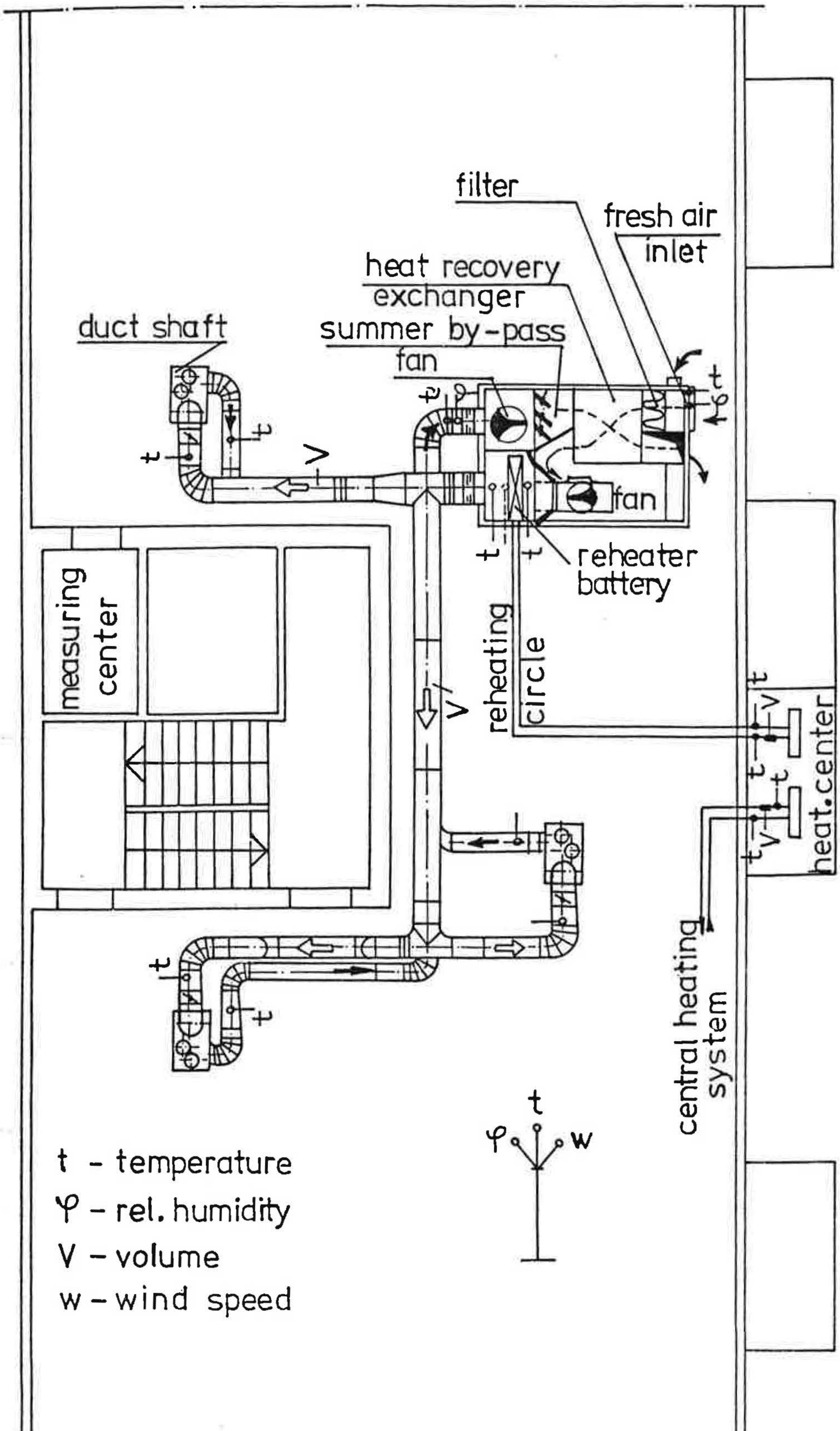


Fig.1. Plan view of the