Statistics, analysis and conclusions from 250,000 blower door tests, including ventilation types.

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ABSTRACT

With lower air leakage in modern homes, ventilation of homes has become more important than ever before. It seems however that we are getting it very wrong. A lack of ventilation can cause building sickness, with degradation of the physical building and also poor air quality which has a big impact on the occupants themselves. Our statistics show that designers and contractors are still not getting it right, leaving us with a generation of poorly ventilated housing stock.

The Air Tightness Testing and Measurement Association (ATTMA) introduced a lodgement system in September of 2015 that records results of approximately 85% of all air leakage tests in the United Kingdom. The Lodgement system also records the type of ventilation installed plus another 25 fields that allow us to study statistics in depth.

The ATTMA is able to therefore demonstrate that the average home is not adapted for the ventilation system installed. From the 200,000 tests, the average result between a System 1 (Trickle ventilators and intermittent extractors) and a System 4 (Whole house heat recovery ventilation) is only 0.39 m3.h-1.m-2@50Pa, the equivalent of a leaky letterbox. A System 4 ventilation type is usually designed to work with very low air leakage homes, yet the same building type and build quality is observed regardless of the ventilation strategy.

From the same data, we can also see that a staggering 58% of dwellings are still built using traditional ventilation strategy, System 1. Perhaps more concerning is the number of properties using a System 1 ventilation type but scoring a very low air leakage (less than 3.00 m3.h-1.m-2@50Pa), an estimated 10,000 dwellings a year. The percentage of System 4 ventilation types in comparison is 29%. Perhaps the scariest statistic of all is 85% of all dwellings tested with a System 4 ventilation type achieve greater than 3.00 m3.h-1.m-2@50Pa which could lead to inefficient heating because of the level of uncontrolled ventilation.

So what can we do to put this right? The legislation makes reference to the ventilation and infiltration needing to be matched but this is not regularly enforced by Building Control or Approved Inspectors. Contractors need to take the issue seriously. This may not happen until the poorly ventilated homes are exposed and building warranty providers are left with millions of pounds of claims.

KEYWORDS

Air Tightness, Lodgement, Data,

1 INTRODUCTION

The Air Tightness Testing and Measurement Association (ATTMA) introduced a lodgement system in September of 2015 that records results of approximately 85% of all air leakage tests in the United Kingdom. The Lodgement system also records the type of ventilation installed plus another 25 fields that allow us to study statistics in depth.

The data recorded has now surpassed 250,000 tests which is one of, if not the, biggest collections of air tightness test data in the world. This paper looks at the conclusions we can draw from the data and how we can use this data to shape building regulations going forward.
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2 BACKGROUND

2.1 Who is ATTMA?

ATTMA is both a UK based trade association and a government appointed Competent Persons Scheme. ATTMA exists to promote the value of air tightness testing to both the construction industry and to vendors that eventually purchase the buildings.
ATTMA run a not-for-profit competent person's scheme which means it reinvests all money made back into the industry which happens in a myriad of ways, from promotion in magazines through to industry research projects.

3 LODGEMENT

3.1 What is Lodgement?

Lodgement is the process of sending information from a test to an independent body and in return, receiving an authorised certificate.
From the 1st September 2015 this became a mandatory requirement for all members of the ATTMA scheme.

3.2 Introducing Lodgement into the Industry

Introducing lodgement to the air tightness industry was arguably the biggest challenge of all. The industry at the time was fragmented, with some testers providing lengthy reports for each air tightness test and some testers providing a single page certificate. The ATTMA sought to unify the industry and have all members produce the same output to make judging the validity of a test a faster, more simple process. The ATTMA were able to step in and reject certificates that are not valid and stop them being used for compliance.

3.3 The Process

In order for lodgement to be successful, it had to:

a) Not be time consuming for the members
b) Be simple and easy to understand

We set about trying to develop a process that worked for all members. We grouped the industry into three categories:

1) **Occasional tester** – tester that would normally conduct less than 50 tests a year, would generally handwrite results onto pre-printed certificates

2) **Medium sized testers** – tester that would normally conduct between 50 and 500 tests per year. Testers would normally provide a copy of the proprietary software output as evidence of the test.
3) **Large testers** – Would conduct more than 500 tests per year, would generally use their own test software and output, typically written on Microsoft Excel.

