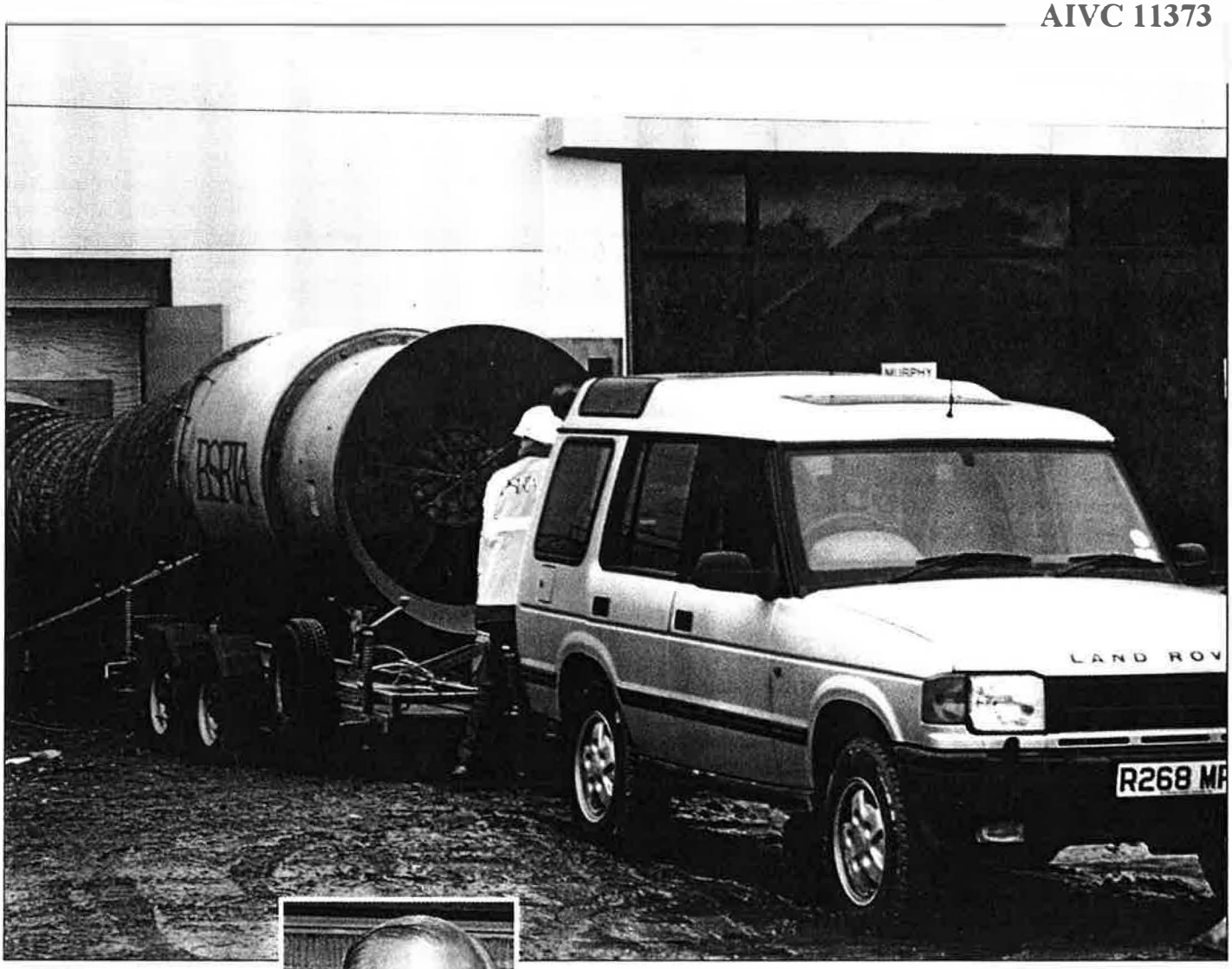

The world's leakiest buildings

Britain has a serious problem with air infiltration rates, as the press has been constantly reminding us, but there is considerable difference of opinion over the best course of action to take. **Geoffrey Brundrett** picks his way through the alternatives for achieving tight buildings.

It is a sad fact, but it appears that Britain has the world's leakiest buildings. We have brought our thermal insulation standards up to levels above those of our European partners, in the past twenty years, but unlike them we have neglected infiltration losses.

Recent attempts to rectify the situation by introducing pressure testing have run into trouble, largely because each set of requirements uses different values, and even different test pressures, making it difficult for architects to translate performance testing into the construction detail needed to achieve it. One simple regulation for all would ease the problem.

There is still much confusion caused by the misplaced association in many people's minds between infiltration and ventilation.

Many delegates at the recent BRE/CIBSE Air Tightness Workshop believed that high infiltration was a good and necessary feature because it actually provided the ventilation.

However, it is the supermarket chains, led by Tesco, that are looking to set the standards today. All supermarkets require two key items for all their new buildings: The first is delivery on time, and the second is pressure testing to a high standard to verify the infiltration performance. Their driving force is economics. Not energy economics, but trading economics. The longer a customer remains in the store the more likely he is to make another purchase. Customer comfort is paramount. The cost savings in energy use, the environmental benefits of low waste and the less rapid ice deposition on frozen goods are beneficial side effects of tight infiltration specification.

Preliminary pilot studies by the BRE suggest that similar benefits can be applied to office workers. Office workers who are warm and comfortable are more productive and happier. They should also be healthier if their ventilation comes in a planned way independent of the

vagaries of weather and with the air properly filtered to remove outdoor contaminants.

