MASTER THESIS

ANALYSING RELATIONSHIPS BETWEEN BUILDING CHARACTERISTICS AND AIRTIGHTNESS OF DUTCH DWELLINGS

Paper and Documentation

CHELY N. BRAMIANA (S1376322)

UNIVERSITY OF TWENTE.

CHELY N. BRAMIANA (S1376322)

CONSTRUCTION MANAGEMENT AND ENGINEERING

GRADUATION COMMITTEE

PROF. DR. IR. J.I.M. HALMAN

DR. IR. A.G. ENTROP

AUGUST 26, 2015

Table of Contents

PREFACE

This research is the final proof of competence for obtaining Master of Science (MSc) degree in Construction Management and Engineering (CME), from the University of Twente. This research has been assigned internally and executed in Department of Construction Management and Engineering, University of Twente under supervision of Prof. Dr. Ir. J.I.M. Halman and Dr. Ir. A.G. Entrop. The executed research focuses on relationship between building characteristics and building airtightness of dwellings. Interest in this work was informed by the lacuna found in both policy on and practice of energy-efficient buildings. This is directly influenced by the quality of building envelope to prevent air leakages. The centre of this study are Dutch dwellings to further expand knowledge on airtightness and air leakages of buildings in The Netherlands. This is hoped that findings could also contribute to the pool of literature on airtightness all over the world.

Enschede, 26th August 2015

Chely N. Bramiana

PAPER

ANALYSING RELATIONSHIPS BETWEEN BUILDING CHARACTERISTICS AND AIRTIGHTNESS OF DUTCH DWELLINGS

STATISTICAL ANALYSIS OF BUILDING AIRTIGHTNESS MEASUREMENTS

Analysing relationships between building characteristics and airtightness of Dutch dwellings

ABSTRACT

Several studies have shown that building airtightness is an important parameter to improve energy efficiency of buildings. Towards this end, many countries also emphasize the importance of addressing air leakage in their regulatory policies. Many scholars and research organizations have attempted and/or developed models to predict building airtightness in order to ensure that buildings comply with the minimum requirements permitted by law. However, none of these models can substantially substitute the results of blower door tests. This warrants the need to explore factors that have both effects and interaction with building airtightness. This paper explores 320 Dutch dwellings by studying the relationship between measured building airtightness and building characteristics abstracted from past studies. Correlational analyses as well as the ANOVA test were done to determine relationships between building characteristics and measured building airtightness. Multiple linear regressions were also done to measure the effects of these factors on building airtightness. Year of construction, total leakage, roof type, building method and building typology were found to have significant relationships with building airtightness; but, only year of construction and total leakage were found to have influence on building airtightness, in terms of specific leakage rate. A significant interaction was also found between these two variables and specific leakage rate ($m^3/(h.m^2)$). This means that actors in the construction industry must strive to minimize the chances of air leakage by improving the quality of workmanship at all phases of construction to reduce the chances of the leakage paths happening in the building at all interfaces. This study recommends more exploration of other factors to test their relationship and effect on building airtightness.

Keyword: *building airtightness, specific leakage rate, air leakage, building characteristics, Dutch dwellings*

Nomenclature:

Symbol	Quantity	Unit
V_m	Measured air flow rate	m^3/h
V_{env}	Air flow rate through the building envelope	m^3/h
V_L	Air leakage rate	m^3/h
V_{50}	Air leakage rate at 50 Pa	m^3/h
C_{env}	Air flow coefficient	$m^3/(.Pa^n)$
C_L	Air leakage coefficient	$m^3/(.Pa^n)$
n	Air flow exponent	-
p	Pressure	Pa
Δp	Induced pressure difference	Pa
A_E	Envelope area	m^2
A_F	Floor area	m^2
v	Internal building volume	m^3
N_{50}	Air change rate at 50 Pa	h^{-1}
Q_{50}	Air permeability at 50 Pa	$m^3/(h.m^2)$
w_{50}	Specific leakage at 50 Pa	$m^3/(h.m^2)$

I. INTRODUCTION

A. Energy-efficient buildings and airtightness: an overview

The building sector is responsible for a significant portion of energy use in the world. Different stakeholders across the world such as governments, scientists and environmentalists are aware of the impact of buildings on the environment. With the issue of sustainability getting more important, several attempts are made to reduce the energy use of buildings by improving building energy efficiency. This calls for more development and wide adoption of sustainable buildings. It motivates the actors in the construction industry to promote innovations such as zero-energy buildings, energy neutral buildings, high-efficiency building and smart buildings. The focus is still the same: to reduce the energy needs of buildings. Therefore, while innovation in the building technology area is rapidly developing to reduce energy consumption, it is also intrinsic that engineers and contractor ensure they construct new buildings in compliance with the current regulations. Apart from guidelines in the policy, other organizations such as the Energy Saving Trust (EST) in the United Kingdom (UK) [1] and SBRCURnet [2] in The Netherlands also foster compliance with the legal directives. This is geared towards the ultimate goal of achieving energy-efficient buildings.

However, to achieve this goal, different active or passive strategies are employed [3]. Measures such as improving heating ventilation and air conditioning (HVAC) systems and installing a solar panel are categorized as active strategies. On the other hand, improving the quality of the building envelope through improvement of the wall, window and door penetration, and roofs is categorized as a passive strategy. Moreover, passive houses, which require certain measures of building envelope (air change rate N_{50} of 0.6 ACH), are obvious examples of passive strategy implementation. In addition, not every household can afford to apply active energy efficient strategies. Therefore passive strategies such as improving the thermal insulation and building airtightness to reduce heat loss are recommended and regulated in the building code.

As part of the passive strategy, airtightness is considered important for improving the energy efficiency of buildings. Building airtightness has been included in the regulations in many countries to achieve energy efficient buildings, which is in most cases usually measured in terms of air permeability level. The term “airtightness” pertains to the intensity of the uncontrolled flow of air through the building envelope as a result of pressure differences between interior and exterior air [4]. Several studies have addressed the importance of ensuring building airtightness in order to reduce air infiltration and thus reducing the cooling load and heat loss of the building [3]. These studies indicate that tightening the building envelope provides a large energy benefit[5], [6]. Recent studies suggest the importance of building airtightness towards energy efficiency, thermal comfort and indoor air quality of dwellings [7]–[10]. Maintaining building airtightness is also essential for the effectiveness of heat recovery installed in the building [11], [12]. Therefore, it is important to maintain a certain level of building airtightness to optimize the energy efficiency of a building.

B. Issues arising: the Dutch context

European legislation on the energy performance of buildings (Energy Performance Building Directive – EPBD) states that member states must calculate the energy efficiency of a building in their countries [13]. The ripple effect of this, for example, is evident in the Dutch Building Code [14], which requires residential buildings to comply with a certain level of energy performance (Article 5.2) and a given limit of total airflow (Article 5.4). However, there is a minor flaw in the Code. It explicitly mentions the minimum requirement of the energy performance coefficient (EPC) to comply with and maximum total airflow allowed. Nevertheless, it does not explain other minimum requirements such as how the total airflow is broken down into ventilation and infiltration; and degree of building airtightness. This might initiate some confusion as it is found in some cases that buildings comply with the minimum required EPC but they do not comply with the minimum value of building airtightness or vice versa. Every Dutch house is required to have an energy performance certificate which contains the energy performance coefficient. And every new Dutch house to be constructed takes the value of q_{v10} into account in the calculation of energy performance coefficient. Therefore, the engineers or architects must include in their design and calculation the value of q_{v10} that will be assigned to the EPC. However, it is still unclear how this value of q_{v10} is generated and justified for certain EPC since the

new building must include this minimum value in the EPC. Moreover, they cannot be certain whether this value can be achieved. To ensure that this minimum value is fulfilled, a blower door test can be conducted, to measure the airflow rate of the assigned building.