We looked at the list and came up with a simple solution for each:

1) **Occasional tester** – we could have them manually fill out information on a 'web based program'
2) **Medium tester** – we could work with the proprietary software manufacturers to introduce a 'lodge' button directly into the software
3) **Large tester** – we could, within the 'web based program' have a csv upload function which would allow large batches of testers to upload information.

From the thought process, we realised our lodgement system would add benefits to the members, which include:

a) Significantly reduced administration time
b) Records of all tests
c) Records of calibration details
d) Third party checking of data in real time

3.4 The Developer

Once we had realised what we needed we had to have the system built. Unfortunately, ATTMA at the time was not cash rich but convinced a developer to take on the project on the basis that we would pay them each time we had a lodgement. The advantage for ATTMA was that we would not need to pay large amounts of money for a developer and the incentive for the developer was that, the better the system, the more members we would attract and therefore the more money they would make in the meantime.

3.5 Proprietary test Software

The hardest part of our development was ensuring our newly created database would work seamlessly with the current software provided by both Retrotec and The Energy Conservatory. Both companies saw the bigger picture and agreed to work with us to complete the automatic lodgement process.

4 DATA

4.1 Fields

The data collected consists of the following fields:

- Test Date
- Plot Number
- Address
- Town / City
- County
- Postcode
- Country
- Dwelling or Non-Dwelling
- Envelope Area
- Footprint Area
- Ventilation Type

- Temporary Sealing
- Deviations
- Result
- Design Air Permeability
- Correlation of Results
- Flow Exponent
- Air Flow Coefficient
- Mastic Sealing Status
- Customer References
- Test Type
- Lodgement Type
- UKAS Registered
- Retested

The following fields were added in May 2017

- Building Type
- Construction Type
- Heating Type
- Air Conditioning
- No of Storeys
- Warm Roof Construction
- Pressurisation (Positive or Negative)
- Method (Manual or Auto)
- Q50
- Volume
- Calibration Exponent
- Calibration Coefficient

4.2 Numbers

We were amazed to see the number of lodgements made through our system. Table 1 shows the number of lodged tests received in our system within the end of the 2015 until 31 May 2017

Table 1: Table Caption

2015*	2016	2017**
40,826	133,599	67,294

*2015 data between 1st September 2015 and 31 December 2015
**2017 data between 1st January 2017 and 31 May 2017