Professor Phil Jones, University of Wales, Cardiff, demonstrated at the workshop how important air leakage was in industrial buildings. A combination of pressure testing and infra red camera scans will show the magnitude of infiltration losses and the routes the air takes, as well as areas where thermal insulation has been accidentally omitted.

Such tests could be invaluable tools for builders.

Simple analysis techniques, such as progressively applying plast c sheeting to the doors, then the windows and so on, while measuring infiltration, can highlight their relative importance. Industrial roller doors are built robustly, but some are particularly leaky. The project, sponsored by the Welsh Development Agency, BRE, British Gas and Rockwool, led to much rethinking on the design of factory units. Typical infiltration rates were from 0.25 air changes an hour (ach) to 1.4 ach in the factories, with excursions up to almost 3 ach in leaky buildings in windy weather.

Insulation

Infiltration can also undermine the benefits of the thermal insulation. Heat flow meters show how a wall designed for 0.45 w/mK°C conducts over three times the heat flow through the wall when poor detailing leads to air infiltration behind the insulation.

Doug Lawson, of Building Sciences, is a missionary Canadian bringing established sealing techniques to Britain. The concept of air barriers, long recognised in other parts of the world, are not too well known in Britain, he says.

The best procedure to achieve tight buildings is to design an air barrier, complete with continuous seals, into the structure. Special attention is needed in linking up all the components of the air barrier to achieve this continuity. Close site supervision is necessary too, particularly if the construction company has only built conventional British buildings. Leaky buildings can be cured, but this is difficult once the final fit of services is completed. Occupied buildings can contain small areas of high infiltration and this is usually blamed on poor or inadequate heating or air conditioning.

Sealant technology is also new to Britain. There is a wide range available which will bond to appropriate materials, will be long lasting and not rot or dry out. Care is needed in selecting the right one and knowledge of the post application odour is essential. In discussion, the selection of window gaskets was questioned. Gasket manufacturers provide a very reliable and high performance specification for the motor industry. However, up to now the construction industry has bought on lowest first cost, regardless of specification. Much better products are available at fractionally higher prices.

The current status of air tightness in buildings in Britain was reviewed by Brian Webb of the Building Performance Assessment Centre, BRE. The theme '*Build tight - ventilate right*' has been a Government slogan for many years and the principle is built into the current Building Regulations - albeit unquantified.

The BRE, in response to requests from architects, produced a guidance document, BRE Report 265, in 1994. Common infiltration paths are identified and solutions offered.

The International Energy Agency recognised the importance of infiltration and sponsored the Air Infiltration and Ventilation Centre, based in Coventry, as the international centre of activity in this area. Many ventilation and infiltration guides and reviews are available.

CIBSE has responded by being amongst the first to specify a performance figure for pressure testing buildings. For naturally ventilated buildings the recommended standard for air tightness is less than 5m≥h/m at 25 Pa overpressure test. The PROBE building assessments now include pressure testing to quantify air tightness. Some buildings to date have been shown to be extremely leaky.

Type	Max air leakage normal	m³/h/m² at 50 Pa best practice
Office natural ventilation	10	
air/conditioned or low energy	5	3
Factories	15	10
Retail stores	5	3
Cold stores	1	0.5
Dwellings	7	3

Infiltration rates for commercial buildings varied from 3 to 40m³/h/m² at 50 Pa pressure.

BSRIA carries out a lot of pressure testing, and Peter Jackman, research director, shared this experience of over 300 tested buildings with the aim of setting best practice targets (The BSRIA test rig is pictured on the previous page.)

Stringent

The essential degree of air tightness varies with the type of building. Cold stores for example require a particularly stringent specification to maintain food quality and to minimise energy losses. Leaky air conditioned buildings will have high energy bills and large running costs.

Naturally ventilated buildings are less critical unless they are in areas of high wind exposure. Museums and archival storage buildings often require very close control of temperature and humidity together with the exclusion of pollutants. Such buildings could require a particularly tight air leakage specification. (The table *above* shows the BSRIA recommendations.)

In practice, a typical UK office will have around 20 m³/h/m² air leakage at 50 Pa. When the client has called for a tight building, even down below 5m³/h/m² at 50 Pa, it has been built without too much difficulty up to now. Conventional wisdom is that, by the time the builder has built three low infiltration buildings, his staff will have learned how to achieve it by adjusting their normal building practices.

● The CIBSE/BRE Workshop agreed to set a standard infiltration test procedure and test pressure; to incorporate an easily achievable pressure test specification into the Building Regulations Part L - so providing one simple standard, which everyone could understand.

It was also agreed to develop a computer program which would convert the result of the pressure test into more meaningful units such as average air changes per hour or energy cost. For services engineers, the worst case design scenario of winds at low temperature needs to be translated into design day heat loss for boiler and radiator sizing.*

There is an urgent need to promote the information on the need for low infiltration buildings to all the many user associations and educational establishments, and to demonstrate the increase in occupant satisfaction and reduction in energy consumption when a known leaky building is made tight.

Delegates at the Balham workshop also agreed to lobby for a building energy label scheme, of which low infiltration would be a critical step.

However, the industry should bear in mind that once designers succeed in producing a tight building shell, full responsibility for the ventilation aspects will fall upon the building services engineer.

Are we ready for this?

* One program, the *Air Infiltration Development Algorithm* by AIVC does this and is a public domain program available from the Air Infiltrat on and Ventilation Centre, Coventry (01203 692050).

● BSRIA has just produced an updated guide: '*Air Tightness Specifications*' 10/98, which outlines much of the technical detail associated with this problem area. Contact 01344 426511.

● Geoffrey Brundrett is the immediate past president of CIBSE.