# A Fresh Look At Default Air Changes In UK Domestic Properties

## Context

One of the details that transpired from the Heat Pumps Unconference (Energy Systems Catapult June 26 2023) was the issue of inaccurate default data used in heat calculations. This can lead to inflated heat pump specifications pushing up costs and complexity while reducing efficiency.

I have gathered the available evidence to inform the debate on the scientific (or otherwise!) basis for default air change rates used currently in heat calculations. It is unclear where the current defaults originate.

Title

**The Reduction in Air Infiltration due to Window Replacement in UK Dwellings: Results of a Field Study and Telephone Survey**

Authors

**T. Oreszczyn,D. Mumovic,I. Ridley &M. Davies**
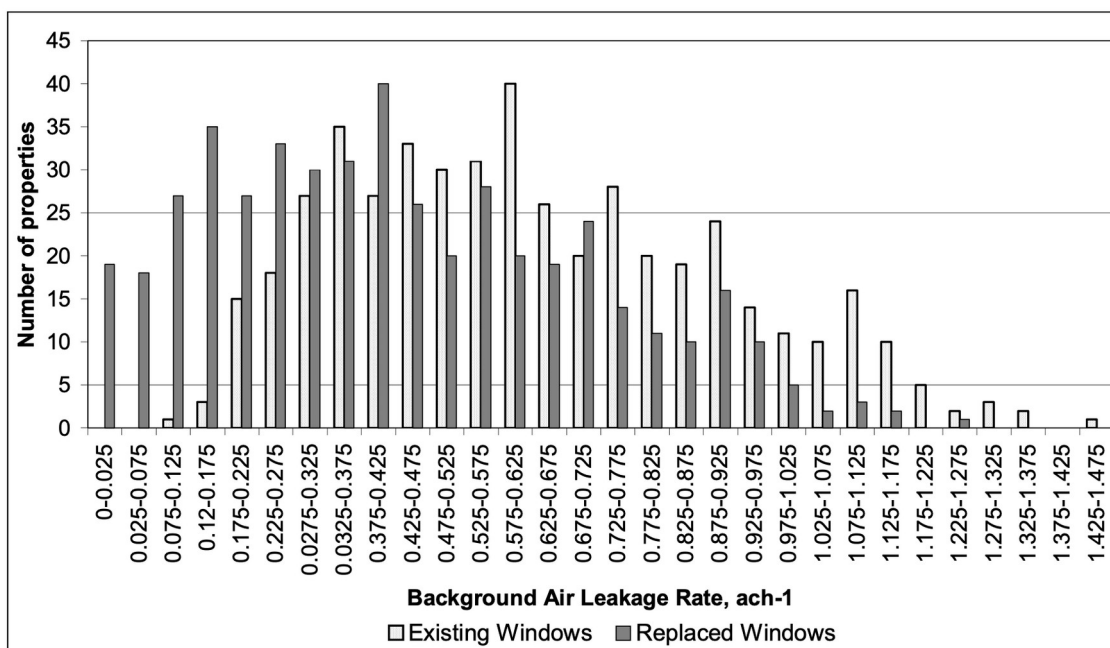
Data



Figure 1. Distribution of air infiltration rates predicted from BRE pressure test data, before and after the possible effect of the installation of new windows.

Observations.

"Analysis of the results suggests that installation of replacement windows in UK dwellings significantly reduces background infiltration rates, and that 65% of dwellings in the UK would have a predicted heating season mean **air change rate below 0.5 ac/h** after the installation of new windows"

Title

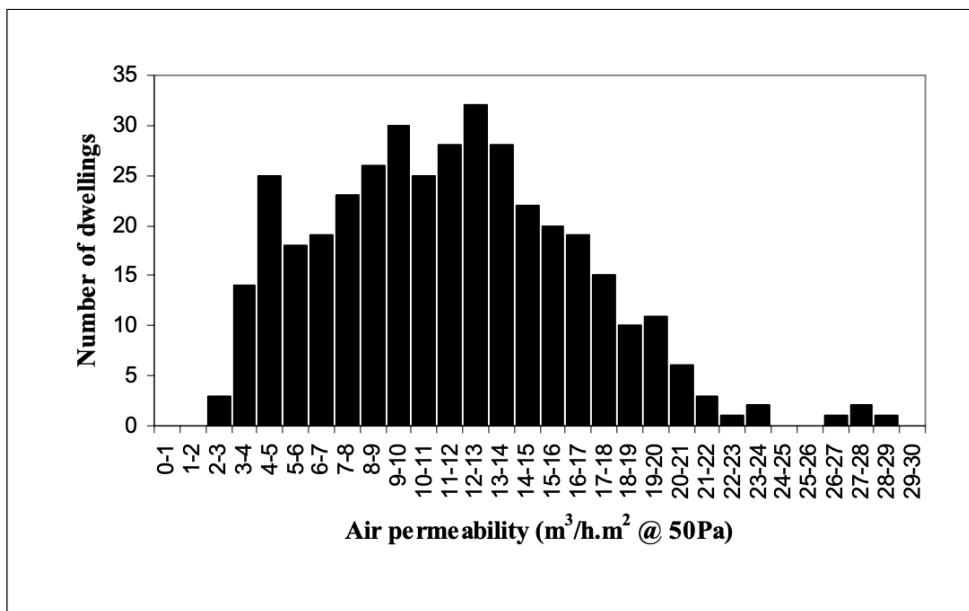**AIRTIGHTNESS OF UK DWELLINGS: SOME RECENT MEASUREMENTS**

Authors

**Johnston D, Miles Shenton D, Wingfield J, Bell M.**

Publishing Date 7 September 2004
Web link
https://eprints.leedsbeckett.ac.uk/id/eprint/644/1/cobra04-3.pdf

Data



**Figure 2** Distribution of air permeability for UK dwellings in the BRE database.

Observations
This study was a small study of modern timber framed properties. But figure 2 above quotes previous research that puts the 'average' ACH of UK properties at around 0.5 ACH ( using the divide by 20 'rule of thumb').