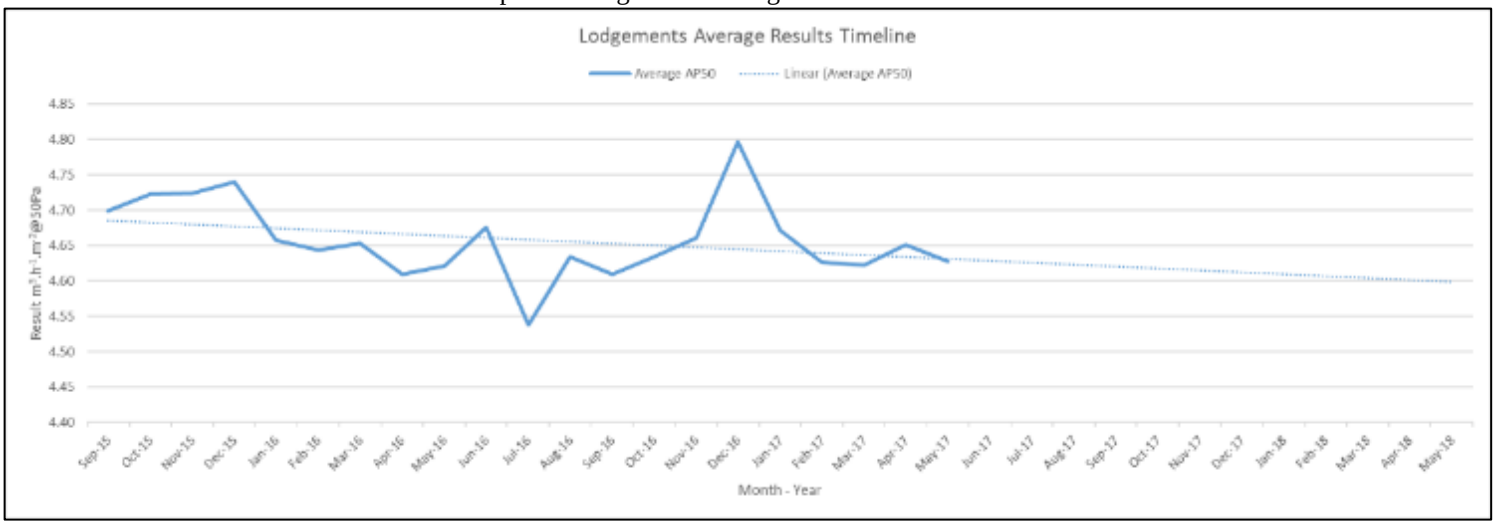
5 STATISTICS

With the large volume of data, we are able to identify trends that, perhaps were always known but never proven. Below is a serious of data graphs and tables that highlight this information.

5.1 Average results over time

The data in Graph 1 shows that the average air permeability result is only very slowly decreasing. Between 1 September 2015 and 31 May 2017 the average result has only decreased by 0.07 m3.h.m2@50Pa.

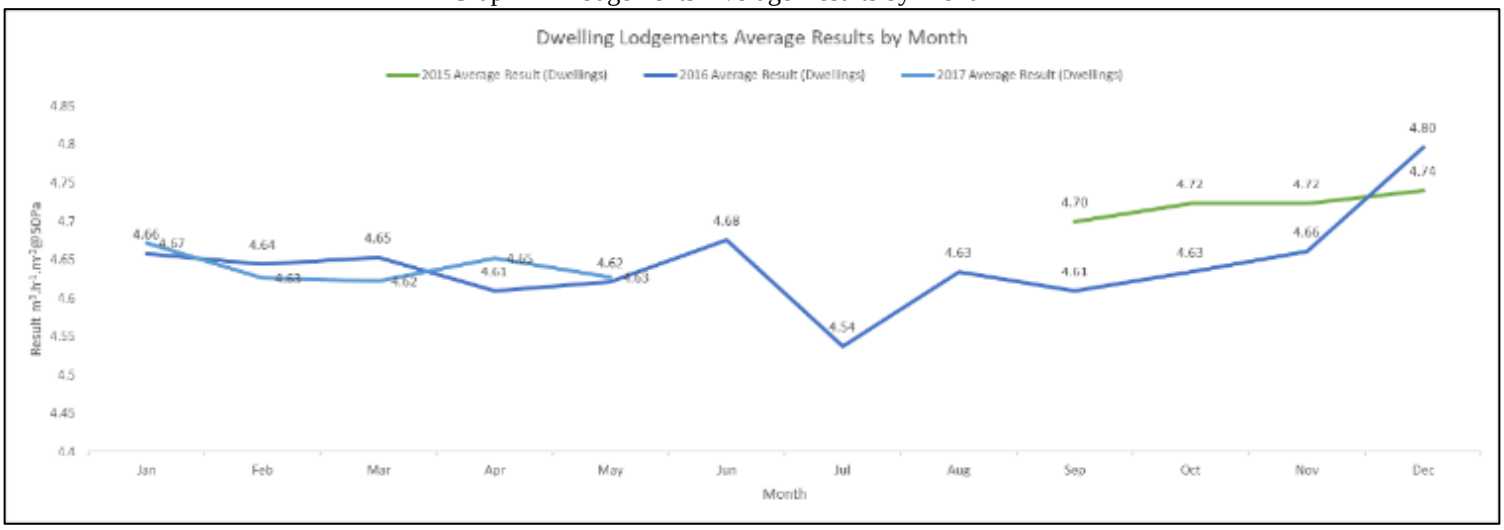
Graph 1 – Lodgement Average Results Timeline



The UK had a target to achieve Near Zero Energy Building status by 2020, but at this rate it will take more than 80 years! Without further input from the UK government it is likely the industry will never achieve NZEB status.

Graph 2 shows the same data but overlaid to give an indication by month.