However, another problem is that contractors only rely on the measurements results done after the completion of the building. The required airtightness is then sometimes not complied with. Whereas, efforts can be taken to ensure that a certain level of building airtightness is integrated from the beginning of any new construction project. For the last couple of years, this blower door test has been taken prior to completion or the moment of turnkey in order to ensure that any minimum requirement set for the building is fulfilled. Therefore, contractors can still manage to improve the building before it is occupied. In addition, plans for the retrofitting or rehabilitation of existing buildings are required to get measured [5], [6], [15], [16]. Nevertheless, it is unfortunate that contractors cannot harness their resources to provide better overview of estimating building airtightness. Even though they have the complete specification of the forthcoming building, they might not be able to estimate the exact value of q_{v10} because they cannot estimate the building airtightness from the drawings they provided themselves. Therefore, analysing estimated building airtightness prior to conducting blower door test, might be an important intervention.

C. Research objectives and scope of study

The objectives of this research are "to determine the building characteristics abstracted from past studies that have significant relationship with building airtightness and those that have the most significant influence on measured building airtightness of existing building ex post". Therefore, this research aims at exploring variables that substantially influences building airtightness by assessing existing measurements in order to develop a predictive model. There have been many studies in the past to estimate airtightness without taking the blower door test. Even though a predictive model still cannot replace the results of a blower door test, it still can help stakeholders to improve building airtightness. At least contractors and designers can use it to maintain the target of minimum air permeability during the early construction phase. Even though not every variable is expected to be useful to develop a predictive model, the findings can contribute to future research in predicting building airtightness of dwellings more consistently.

The scope of this research will cover only residential buildings in The Netherlands, based on data from pressurization tests on dwellings gathered by the University of Twente. The reason residential buildings are in this study's interest is predicated on the following facts. First, there are more residential buildings than service buildings in the Netherlands. The 2013 report from the Central Bureau of Statistics shows that there are more than 7.2 million dwellings in The Netherlands. With a share of 87.3%, dwellings constitute the bulk of the total building stock compared to non-dwellings, which only made up approximately one eighth of the total building stock in the Netherlands (nearly 1.1 million objects) [17]. Consequently, the residential buildings yield the highest energy cost. Second, the inhabitancy of residential buildings and the usage of the structures differ to service buildings, because people generally live their lives and spend more time at home. Therefore, residential buildings are more intensely used than service buildings, which have more structured and regular opening and closing hours.

The remaining part of the paper proceeds as follows. Section 2 begins by laying out the theoretical dimensions of the research by defining building airtightness, followed by the previous research conducted in the field of building airtightness. The third section is concerned with the methodology used for this study. The fourth section presents the findings of the research, focusing on the correlation between variables and target of measured building airtightness. Section 5 discusses the findings in more elaborate manner. Finally section 6 concludes the research and presents the recommendation for further studies.

II. LITERATURE REVIEW

A. *Air leakage measurements*

In order to determine the airtightness of a building, a test is usually carried out to measure the amount of air leaking within building envelope. The level of building airtightness is firstly measured in terms of the amount of air leakage between different indoor and outdoor pressure using standardized method. The most common method to measure air leakage in a building is the pressurization test, which uses a blower door. This method is based on the mechanical pressurization or depressurization of a part of a building, using a blower door mounted in the front door with all ventilation sealed and all adjacency remain open. The airflow rate measured through the building envelope is caused by the differences in pressure between the air inside and outside. The airtightness of building components and elements is measured according to standard NEN-EN 13829 [18]. Another thing to be noticed is that even though the measurement method is not complicated and can be carried out with little amount of equipment and time, the interpretation of the results requires a certain extent of knowledge.

When measuring the building airtightness, the occurring air leakage is quantified as the airflow getting through the building envelope, which is V as a function (m^3/s), through differences in pressure, expressed in P (Pascal). The pressure-flow relationship, which acts according to the power law, is often expressed by the equation:

$$V_L = C_L \cdot \Delta P^n \qquad \textbf{Equation 1}$$

The flow coefficient is a function of the size of building openings, and the pressure exponent is expressed $0.5 \leq n \leq 1.0$. An exponent of 0.5 denotes fully turbulent and an exponent of 1.0 represents laminar flow. Usually the flow exponent is 0.65 [10]. The airflow is often denoted with the reference pressure as a sub-script (e.g. V_{50} or V_{25}). The reference of 50 Pa in air pressure differences is most often used. Another common reference pressure used is 4 Pa, but 1 Pa, 10 Pa, 25 Pa, and 75 Pa are used as well [10].

B. *Defining airtightness*

The next step of measuring airtightness is to define the building airtightness term by normalizing the measured air leakage (V_L). There are three quantities commonly used to normalize the measured air leakage: building volume, envelope area and floor area [10], [19], [20]. These normalisations are used depending on the context of the regulation either where or for what purpose. Consequently, there are three different terms used to address building airtightness, which this research borrowed the term from NEN-EN 13829. Each has advantages and disadvantages and each is useful for evaluating different issues:

1) *Air change rate*

When the building volume is used to normalize such data the result is normally expressed in air changes per hour at the reference pressure and it is the second most common air tightness metric reported in the literature [7], [21], [22]. Many people find this metric convenient since infiltration and ventilation rates are often quoted in air changes per hour. The air change rate at 50 Pa pressure difference (N_{50}) is calculated by dividing the mean air leakage rate at 50 Pa by the internal volume using equation 2 with unit h^{-1}:

$$Q_{50} = \frac{V_{50}}{v} \qquad \textbf{Equation 2}$$

2) *Air permeability*

Most studies used the terms air permeability as the target of their research [4], [8], [16], [19], [23], [24]. Air permeability is the capability of a surface to let air pass through – in this case, the capability of the building envelope itself. Normalization using envelope area is particularly useful if one is looking to define the quality of the envelope as a uniform "fabric" [10]. In the case of Ref. [24], it includes building components and ventilation devices. Such a term can sometimes be hard to use. However, it can be particularly useful in attached buildings were some walls are exposed to the outdoors and some are not. The terms air permeability and airtightness are sometimes interchangeably

used, but they are actually opposing terms. The lower the air permeability is, the more airtight a building is.

The air permeability in 50 Pa pressure difference is symbolised as Q_{50} and the unit is $m^3/h.m^2$. Air permeability is calculated by dividing the mean air leakage rate at 50 Pa by the envelope area using equation:

$$N_{50} = \frac{V_{50}}{A_e}$$ **Equation 3**

3) Specific Leakage Rate

Normalization using floor area, expressed as specific leakage rate at reference pressure difference, is the easiest to determine from a practical aspect compared to the other normalizations. Since usable living space scales most closely relate to floor area, normalizing these scales is sometimes viewed as being more equitable [10]. This normalisation is also used in the EPC in the Dutch Building Code. Specific leakage rate at 50 Pa difference, w_{50}, is calculated by dividing the mean air leakage rate at 50 Pa by the floor area using equation 4 and the unit is $m^3/h.m^2$:

$$w_{50} = \frac{V_{50}}{A_f}$$ **Equation 4**

Table 1 explains the difference between different building airtightness terms used in different context.

Table 1 Differences in building airtightness terms

Terms	Normalisation	Symbol	Units
Air change rate (infiltratie voud)	Air leakage rate divided by internal building volume	N	h^{-1}
Air permeability	Air leakage rate divided by building envelope surface	Q	$m^3/h.m^2$
Specific air leakage rate	Air leakage rate divided by usable floor area	w	$m^3/h.m^2$

Even though, Q_{50} and N_{50} are the most commonly used in many countries, The Netherlands use the norms w_{10} (equivalent to q_{v10} in Dutch policy) which is the specific leakage rate at 10 Pa difference. On the other hand, Dutch Building Code only mentions that the permitted total air flow rate of residential including toilet and bathroom must not be bigger than 0.2 m^3/h. The desired specific leakage rate is stated in EPC, depending on the volume of the building. For comparison, the relation between q_{v10} and N_{50} is depending on the flow coefficient (n) and divided by about 25 – 30. The airflow (q_{v10}) of about 113 dm^3/s, equals to an N_{50} of about 3.5 to 4.5 [De Gids, 2010].