Title
**Estimation of the infiltration rate of UK homes with the divide- by-20 rule and its comparison with site measurements.**

Authors
Alan Vega Pasos1, Xiaofeng Zheng1*, Luke Smith2, Christopher Wood1

Web Link
https://www.sciencedirect.com/science/article/abs/pii/S0360132320306466?via%3Dihub

Data

Table 4. Blower door test results.
Mean value from pressurisation and depressurisation.

| Dwelling | Air change rate @50 Pa ($n_{50}$) $h^{-1}$ | Air Permeability @50 Pa ($q_{50}$) $m^3 \cdot h^{-1} \cdot m^{-2}$ |
|---|---|---|
| 1 | 7.62 | 7.88 |
| 2 | 5.76 | 6.03 |
| 3 | 8.59 | 7.90 |
| 4 | 5.31 | 4.40 |
| 5 | 3.51 | 3.86 |
| 6 | 7.86 | 7.60 |
| 7 | 8.61 | 7.22 |
| 8 | 5.77 | 6.04 |
| 9 | 7.10 | 6.81 |
| 10 | 10.45 | 10.04 |
| 11 | 9.73 | 8.77 |
| 12 | 8.33 | 5.85 |
| 13 | 14.97 | 13.61 |
| 14 | 5.07 | 4.68 |
| 15 | 5.58 | 5.33 |
| 16 | 13.27 | 11.16 |
| 17 | 4.13 | 4.29 |
| 18 | 11.34 | 9.92 |
| 19 | 13.29 | 13.43 |
| 20 | 12.24 | 13.87 |
| 21 | 7.73 | 7.60 |

Observation  "The average air permeability of the 21  dwellings is 7.92 m3•h-1•m-2."
which equates to  **0.4 ACH** using the divide by 20 rule of thumb.

Title
**Air-tightness field data for dwellings in Ireland**
Authors
Derek Sinnott and Mark DyerDate Published May 2012

Web link

https://www.sciencedirect.com/science/article/abs/pii/S0360132311004008

Data and Observation

This extract shows a **0.4 ACH** for pre 1975 buildings in Ireland

This last bit of data is not from a peer reviewed study but is informative, along with a comment by Build Test Solutions technical director Richard Jack. A pulse test is an alternative to the more traditional ' blower door' test.
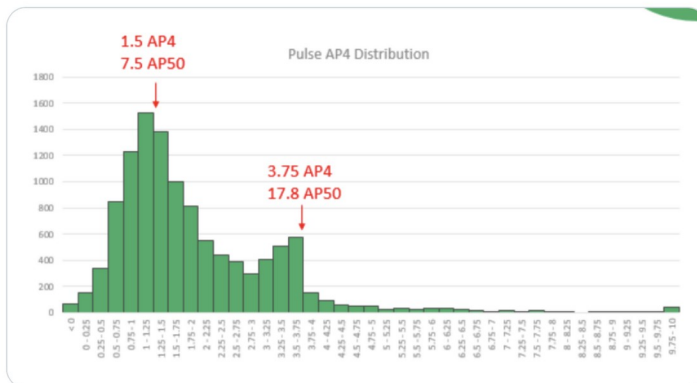
You can see that the vast majority of properties are below 0.9ACH suggesting a 'default' average at around half that figure.



**The Divide by 20 'rule of thumb'**

A blower door or Pulse test is used to measure the leakiness of a property. The property is pressurized to 50Pa and results are derived. In order to give a meaningful figure for the property in normal operation the results are divided by 20. This is often where confusion sets in because some results are published before this division and some after. The figure used in heat calculations is the divided by 20 figure.

There is evidence that this 'divide by 20 rule of thumb' is underestimated and should be adjusted to 'divide by 39' for accuracy. See the conclusion below taken from a study of 5 houses in the East Pennines. Note that the average ACH for the properties is 0.17 ACH.

## 4  CONCLUSION

Five houses in the East Pennines region of the UK were tested by means of pressurisation. Air permeability ($m^3h^{-1}m^{-2}$) and air change rate ($h^{-1}$) quoted at 50 Pascals were presented. Tracer gas concentration decay tests were carried out, following the pressurisation tests in the same dwellings to directly determine the air infiltration rate.

Pressurisation tests showed that all the houses comply with the British building standard requirement with air permeability rates lower than 10 $m^3h^{-1}m^{-2}$. Tracer gas tests showed an average infiltration value of 0.1755 $h^{-1}$.

Standard Assessment Procedure (SAP) evaluates the energy efficiency of dwellings in the UK. An important factor in SAP is the air change rate and it is obtained through dividing the air permeability ($q_{50}$) value of the house (obtained by a pressurisation test) by 20. This rule is known as the divide-by-20 rule of thumb. The rule of thumb was evaluated and results suggest that, if a ratio is used, a number closer to reality is 39 for the test dwellings in this study. This was true for both, $q_{50}$ and $n_{50}$. Errors between 5% and 165% were found; the rule overestimated the infiltration rate for all tested dwellings. After adding the modifying factors, SAP overestimated the air infiltration rate creating errors larger than 500%. The fact that dwellings are getting tighter might not be reflected by SAP.

Suggestion of the revision of the modifying factors and the utilisation of the rule of thumb were given. A larger testing campaign in different areas of the country would deliver a better vision on whether the rule should still be used, or a more accurate model must be included in the regulation.

Compilation and comment created by Andrew Cunningham

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