Graph 2 – Lodgements Average Results by Month

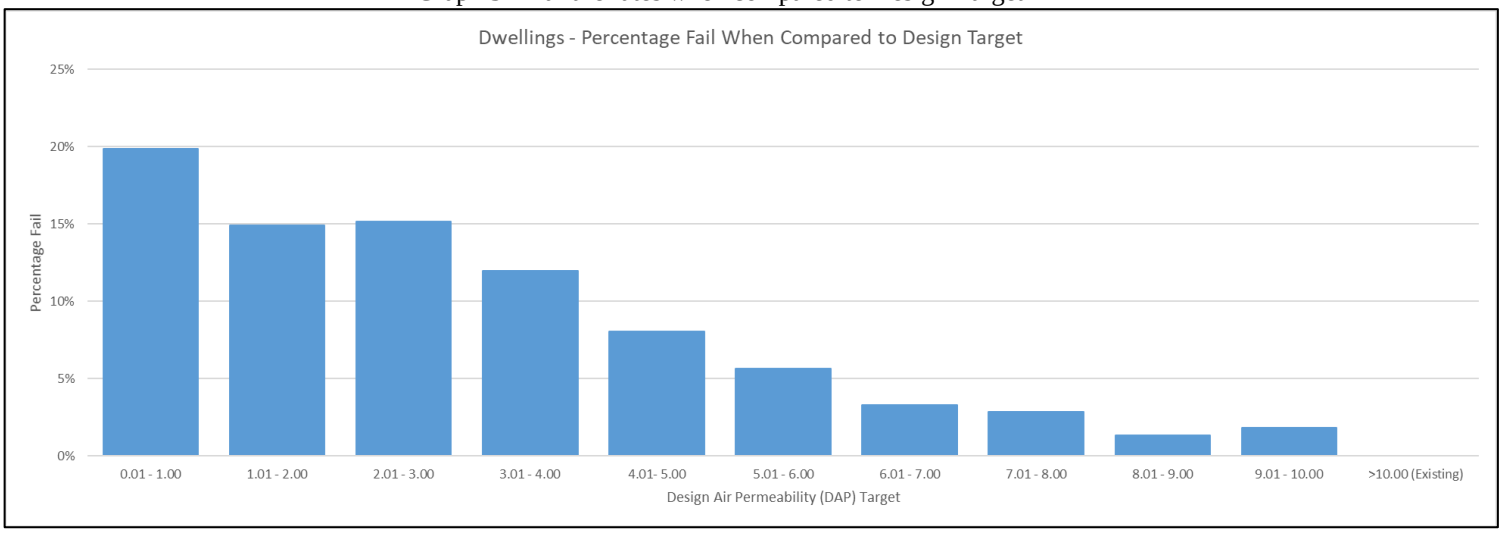


We had initially expected that the fall in air permeability would be much sharper, as the average results appeared to be reducing quickly between 1 September2015 and 30 April 2016.

5.2 Failure Rates Compared to Design Target

One of the more obvious statistics was the failure rates when compared to design target, as identified in Graph 3.