C. Airtightness prediction and important variables

Studies carried out with the purpose to develop a model to predict building airtightness can be divided into two broad research categories: 'experimental' and 'correlational'[8].'Experimental' research is carried out under controlled experimental conditions with the purpose of measuring the causal effects of independent variables on dependent ones, while 'correlational' research is carried out under statistical control with the purpose of understanding the correlation between variables. Experimental studies can be carried out by building simulation and test specimen which can be found in the studies carried out in Portugal [24], in Ireland [16] and in Italy [25]. 'Correlational' research mostly employ regression method, which can be found in some studies carried out in Finland [7], in the UK [8], in the US [19], in Catalonia [21], in Greece [22] and in Estonia [23]; and the most recent one used neural networks conducted in Croatia by Krstic et al. [4]. These studies, furthermore, were carried out to develop a model to predict or estimate value of building airtightness prior to a blower door test. Moreover, Relander, Holøs and Thue [26] categorized method to estimate building airtightness into three groups: (1) estimation based on multiple regressions, (2) estimation based on the rough characteristics of the building and (3) estimation based on the component leakage and geometry of the building.

There is a plethora of variables influencing airtightness which are suggested in the literature. Chan, Joh & Sherman [19], Alev et al. [9], Montoya et al. [21], Sinott & Dryer [16] considered year of construction as one of the predictors when estimating airtightness. Structural and non-structural building characteristics have also been noted as variables to be considered in estimating building airtightness. Structural building characteristics include variables such as dwelling type [8],

construction type [21], type of foundation [19] and building method [23]; while non-structural building characteristics includes floor area [19], house height [19] and number of storeys [23], ventilation system [19], [23], insulation type [21] and management context [8].

Many literary studies has shown that the quality of workmanship plays a critical role in achieving building airtightness [16], [23], [24], especially that it corresponds directly to possible leakage path. Parameters included in workmanship are: installation methods, detail of joints and amount of opaqueness and transparency of building envelope. The possible leakage paths on joints were found in the window-wall interface [27], as well as the structural floor [28]; the joints between the basement wall and the wooden frame wall [29]; between the wall and the roof [30]; and in the roof joints [31]; many of which were caused by the method of sealing joints [27]–[29]. Table 2 summarised the abstracted variables from past studies. These abstracted variables will constitute the independent variables to be tested for significance and included in the analysis.

Table 2 Summary of predictors of building airtightness from past studies

Country	Average permeability	Influencing variables	Number of measurements	Method	Source
United Kingdom	Q_{50} of 5.97 $m^3/(h\ m^2)$	• Construction type • Type of residential building • Management context	287	Multi linear regression	[8]
United States		• Year of construction • Climate zone • Floor area • House height • Type of foundation • Location of ventilation system • Energy class of family house	134.000	Multi linear regression	[19]
Finland	N_{50} 3.70 ACH	• Annual infiltration rate	1	Sensitivity analysis simulating building model	[7]
Greece	N_{50} 6.79 ACH	• Total window frame length	20	Regression	[22]
Estonia	Q_{50} 4.2 $m^3/(h\ m^2)$	• number of storeys, • workmanship quality and supervision, • building technology (built in site or prefab), and • The ventilation systems.	32	Experimental analysis	[23]
Spain and France		• year of construction, • Construction type • Number of storeys • Floor area	251	Multi linear regression	[21]
Ireland	Q_{50} 9.1 $m^3/(h\ m^2)$	• Year of construction • Design detail • Retrofitting	28	Experimental study	[16]
Portugal		• Quality of workmanship	5	Experimental study	[24]
Croatia	Q_{50} 0.76 – 19.64 ACH at 50 Pa	• opaque part of building envelope, its material and structure • transparent part of building envelope, its material and structure	58	Neural network prediction	[4]

III. RESEARCH METHOD

This research focused on the results measurements of 320 Dutch residential buildings. A quantitative analysis was employed in this research to study the correlation between variables since it can give more elaborate analysis. This study falls into correlational research.

A. Description of data

Measurements are gathered from several organizations that run blower door tests in many houses in The Netherlands. Because the blower door tests were conducted by different organization, consequently, there are different formats of measurements results. Some reports reported more data than the others and few of them did not mention the location of the building, only the results of the blower door test. 7.5% of the measurements were taken during construction, 70% around completion, 8.1% during occupancy and 14.4% of them were unknown.

Even so, all reports must indicate some essential elements which are: the value of q_{v10}, which further will be mentioned as w_{10} in this paper, the airflow leakage from different pressure difference, flow coefficient and pressure exponent. Some reports separate the results by pressurization and depressurization, while other only mention the general result. The building data, such as: drawing plan, ventilation system and building characteristics; leakage path and infra-red image to identify the leakage path were also provided in some reports.

Nevertheless, the regulation in The Netherlands mentioned the pressure reference is at 10 Pa difference, the results of 50 Pa difference are also analysed. The pressure reference at 10 Pa difference is used because it refers to the condition under normal weather circumstances, while 50 Pa difference is used to measure building airtightness since it is low enough not to deteriorate the measurements and high enough to be independent from weather condition. Equation 1 and 4 is used to convert the specific leakage rate to 50 Pa by calculating the flow exponent and leakage coefficient gathered from the measurement results. The specific leakage rate at 50 Pa difference (w_{50}) will be used in some analysis because regarding the local context of Dutch regulation, the building airtightness is measured as specific leakage rate at 10 Pa difference (w_{10}). Hence, the main target of this research will be the specific leakage rate at 10 Pa difference.

B. Variables accounted

Literature on building airtightness suggests a wide range of influencing variables grouped under year of construction, structural and non-structural building characteristics and quality of workmanship. Besides those variables, some additional parameter also included in the measurement results will be taken into account in the research. This section summarizes the variables from those two sources that will be analysed in this research.

The variable ‘year of construction’ (YEAR) is included in this research, because many studies suggested that there is a correlation between year of construction and building airtightness. Even though the target found in the literature is mostly air permeability at 50 Pa difference (Q_{50}) and air change rate at 50 Pa difference (N_{50}), this research will test the correlation of year of construction and specific leakage rate at 10 Pa difference (w_{10}). Variables that fall into structural building characteristics are building method (BM) and building typology (BT). Building method corresponds on how the building is constructed, either by on-site construction, prefabrication or combination of both. Building typology correspond to the main material of the construction type such as: concrete, wood frame, masonry and steel construction.

Variables non-structural building characteristics that will be included in this research are: dwelling type (DT), roof type (ROOF), design target (QEPC), and floor area (FLOOR). Other variables such as ventilation type and insulation type are not included because there is no complete information regarding those provided in the measurements results, which yield in many missing data and possibly affect the reliability of the research. While other non-structural variables have been studied, the correlation between variable roof types and building airtightness has not been deeply researched. Different types of roof such as: pitched roof, flat roof, shed roof or combination of roofing are tested because different roof types have different construction details.

The next variables measured are leakages occur in the measured building. Some measurements results reported the leakage path or air leakage penetration either with infra-red image or using smoke to identify the location of leakage paths and determine the damage caused by the leakages. There are four classifications of leakages provided in the measurements results. Level 1 is for the least damaging leakage and level 4 is the most critical one. To accumulate this different level of leakages, we compute the total score of leakages and name it under a new construct 'TotalLK'. Construct Total Leakage is defined by the cumulative amount of all leakage together by weighting the leakage level 1 is 1 and so on. Therefore, the construct TotalLK = LK1*1 + LK2*2 + LK3*3 + LK4*4. This variable is tested to show the relationship between leakages that occur in the building and building airtightness.

C. Analysis method

There are 320 measurement results of different houses in The Netherlands provided. The first attitude towards the data is to compile the data in the Microsoft Excel to ease the categorization of the measurement results. Afterwards, the spread sheets will be exported into statistical software program for more complex analysis. This research used IBM SPSS 20 because this software provides more elaborate analysis results.