roof, roof-top ventilation unit and duct network

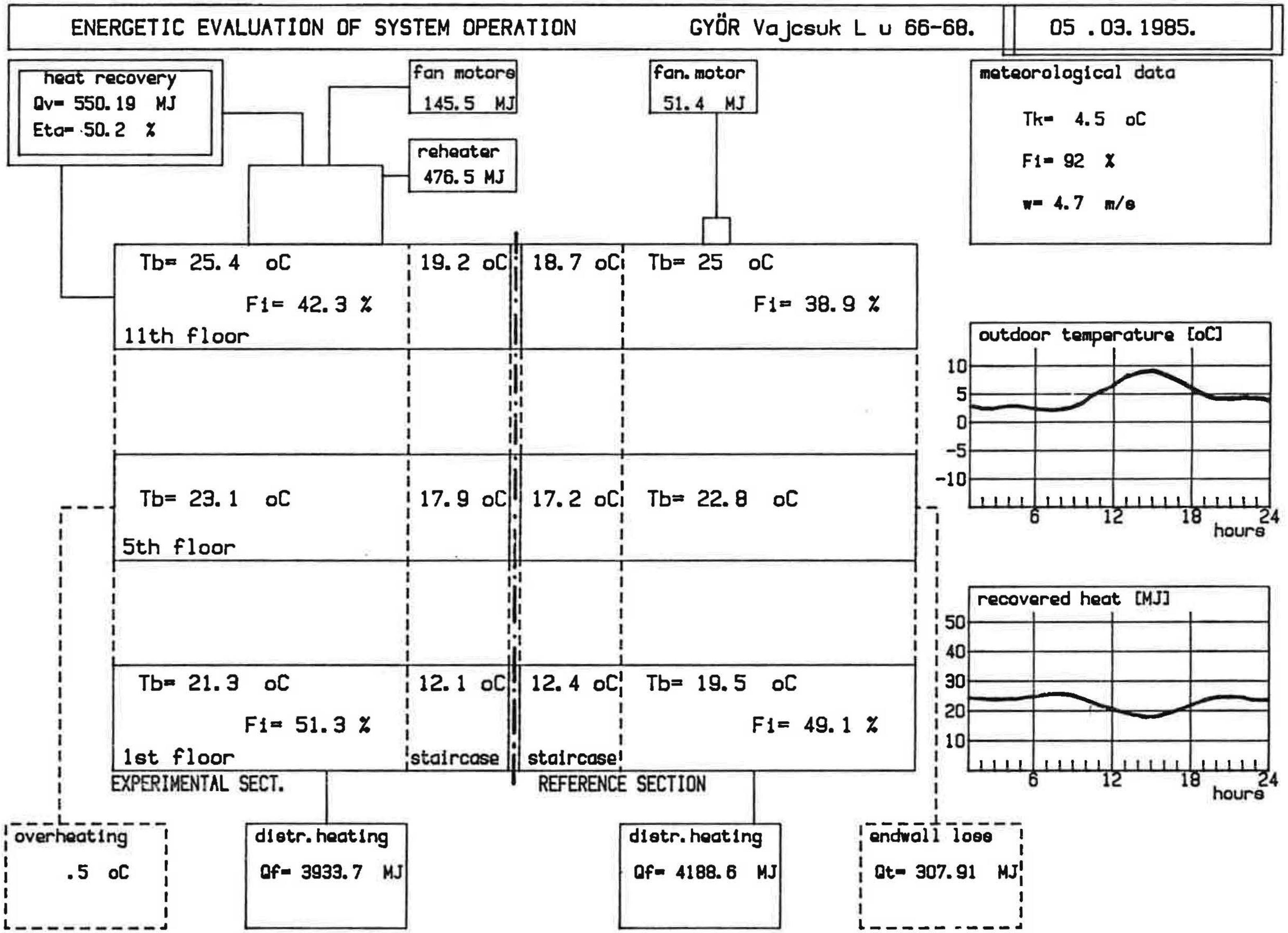
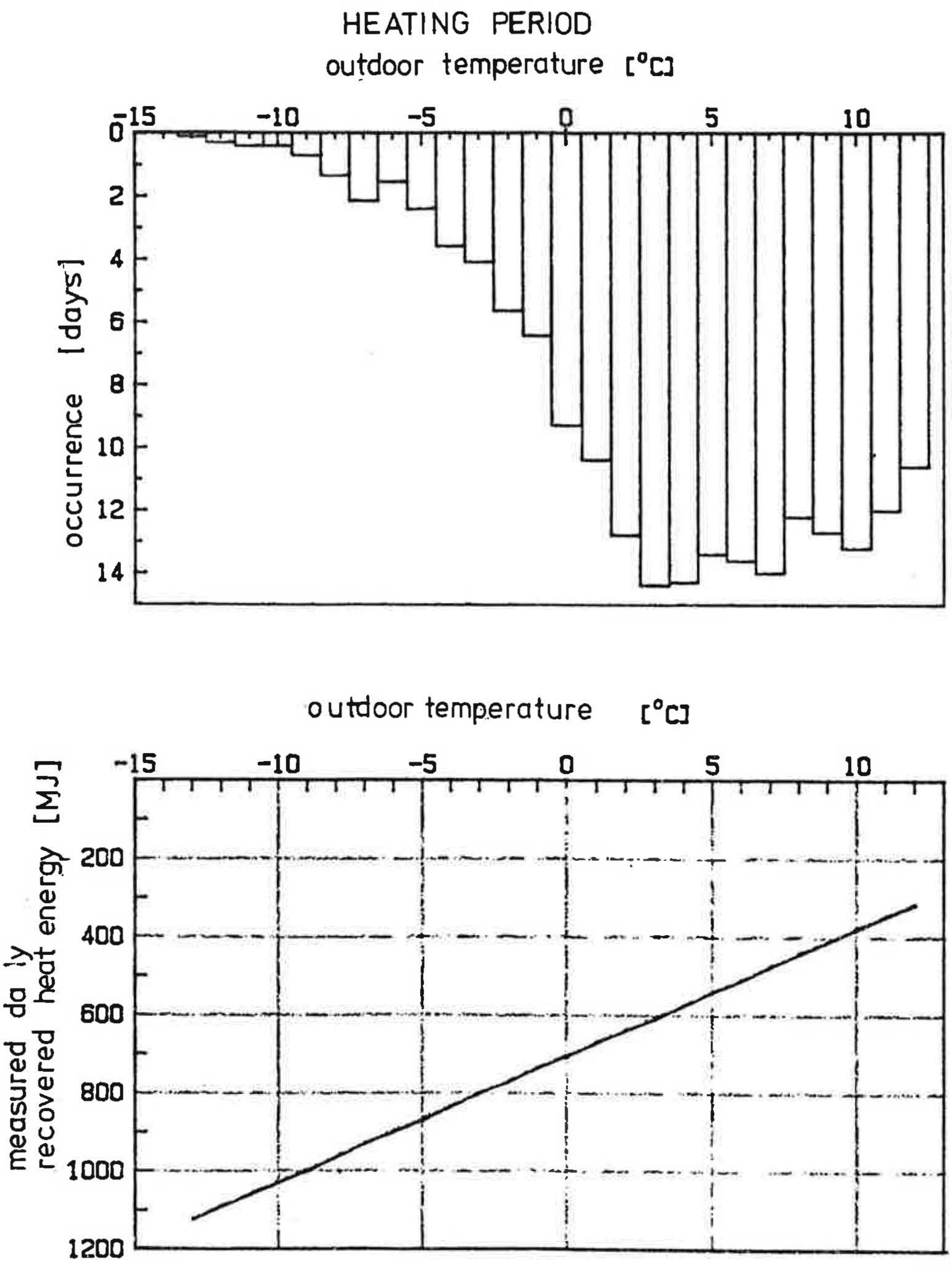