Graph 3 – Failure rates when compared to Design Target

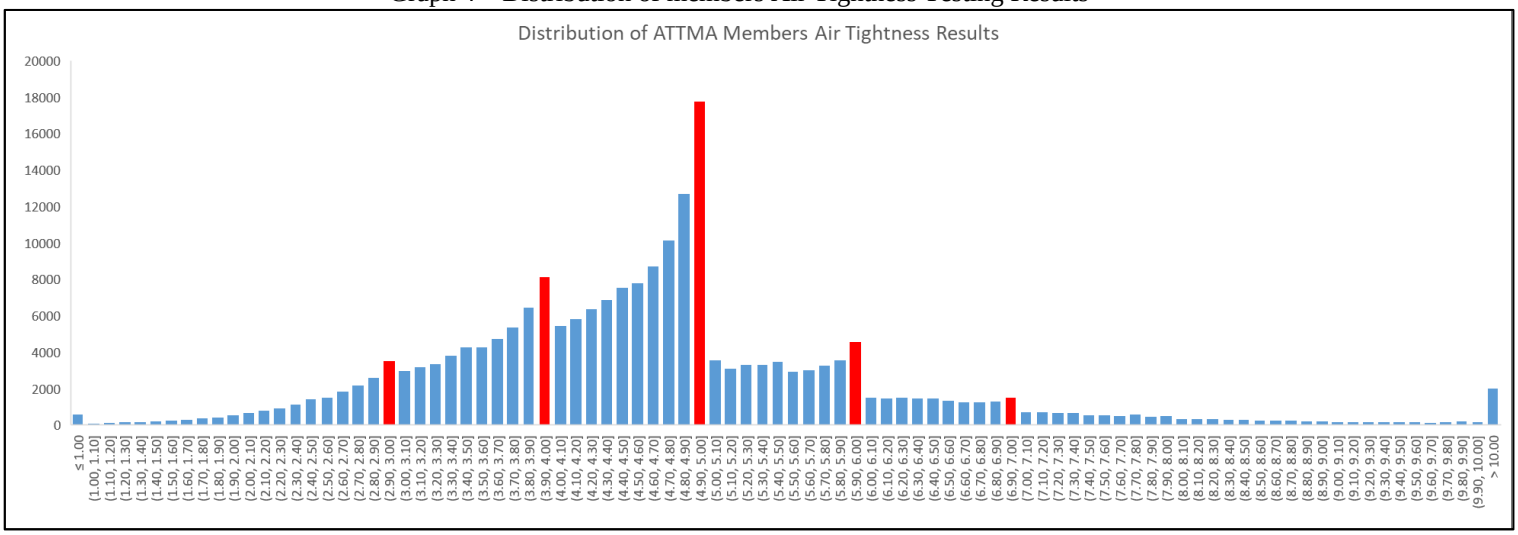


In short, the lower you set your target, the more likely you are to fail to meet your target.

5.3 Distribution of Data

We took the results for all tests and created a distribution graph, as shown in Graph 4, which raises some very serious concerns.

Graph 4 – Distribution of members Air Tightness Testing Results



The columns highlighted in red show the typical targets set by the energy modellers for air tightness testers.

Perhaps the most striking part of this graph is the drop between the number of results that achieve between 4.90 and 5.00 compared to the number of tests that achieve between 5.01 and 5.10.

We can conclude that, as a country, we are not comfortably meeting air tightness targets but scraping through each test, relying on final finishes to ensure we achieve the desired targets.

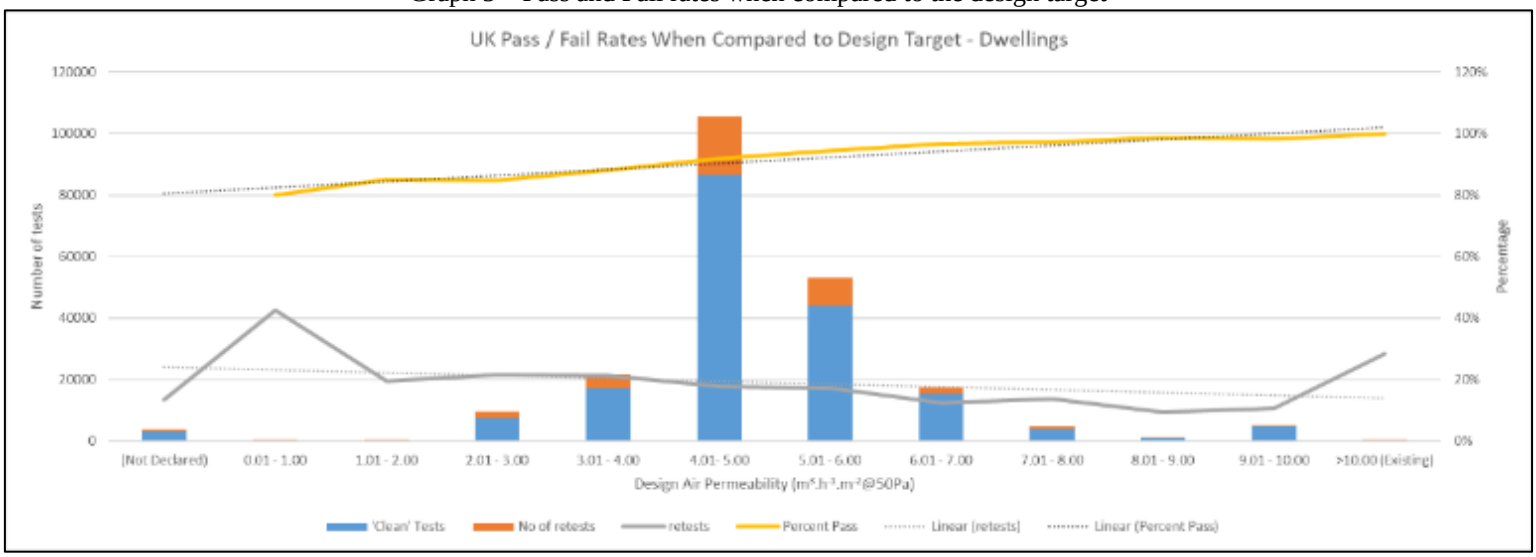
Perhaps the second most interesting part of the graph for me is that the drops from the target change when the target is reduced. When contractors need to achieve a low target they react