Variables mentioned in the previous section will act as independent variables with the target of specific leakage rate at 10 Pa difference (w_{10}) and 50 Pa difference (w_{50}), act as dependent variables. The variables are treated differently according to the type of data. Variables YEAR, DT, BM, BT and ROOF are nominal data where each number represents another value. To check the correlation between these variables and dependent variables, we run the ANOVA test between variables by comparing means the independent and dependent variables. The variables are tested to see which variables differs significantly, thus are significant factors to predict building airtightness. For the scale data, which are FLOOR, QEPC and TotalLK, linear regression analysis is carried out to see the relationship and how significant the correlation is. For both kind of data type, correlation analysis is carried out for all dependent variables and independent variables.

The ANOVA test is run to compare means and the results shows whether there is a significant difference between-group of means. The significance of each variable was assessed according to the P-value of the F-test, and applying confidence interval of 95%; that is, Pearson value (p-value) higher than 0.05 is considered not significant. Variable year of construction, for example, have F-test 103.058 with p-value < 0.05 implies that there is significance difference in means between groups, meaning that this variables is a good predictor to be included in the model development. On the other hand, the test of homogeneity of variances is also carried out to check the equal variances of the data (Levene 14.801, $p < 0.05$). The variance of the data in variable year is not equal. Higher F-test results means the data is spread out around the mean and to each other. Because F test only tells whether there is significant difference between groups but do not inform where it lies, therefore, a post-hoc Scheffe test was run to suggest significant difference between the means of all the pairs. Furthermore, the interaction between variables is studied using two-way ANOVA, because there are some variables that do not give significant effect individually but give significant effect with interaction with other variables.

IV. RESULTS

The average specific leakage rate at 10 Pa of all dwellings is 0.55 $dm^3/s.m^2$ (SD = 0.538). There are nine extreme cases with specific leakage rate higher than 2.0 $dm^3/s.m^2$ as seen in Figure 1. In most cases, the maximum specific air leakage at 10 Pa allowed in EPC is 0.625 $dm^3/s.m^2$, which indicated by the red line in the Figure 1. 77.2% of the dwellings studied lie before the line, which means they comply with the minimum requirements.

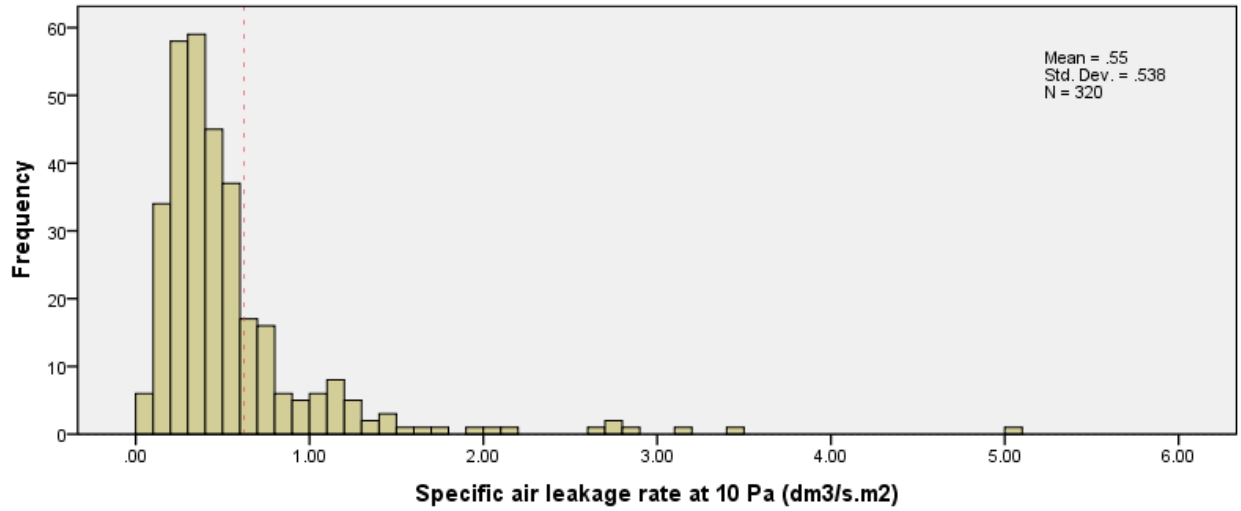


Figure 1 Specific air leakage of all dweliings studied; max = 5.04 dm3/s.m2, min = 0.06 dm3/s.m2

From 320 measurements, only 310 mentioned the location of the building in 11 provinces: Groningen, Friesland, Overijssel, Flevoland, Utrecht, Noord-Holland, Zuid-Holland, Gelderland, Zeeland, Noord-Brabant, and Limburg. Figure 2 illustrates the mean dispersion of building airtightness in The Netherlands. From the representation, houses measured in Province Utrecht have the lowest mean of specific leakage rate (0.32 $dm^3/s.m^2$) compared to other provinces, followed by Limburg (0.33 $dm^3/s.m^2$) and Groningen (0.38 $dm^3/s.m^2$). The highest mean of building airtightness is reported from houses in Province Zeeland (0.68 $dm^3/s.m^2$).

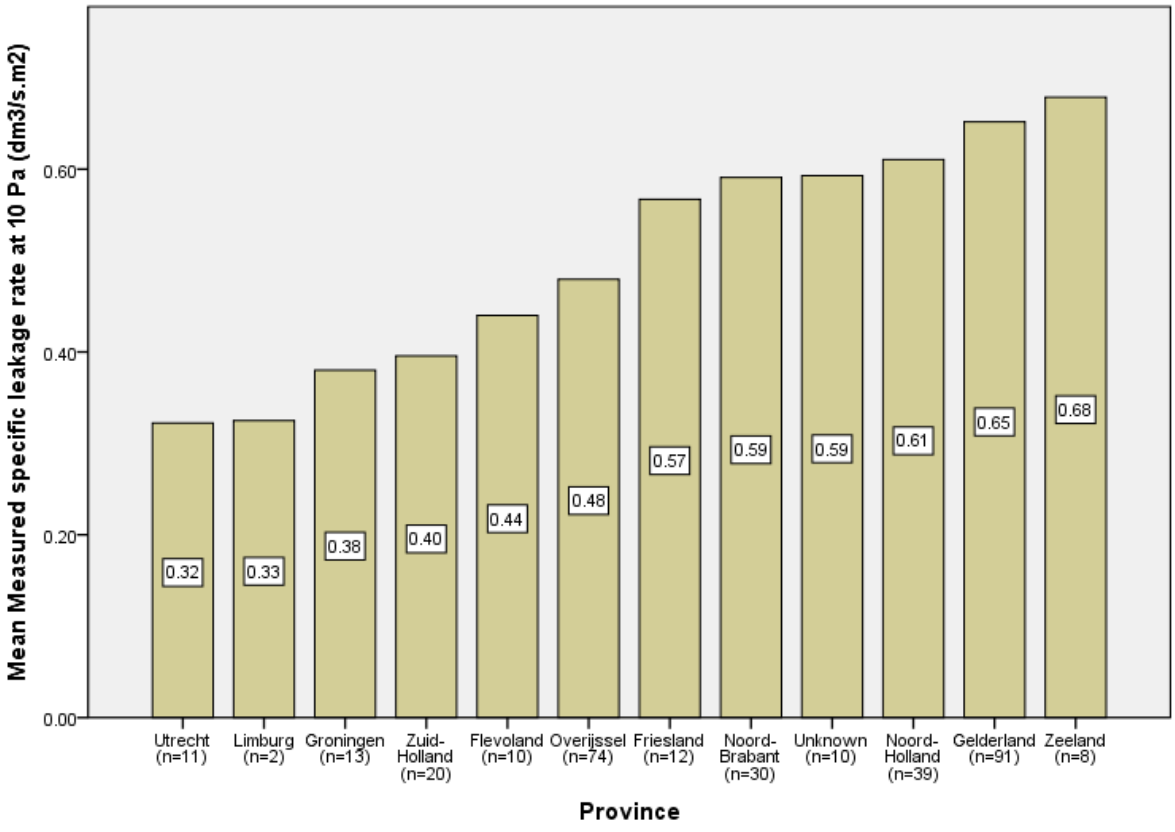


Figure 2 Distribution and airtightness means of sampled Dutch Buildings by Province

A. Correlation between building characteristics and specific leakage rate

The first analysis carried out is the correlation analysis between dependent variables w_{10} and w_{50}, and independent variables. Table 3 presents the results of the correlation analysis. Pearson value (P-value) suggests the type of correlation and how strong the correlation is. In this case the correlation is significant at 0.01. N shows how many valid data is used to analyse the correlation between variables and missing data is not included in the analysis.