Fig.2. Sheet of summarized results



Summarized recovered heat energy weighted with the relative occurrence	:	106.8	[GJ]
Summarized surplus energy consumption	:	17.8	[GJ]
Regainable energy during a heating period	:	89.0	[GJ]

Fig.3. Predicted energy saving

In the reference section the suction-type ventilation system was the same as the exhausting part of the experimental one. The fresh air supply there, was provided through the cracks of the windows.

The main unit of the experimental system consisted of the following parts: 2 fans, fresh air grid, filter, air-to-air recuperative heat exchanger for recovery, re-heater battery supplied by the warm water district heating system, shutters for by-pass out of the heating season. The ventilation systems operated continuously through the days without interruption. The air change rate was about 0.6, the fresh and exhausted air volumes were balanced in about 100 m3/h (sucked 40 m3/h from kitchen and bathroom, 25 m3/h from lavatory/.

The one-year running of the experimental and reference ventilation systems was monitored. The data acquisition system was automatic in operation and was controlled by a Hewlett-Packard HP-85 desk-top microcomputer. The temperature-, rel.humidity- and pressure sensors were connected through cables into a scanner controlled by the HP-85. The collected data in every minutes were temporarily stored, then hourly averages were constituted and stored onto the tape-cartridge. Later the data were processed to the necessary form by a suitable program.

3. Results

The measured results were analysed and evaluated from three aspects:

- energetic evaluation,
- examination of indoor air quality produced by the ventilation system,
- effects of the occupants' behaviours on indoor climate.

The operational and energetic evaluation were the main target of the measurements. Complete energy balances were determined from the measured results. The daily balances were presented in summarized form as can be seen in Fig.2. Special attention was focussed on the amount of recovered heat (Q_v) and the efficiency of the recovery (Eta).

From the continuous measurement during heating period and from the statistics referring to the outdoor temperature occurences in Hungary the predicted amount of regainable heat energy (during the heating period) was determined (see Fig.3.).

The average indoor temperatures in the dwellings were in the range of 19-25 centigrades. Unfortunately - due to the badly adjusted central heating system - temperature gradient of 5-6 centigrades through the 11 storeys was found. The inside relative humidity was measured between 35-60 percent.

Beyond the measurement of the temperature and rel.humidity the effect of the air jet blowing from the fresh air inlets was also examined. The air jets coming from the inlets positioned above the doors did not cause unpleasant draught feeling in the occupation zone. The velocities measured within the jet decreased below 0.3 m/s within 0.8 m /distance from the inlet/, i.e. jets decayed rapidly.

To examine the influence of the occupants' behaviours on the indoor air quality some deliberate tests were also accomplished. Two kinds of activity were analysed:

- the influence of the durable window opening on indoor temperature run and
- the effect of the cooking on the indoor air.

The results of the tests were presented in form of daily temperature runs. Fig.4. shows an example. Windows of the two rooms of dwellings in the 11th and 1st storeys was open through 1 and 2 hours respectively. Due to the very intensive air change remarkable drop /3-6 centigrades/ in the temperatures could be observed.

Furthermore subjective tests were also made. Some occupants were asked about the ventilation efficiency after cooking and public opinions were collected and evaluated.

4. Conclusions

The main goal of the presented investigation work was to examine a newly developed balanced ventilation system - with comparison to a reference - and evaluation it's performance, operation and efficiency. However being a well equipped experimental site for comprehensive monitoring, there were possibilities to examine other problems, as well as the consequences of several occupants' activities, measurement of indoor flow patterns etc.

During the monitoring no operational problem was observed and from running experiences proposals for maintenance could be made /such as cleaning or changing the air filter is recomended bimonthly, some seasonal changes have to be made in the roof-top unit to alter the fresh air path etc./. Results coming from the energetic evaluation showed, that rémarkable amount of heat energy could be saved. This fact and the positive responses of the occupants proved the new balanced ventilation system more efficient and perfect compared to the reference one.

On the basis of the results of the comprehensive examinations the widespread utilization of the new system was proposed and the preparation for this has been launched.

