RESEARCH REPORT

MEASURING AIR LEAKAGE

Christine Uglow describes a simple fan pressurisation technique being used at BRE to study the air leakage characteristics of dwellings.

The importance of providing correct levels of ventilation in dwellings is becoming more widely recognised, as a result of increased awareness of the problems of condensation[1] and the potential effects of other indoor pollutants, including carbon monoxide, formaldehyde and radon[2].

Overall air change rates give some indication of the likely quality of the internal environment, although these do not of course deal with ventilation rates in individual rooms or air movement within the dwelling. The BRE research programme on ventilation and air movement in dwellings tackles these issues in a number of ways. It includes both the development of computer-based mathematical models for predicting air infiltration rate and air movement in dwellings using tracer gas techniques, as described in earlier articles in this series[3,4].

This article is about the development and use of a much simpler technique, fan pressurisation, which is being used to improve understanding of the air leakage characteristics of dwellings. A portable fan assembly is sealed into the doorway of the dwelling (Figure 1) and the air flow rates required to maintain a series of pressure differences are measured. A standard procedure[5] is used by BRE to ensure that measurements from different dwellings are directly comparable. Accuracy and consistency of the equipment used for fan pressurisation testing are also important factors; a calibration chamber has recently been constructed at BRE to facilitate regular checking of the equipment's calibration. It is expected that this facility will be of interest to other organisations using pressurisation equipment.

BRE researchers and contractors have now carried out pressurisation tests in about 130 low rise dwellings and tests in a further 120 dwellings are under way. To date, air leakage rates (expressed, according to international convention, in air changes per hour at an applied pressure difference of 50 Pa) of between 5 ac/h (50 Pa) and 25 ac/h (50 pa) have been found. Results for 100 dwellings, covering a cross-section of dwelling age and construction type, are shown in Figure 2.

Variations of up to 30% have been found in the total air leakage rates of nominally identical houses, which means that large numbers of houses must be tested to provide firm trends and correlations with key physical characteristics. There is some indication, supported by measurements from overseas, that leakage rates increase during the first year of occupation of the house, but thereafter remain relatively constant, except for small seasonal variations.

The total air leakage rates in a group of 62 pre-1939 houses tested by the City of Birmingham Polytechnic varied between 5·3 ac/h (50 Pa) and 20·3 ac/h (50 Pa), with an average of 10·6 ac/h (50 Pa). The majority of the houses in this sample were of terraced construction. By comparison, leakage rates in a group of 38 post-1960 houses tested by BRE, predominantly of semi-detached construction, varied between 4·9 ac/h (50 Pa) and 24·7 ac/h (50 Pa), with an average of 13·0 ac/h (50 Pa).

The major advantages of the fan pressurisation technique are speed and simplicity; a whole house test can usually be conducted in less than two hours, with minimal disturbance to occupants. Tests are carried out at high differential pressures (typically 10 to 60 Pa), to ensure an even pressure distribution over the dwelling and air flow rates and pressure differences which can be accurately measured. Obviously, the results obtained do not give a direct indication of the infiltration rate which would occur under the natural pressure differences caused by the effects of wind and temperature difference. However, this can be estimated from the results of the fan pressurisation test using a single-cell mathematical model developed at BRE[6], which, together with surface pressure coefficients determined from wind tunnel studies, predicts air infiltration rates under chosen weather conditions.

The pressurisation technique can also be used to indicate the relative importance of different air leakage paths. Measurements to date indicate that leakage through windows can account for between 5 and 60% of total air leakage (at an applied pressure difference of 50 Pa), although 20 to 40% is a more representative range. This means that in most houses, less obvious leakage paths account for the major proportion of ventilation, which must be taken into consideration when assessing the cost effectiveness of routine draughtproofing treatments.

To investigate this further, measurements of whole house air leakage rates, before and after draughtproofing, are being made in collaboration with a number of Neighbourhood Energy Action Groups.

Use of the pressurisation technique could increase in the UK, both as a quality control for new dwellings and to determine when dwellings should or should not be draughtproofed. BRE contractors will be using the equipment and recommended procedure over the next few months, with a view to identifying areas for possible improvement.

While not answering all questions about ventilation performance, fan pressurisation promises to provide useful data on the housing stock and a possible way forward on at least one aspect of quality assurance and quality assessment of an individual dwelling.

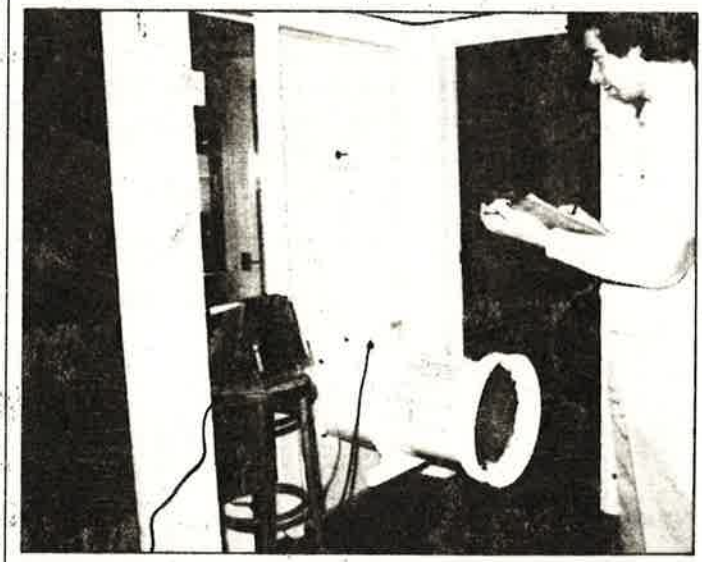

Figure 1: **Pressurisation rig in a BRE experimental house. The calibration of the equipment is checked regularly in a new chamber at a Garston.**

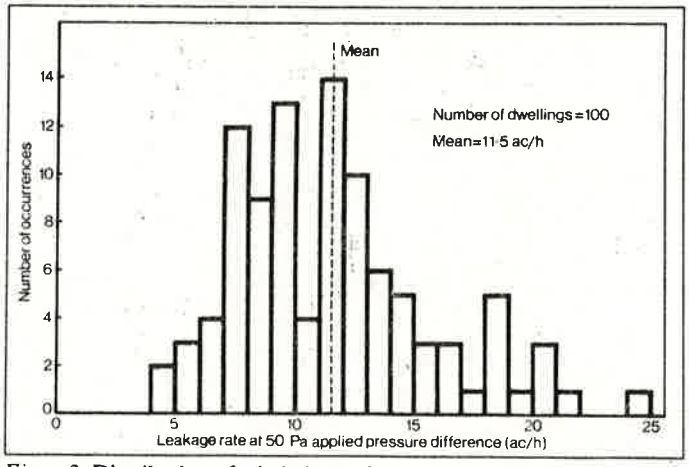

Figure 2: **Distribution of whole house leakage rates at 50 Pa.**

References

1. BRE Digest 297 *Surface condensation and mould growth in traditionally built dwellings.*
2. BRE Digest 306 *Domestic draughtproofing: ventilation considerations.*
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5. Stephen, R K and Webb, B C. *BRE recommended standard procedure: determining the airtightness of buildings using the fan pressurisation technique.* To be published.
6. Warren, P R and Webb, B C. *The relationship between tracer gas and pressurisation techniques in dwellings.* Proc 1st Air Infiltration Centre Conference, Windsor, Oct 1980.

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