Table 3 results of correlational analysis between variables

	N	w_{10}	w_{50}
Total Leakage	230	.437* (.000)	.426* (.000)
Design Target	293	.064 (.272)	.073 (.212)
Floor Area	320	-.097 (.083)	-.073 (.192)
Year of Construction	317	-.543* (.000)	-.531* (.000)
Dwelling Type	320	-.086 (.125)	-.060 (.288)
Building Method	320	-.230* (.000)	-.204* (.000)
Building Typology	320	-.160* (.004)	-.119* (.033)
Roof Type	320	-.088 (.117)	-.074 (.187)

Note. * Significance at 0.05. w10 = specific leakage rate at 10 Pa difference. w50 = specific leakage rate at 50 Pa difference

Table 3 suggests that variables year of construction, building method, building typology and total leakage are significant and might be a good predictor to specific leakage rate at 10 Pa. However, variable building year and total leakage are the best predictors because they have higher P value (-0.543 and 0.437) compared to the rest. Compare to specific leakage rate at 10 Pa, variable year of construction, building method and total leakage are also significant for specific leakage rate at 50 Pa. However, the correlation analysis only shows whether there is correlation between variables but not the effect of one variable to another; and also did not give deeper insight of the differences between groups' means. Therefore, an ANOVA test is carried out to explore those variables that influence specific leakage rate.

1) Total Leakages

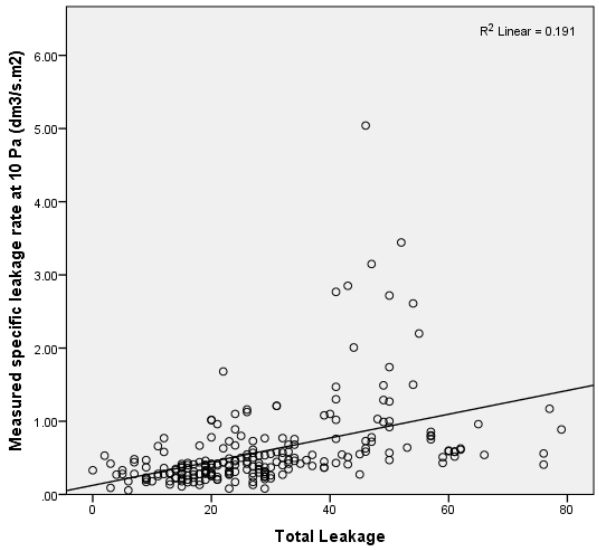


Figure 3 Scatter Plots of Total Leakages

Some of the data show the number of leakage path found in the building measured and also the level of leakages. 41% of leakage paths were found occur in window-wall interface, 22% in joint between floor and wall, 3% in joint between ceiling and wall, 7% were found in roof joint, 14% in plumbing installation, 5% in electrical socket and 8% in vent. This empirical study sought to see the correlation between numbers of leakage path by accumulating it using construct 'TotalLK'.

A positive correlation was found between measured specific leakage rate at 10 Pa difference and total leakages in the building with r = 0.437, ($p < 0.05$, 2-tailed) for 10 Pa difference, as plotted in Figure 3. Further statistical tests revealed the correlation for measured specific leakage rate at 50 Pa and total leakages (r = 0.426, $p < 0.05$, 2-tailed). However, only 19.1% of the variation in w_{10} and only 18.2% of the variation in W_{50} can be explained by the variable total leakages. This result points out that leakages in the building contributes to the building airtightness in considerable amount.

2) Design Target

As mentioned in the introduction, most of the buildings were assigned a q_{v10} to be included in the EPC calculation. This assigned q_{v10} is treated as a variable design target, which means that this value is the minimum value that must be compelled. 91.6% of the measurements mentioned the target q_{v10} of the EPC. 8.5 % of the entire measurement results has targeted below 0.15, 49.5% below 0.4 and 91.1% below 0.625.

However, no significant correlation is found between the variable design target and specific leakage rate at 10 Pa difference (n = 293, r = 0.064, p = 0.272) as well as at 50 Pa difference (n = 293, r = 0.073, p = 0.212). The scatter plot of design target and specific leakage rate at 10 Pa, as seen on Figure 4, shows that the assigned q_{v10} on EPC does not necessarily ensure the accomplishment of building airtightness.

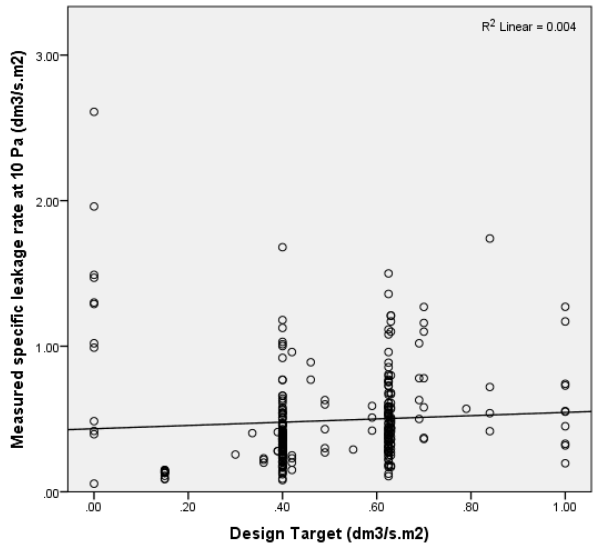


Figure 4 Scatter Plot of Design Target

3) Floor area

Analysis was also carried out of the correlation between measured specific leakage rate and floor area. The result suggests there is no significant correlation between floor area with specific leakage rate at 10 Pa difference (n = 320, r = -0.097, p = 0.083) and at 50 Pa difference (n = 320, r = -0.073, p = 0.192).

B. One way ANOVA

An exploratory analysis using the ANOVA test was conducted to identify possible significant relationship between building characteristics variables and building airtightness in terms of specific leakage rate. The variables accounted in the ANOVA test has been mentioned in previous section. The way of ANOVA test works is by comparing means between different groups included in the variable.

1) Year of construction

The variable 'year of construction' is going to be studied its correlation with building airtightness. Because there are many buildings with different year of construction, the first step is recode year built into range. The consideration is based on Dutch Building Code, which are 'Bouwbesluit 1992, 2003 and 2012'. Therefore, we categorized the year range based on the year of the regulation apply. Figure 2 shows that older buildings (pre-2003) have significantly higher specific leakage rate (3.09 $dm^3/s.m^2$) compared to newer buildings (0.17 $dm^3/s.m^2$ and 0.52 $dm^3/s.m^2$). However, the measurement results were dominated by building from post-2012 (92.2%). Consequently, there is more spread in the building from this group with more extreme cases occurring.