accordingly and design the building to be air tight. This means testers will regularly achieve between 2.5 and 2.9 when aiming for less than 3.00 m3.h.m2@50Pa.

5.4 Buildings that require testing multiple times.

Another striking statistic is the number of dwellings that need to be tested multiple times in order to achieve an air permeability lower than the target set by the energy modellers. Graph 5 shows this in more detail.

Graph 5 – Pass and Fail rates when compared to the design target



The area in red at the top of each column shows the number of retests conducted in order to achieve a pass. This represents about 18% of the tests conducted, which can be loosely described as 1 in 5 buildings tested require a second or third test before it met the target.

5.5 Ventilation

As part of the lodgement process, members are required to describe the ventilation system as part of the test. From this, we can compare the ventilation against average results which throws up perhaps the most concerning statistics of all. Table 2 shows the breakdown.

Table 2: Ventilation Statistics

Ventilation System	Ratio	Average Result	Concerns
System 1 - Background ventilators with intermittent extractors	60.80%	4.80	25% of tests using System 1 ventilation achieve less than 4.00. This could lead to air quality issues.
System 2 - Passive Stack Ventilation	0.59%	4.62	36% of tests using System 2 ventilation achieve less than 4.00. This could lead to air quality issues.
System 3 - Continuous Mechanical Extraction	12.78%	4.51	24% of tests using System 3 achieve greater than 5.00 which could cause inefficient ventilation.
System 4 - Continuous Mechanical Ventilation with Heat Recovery	25.21%	4.38	85% of tests using System 4 achieve greater than 3.00 which is against the majority of design specifications. This could lead to inefficient ventilation
System 5 – Other	0.64%	4.75	

The concerns raised with ventilation in dwellings are plentiful.

1. System 1 – 25% of tests using a system 1 ventilation system achieve results below 4.00 m3.h.m2@50Pa which is circa 35,000 tests in 20 months, and could mean as many as 30,000 homes a year are being constructed with inadequate ventilation which could cause occupant sickness.
   It should be noted however that some plots with a low air tightness score will, in theory, comply with the regulations due to an increased level of trickle ventilation. In the same token we can say that some ventilation systems for plots with higher air permeabilities could be ineffective and there are no figures available to back up these findings.
2. System 4 – Continous mechanical ventilation with heat recovery systems show that 85% of all dwellings tested achieve greater than 3.00 m3.h.m2@50Pa which is greater than almost all manufacturers specifications and will lead to ineffective heating of the building over time.

6 CONCLUSIONS

In conclusion, the Lodgement system allows us to look at air tightness results in ways we have never been able to in the past.
Data shows that the construction industry is not taking air tightness seriously, as around 18% of dwellings tested fail to meet the criteria on the first attempt.
The spread of data shows that many plots are only just achieving the targets, some by the smallest of margins which raises concerns about the validity and longevity of the air permeability in these plots.
We, as the ATTMA, believe that regulation plays a strong part in delivering performance and reducing the performance gap in the UK. The current regulations are not stringent enough and are littered with loopholes that allow the construction industry to make small adjustments in order to achieve Building Regulations compliance. We must look to our Government to change the regulations in both air tightness and ventilation to avoid a generation of poor quality construction.