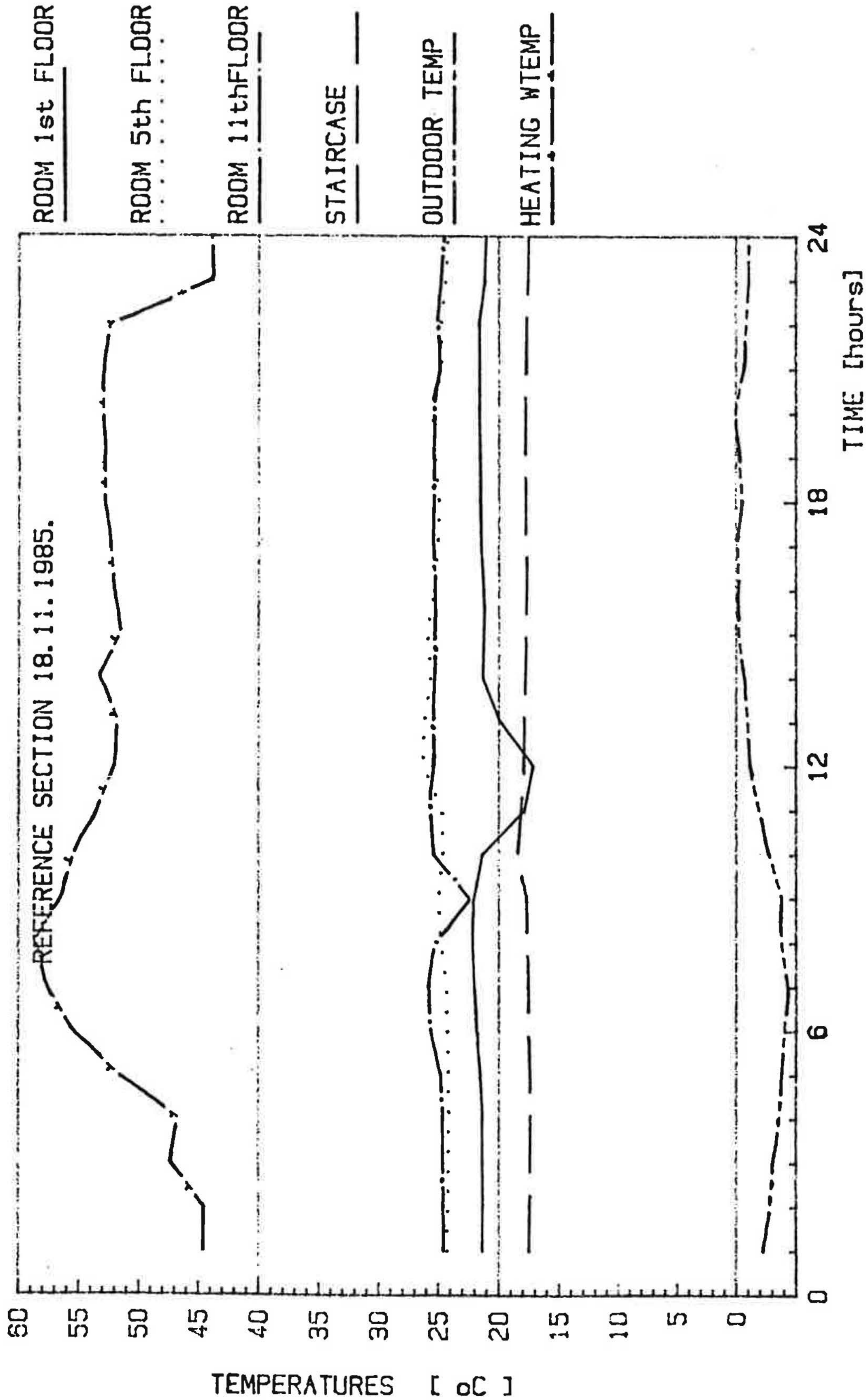


Fig.4. Temperature runs. The effect of window opening