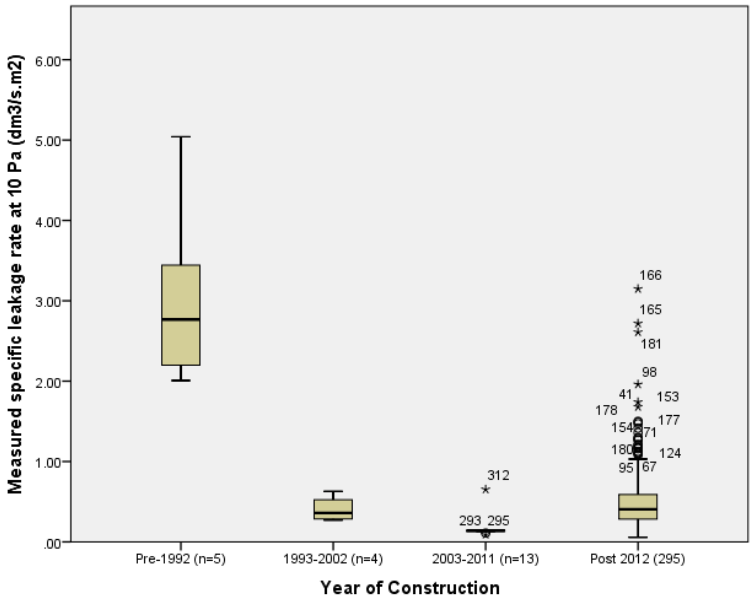


Figure 5 Specific leakage rate by year built

To compare the means of building airtightness among different group of year of construction, a one-way ANOVA F-test was used. F test of 68.876 ($p < 0.01$), for target of specific leakage rate at 10 Pa difference, suggests that the different between groups is significant. Likewise, the results with specific leakage rate at 50 Pa difference ($F = 61.864$ $p < 0.01$) also suggests that conclusion. The test of homogeneity (Levene Statistic 10.192, $p < 0.05$) suggests that the variance between 4 groups is not statistically equal. It means there is at least one group that differs significantly than the others. Therefore, a post-hoc Scheffe test was run to reveal where the differences lie between groups. The same procedure applies for the target of specific leakage rate at 50 Pa (Levene Statistic 7.468, $p < 0.05$) because the homogeneity test suggests the same results.

There is a positive linear relationship, as shown on Figure 5, amongst the groups from pre-1992 until the previous building code (Bouwbesluit 2003). This might be caused by the spread occurs in the newer building group (post-2012). Therefore, the variable year of construction encompasses other building typology variables, which will be explained further in the discussion. On the other hand, statistics suggest that there is significant difference in means specific leakage rate at 10 Pa difference ($p < 0.05$) between buildings from pre-1992 with each of other 3 groups and between buildings from 2003-2011 and buildings from post 2012. However, the result on the mean specific leakage rate at 50 Pa differences suggests slightly different results. The significant difference only existed between buildings from pre 1992 and the other three groups. The results together indicate that newly built dwellings is considerably more airtight than older buildings.

2) Dwelling type

The residential buildings studied were grouped into seven types of dwelling type: apartment, duplex house, end-terraced house, mid-terraced house, semi-detached house, detached house and the remaining buildings which type weren't known is grouped as unknown. ANOVA tests were run to compare between-groups means divided by the within-groups one.

Firstly, the test of homogeneity (Levene's test) carried out to show that the variance between 7 different groups. The results of the homogeneity test suggests that variance between groups on specific leakage rate at 10 Pa difference as target is equal ($F = 1.948$ $p = 0.073$); however, with specific leakage rate at 50 Pa different as target, it was found that there is a difference between the variances among 7 groups ($F = 2.944$ $p < 0.05$). However, the results of the ANOVA test suggests otherwise. The F ratio of 1.817 ($p = 0.095$) implies that the differences between means of specific leakage rate at 10 Pa difference were not statistically significant. The same conclusion applies to the means of specific leakage rate at 50 Pa difference ($F = 2.064$ $p = 0.057$). In conclusion, variables dwelling type is not a suitable predictor for specific leakage rate, neither at 10 nor 50 Pa difference, because statistics suggest means between groups are not significant.

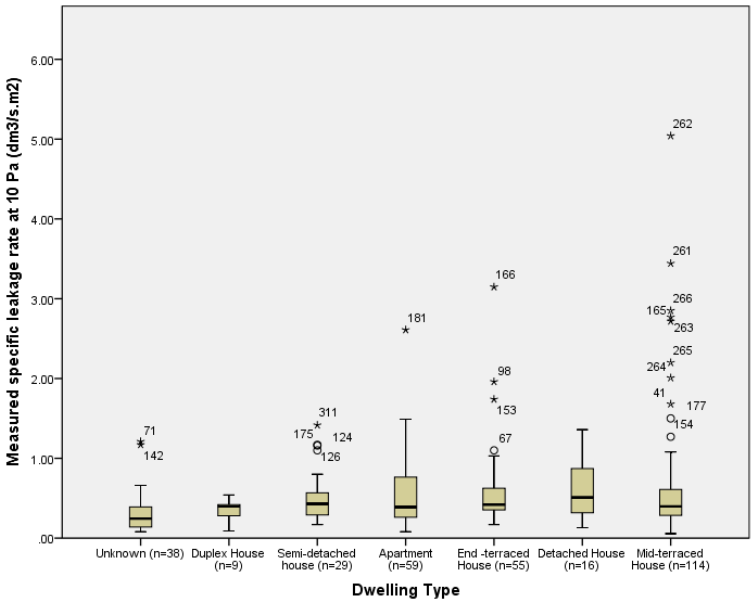


Figure 6 Specific leakage rate by dwelling type

3) Roof type

The differences between roof types are also studied in this research. The dwellings studied in this research were grouped according to the roof types that are: shed roof, flat roof, pitched roof, combination (of more than one roof type) and the unknown group, which the roof type is not recognized. The test of homogeneity (Levene Statistic 2.551, $p < 0.05$) suggests that the variance between 5 groups is not statistically equal. It means there is at least one group that differs significantly than the others. The same procedure applies for the target of specific leakage rate at 50 Pa (Levene Statistic 5.168, $p < 0.05$) because the homogeneity test suggests the same conclusion. ANOVA test results suggest ($F = 4.251$, $p < 0.01$), for target of specific leakage rate at 10 Pa differences, that the difference between groups is significant. Likewise, the results with specific leakage rate at 50 Pa difference ($F = 4.719$ $p < 0.01$) also suggests the conclusion. A post-hoc Scheffe test is run to reveal where the differences lie between groups.

In case of roof type variables, the results suggest that there is significance difference in means specific leakage rate at 10 Pa difference ($p < 0.05$) between buildings with pitched roof and the unknown group. Similar findings also occurs on the mean specific leakage rate at 50 Pa differences. The only

significant difference was found in unknown group and pitched group. The explanation of this result will be discussed in section 5.

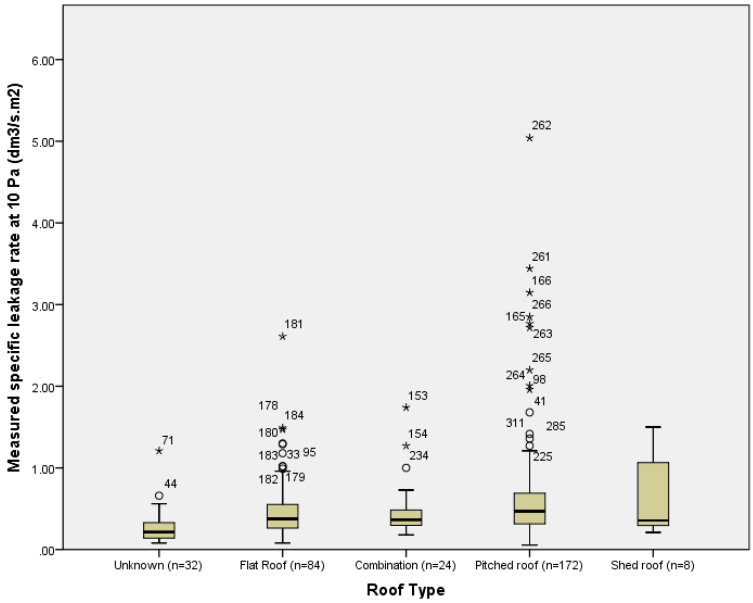


Figure 7 Specific leakage rate by roof type

4) Building method

The dwellings studied are constructed using three different methods: on-site construction, prefabrication and combination of both. Other buildings with unknown build method fall into the group 'unknown. F test of 8.505 ($p < 0.01$) suggests that there is significant difference in mean specific leakage rate at 10 Pa difference between groups. Likewise, the results with specific leakage rate at 50 Pa difference ($F = 61.864$ $p < 0.01$) also suggests that conclusion. The test of homogeneity (Levene Statistic 7.204, $p < 0.05$) suggests that the variance between 4 groups is not statistically equal. It means there is at least one group that differs significantly than the others. Therefore, a post-hoc Scheffe test was run to reveal where the differences lie between the groups. The same procedure applies for the target of specific leakage rate at 50 Pa (Levene Statistic 9.323, $p < 0.05$) because the homogeneity test suggests the same conclusion. The results of post hoc test suggest that there is significant difference in means specific leakage rate at 10 Pa difference ($p < 0.05$) between buildings with prefabrication method and unknown group. The results on the mean specific leakage rate at 50 Pa differences suggest the same conclusion. The statistical results indicate the mean specific leakage rate does not differ significantly, except for the unknown group.

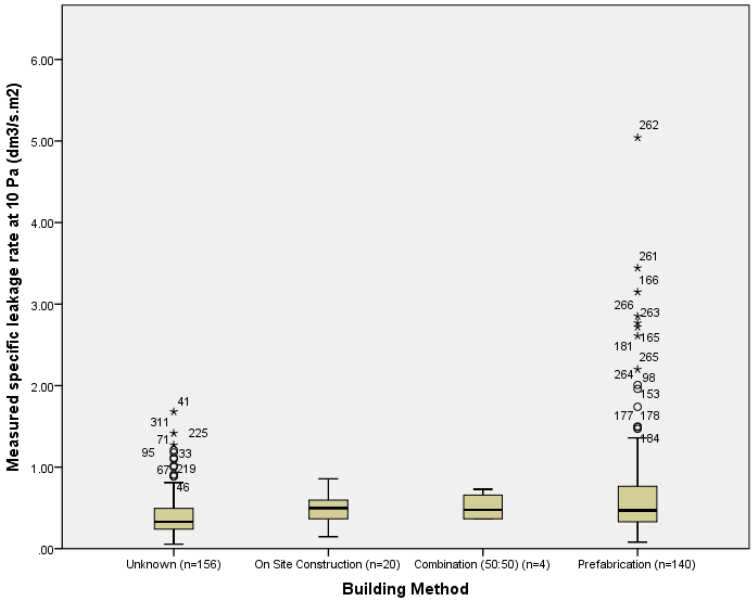


Figure 8 Specific leakage rate by building method

5) Building typology

The building typology is categorized according to the material of the structure, which are: concrete, wood frame, masonry, steel construction and group 'unknown'. F test of 4.598 ($p < 0.01$) suggests that there is significant difference in mean specific leakage rate at 10 Pa difference between groups. However, the other results ($F = 3.025$ $p = 0.018$) suggest that there is no significant different in mean specific leakage rate at 50 Pa difference between groups. The test of homogeneity (Levene Statistic 9.827, $p < 0.05$) suggests that the variance between the four groups is not statistically equal. There is at least one group that differs significantly from the others. Therefore, a post-hoc Scheffe test was run to reveal where the differences lie between groups. However, a post-hoc test cannot be run because there is one group that has less than two cases and that is the steel construction group.

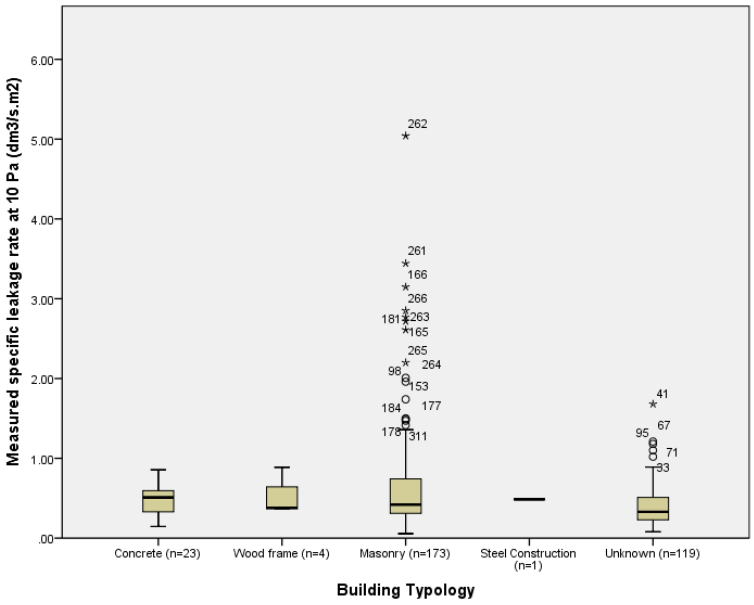


Figure 9 Specific leakage rate by building typology

In general, these results indicates that stronger correlation occur between variables and measured specific leakage rate at 10 Pa difference. The results of the ANOVA test (Table 4) showed that the

following variables have significant influence on specific leakage rate at 10 Pa difference: year of construction, total leakage, dwelling type, roof type, building method and building typology.

C. Two-way ANOVA

The analysis above suggests that all variables, except floor area, design target and dwelling type are significant to predict specific leakage rate at 10 Pa difference. Even though every variable is significant, or equivalent as having main effect on building airtightness, the interaction between variables might have effect on building airtightness as well. Therefore, two-way ANOVA tests were run to analyse the interaction between variables. The difference between one-way and two-way ANOVA is that one-way ANOVA only studies main effect of variables to the target variables, while two-way ANOVA also studies whether interaction between variables giving effect on target variables. There are six variables included in the analysis, which resulted in seventeen pair of two-way ANOVA to run. Although previous analysis shows both measured specific leakage rate at 10 and 50 Pa difference, the main target of this research is still the Dutch context with 10 Pa difference.

However, not all variables showed interaction effect and cannot be accounted as good predictors. The results of two-way ANOVA test suggest that interaction effect occur between building year built x total leakages ($F = 6.655$ $p < 0.01$) with adjusted R-squared 0.703; total leakages x roof type ($F = 2.128$ $p < 0.01$) with adjusted R-squared 0.528; total leakages x building method ($F = 3.135$ $p < 0.01$) with adjusted R-squared 0.609; total leakages x building typology ($F = 3.676$ $p < 0.01$) with adjusted R-squared 0.607. These results prove that interaction between total leakage and other variables give effect on building airtightness.

The results of the entire exploratory analysis can be summarised as seen on Table 4.

Table 4 Summary of Exploratory Analysis results

Variables	Analysis Method	p-value*	F-test	Pearson's r	R squared
Total leakages (TotalLK)	Linear regression	.000		.437	.191
Design target (QEPC)	Linear regression	.272		.064	.004
Floor area (FLOOR)	Linear regression	.083		-.097	.009
Year of construction (YEAR)	One-way ANOVA	.000	68.876		
Dwelling Type (DT)	One-way ANOVA	.095	1.817		
Roof Type (ROOF)	One-way ANOVA	.005	1.817		
Building Method (BM)	One-way ANOVA	.000	8.505		
Building Typology (BT)	One-way ANOVA	.001	4.598		
Year x TotalLK	Two-way ANOVA	.000	6.655		.791
Year x DT	Two-way ANOVA	.768	0.264		.414
Year x ROOF	Two-way ANOVA	.433	0.617		.410
Year x BM	Two-way ANOVA	-	-		.421
Year x BT	Two-way ANOVA	-	-		.414
TotalLK x DT	Two-way ANOVA	1.000	0.462		.687
TotalLK x ROOF	Two-way ANOVA	.001	2.128		.753
TotalLK x BM	Two-way ANOVA	.000	3.135		.771
TotalLK x BT	Two-way ANOVA	.000	3.676		.770
DT x ROOF	Two-way ANOVA	.251	1.263		.091
DT x BM	Two-way ANOVA	.855	0.567		.115
DT x BT	Two-way ANOVA	.985	0.259		.081
ROOF x BM	Two-way ANOVA	.701	0.637		.109
ROOF x BT	Two-way ANOVA	.622	0.735		.098
BM x BT	Two-way ANOVA	.352	1.048		.085

Note. *significant at 0.05.

D. Regression Analysis

The analysis above shows that variable building year (YEAR), total leakages (TotalLK), roof type (ROOF), building method (BM) and building typology (BT) are significant to predict building airtightness in terms of specific leakage rate at 10 Pa. Then we run linear regression analysis (with confidence level 95% = 1.960). This research uses linear regression with 'enter' method. Some articles found in the literature review using either 'stepwise' or 'forward' method [21]. Both of them automatically show the different regression results by accounting only the most significant variables, and directly show comparison between more than one model where each model accounted different

significant variables; while enter method only show one model which shows only selected variables. Either enter, stepwise or forward method has been tested in this research using SPSS 20 and all yield on similar results.

The initial model developed as followed:

$$w_{10} = \alpha + \beta_{totalLK} \cdot TotalLK + \beta_{YEAR} \cdot YEAR + \beta_{ROOF} \cdot ROOF + \beta_{BM} \cdot BM + \beta_{BT} \cdot BT \quad \textbf{Equation 5}$$

The parameter β_{YEAR} represents the coefficient for year category when the building was built. Parameter $\beta_{TotalLK}$ represents the coefficient of total leakage and variable TotalLK is the total value of leakage damage level found during measurements. The reason to include total leakage known in the measurements is to predict whether sealing certain point of leakage path can improve building airtightness of the building prior to next measurements. The same applies to ROOF, BM and BT, where β represents the coefficient and the variables are the value that represents the dwelling type, roof type, building method and building typology.

Apparently, the regression analysis has shown that variables ROOF, BM and BT are not significant to be applied in the model. Table 5 provide elaborate coefficient value for constant and predictor variables for the equation. Therefore, regression was run again by removing the not significant variables.

$$w_{10} = \alpha + \beta_{totalLK} \cdot TotalLK + \beta_{YEAR} \cdot YEAR \quad \textbf{Equation 6}$$

As seen on Table 5, Eq. 6 has slightly lower R-square than Eq. 5, meaning that 42.1% of w_{10} can be explained by the model regression. However, Eq. 6 only accounted significant variables compare to Eq. 5 that still accounted variables ROOF, BM and BT, which have significant influence according to ANOVA but not according to multiple linear regression. The justification this model will be discussed in following section.

Table 5 Coefficient and adjusted R-squared value for both models

Coefficient	Regression 1 (Eq. 4)	t	p-value	Regression 2 (Eq. 5)	t	p-value
α	2.412 ± 0.561	8.485	.000	2.362 ± 0.477	9.764	.000
β_{YEAR}	-0.555 ± 0.115	-9.530	.000	-0.553 ± 0.115	-9.534	.000
$\beta_{TotalLK}$	0.013 ± 0.004	6.233	.000	0.013 ± 0.004	7.150	.000
β_{ROOF}	0.025 ± 0.025	.708	.480			
β_{BM}	-0.102 ± 0.102	-1.963	.051			
β_{BT}	0.051 ± 0.051	1.148	.252			
Adjusted R-square	0.425			0.421		
F	34.365		.000	83.036		.000

V. DISCUSSION

This study aimed at determining the significant relationship between building characteristics and building airtightness. Correlational analysis and ANOVA tests were carried out to measure these relationships. Furthermore, by incorporating significant variables derived from the ANOVA test, a multi linear regression is run to determine significance factors that influence building airtightness. Many variables were considered from literature and the year of building construction, building method, building typology, roof type and total leakages were found to have significant relationships with specific leakage rate. However regression analysis shows that only building year and total leakage influences specific leakage rate. The results above showed that building characteristics such as dwelling type and floor area cannot explain the building airtightness because the difference in means were not significant. Even though the ANOVA test and the correlation test were run for both target of specific leakage rate at 10 Pa and 50 Pa difference, the results suggest slightly different numbers with similar outcomes.

The ANOVA test suggests that older buildings tend to be leakier than newer buildings. The findings from the regression analysis confirm that year of construction actually have influence over airtightness. This corroborate with Chan, Joh & Sherman [19], Montoya et al. [21], and Sinott & Dryer [16]. Although this is an interesting discovery, it has little impact on practice because legislation only applies to newer buildings, particularly since the 1992 Building Code was enacted. Other factors such

as building method, material used and building technology are inculcated in the 'year of construction' which is directly related to materials and building practices prevalent at that time. These might not be influenced in current legislation, but might be improved, for example, by retrofitting the leaky buildings.

The analysis shows that total leakage has a strong correlation with specific leakage rate and regression results proved that the amount of leakage happen in the house give influence to the specific leakage rate. This confirms that the more leakages occur in the building, the less airtight the building would be. Empirical data also suggests range of leakage path found in the buildings: window-wall interface, joint between floor and wall, joint between ceiling and wall, were found in roof joint, in plumbing installation, in electrical socket and in vent. This suggests that attention to details improves the quality of workmanship. As the literature shows[16], [23], [24], workmanship is critical to achieve building airtightness. Statistics also showed the same results that leakages occur in the building give significant influence on specific leakage rate, which in this case happen at 10 Pa different. In new houses, leakages can be minimized by paying close attention to details and this is anchored more on the quality of workmanship.

Building method was found not to have an impact on specific leakage rate. This is in contrast to the findings of Kalamees [23], who discovered that prefabricated detached houses are less leakier than houses that were constructed on site and therefore more airtight. However, because some of the cases did not explicitly categorize the building method, which in this study was categorized as 'unknown', it is possible that this could have influenced the outcome. Moreover, the ANOVA test suggests that there is a significant difference in specific leakage rate means between groups. However, the significant difference lies between group 'unknown' and prefabrication building. Even though, the regression analysis suggests no effect whatsoever. Although Montoya et al. [21] and Chan, Joh & Sherman [19] noted building typology to be a predictor of building airtightness, in the case of Dutch residential buildings, this variable was not discovered statistically significant as a predictor of specific leakage rate. Just as in the building method, the ANOVA test suggests there is a significant difference in means of specific leakage rate between groups. However, where the mean difference lies between groups cannot be determined by post-hoc 'Scheffe' test in this study. This could have influenced the outcome that building typology cannot be a predictor.

As the ANOVA test presents, there is relationship between roof type and specific leakage rate; this difference in means of specific leakage rate lies between group 'unknown' and pitched roof. However, results of regression shows no impacts of roof type on specific leakage rate. Nevertheless, just as in building method, because some of the cases did not explicitly categorize the roof type, which in this study was categorized as 'unknown', it is possible that this could have influenced the outcome.

Even though year of construction and total leakage both had main effect on specific leakage rate, their influences on specific leakage rate is not simultaneous but interactive. This means that the effect of total leakage is dependent on the age of building and vice versa. Total leakage also has interaction with other significant factors which are: roof type, building method and building typology. However they were statistically insignificant as predictors, therefore, the interaction effect has no consequences on specific leakage rate.

A. Implications

Based on the significance building characteristics determined from the ANOVA test, regression results suggests that only variable year of construction and variable total leakage influence specific leakage rate at 10 Pa difference. Although the year of construction has influence on specific leakage rate, this discovery however, has little relevance on buildings post-2012. This means that, at the end of the day, the regulation (Dutch Building Code) on building airtightness is only relevant on newly built houses. This study confirms that year of construction and total leakages actually have influence on building airtightness as suggested in the literature. Apparently the influence of these factors is subject to their interaction with each other as confirmed by the two-way ANOVA test. In addition, year of construction actually encompasses other factors such as building typology, building material, building method, HVAC system, insulation type, etc. This is because these factors cannot be dissociated from the prevalent practices of relative periods in time. On the other hand, leakages path found in some part

of the building is still a relevant finding because it still could be considered during the construction of new houses. Since total leakage has significant effect on specific leakage rate, more attention should be paid to minimizing air leakage at the early phases of construction and this is dependent on the quality of workmanship. Also other studies have suggested that supervisor and management play important role in achieving high quality workmanship and this could have positive impact on attaining less leakages and subsequently more airtight building. Therefore, a reliable model could not be generated with the findings of this study.

One interesting area of this research was to explore if roof type influences specific leakage rate, because previous studies overlooked it. A remarkable discovery is that roof type is actually related with specific leakage rate although it has no effect on it. Together with variable total leakage, roof type has an interaction effect on specific leakage rate. This might support the facts that leakage path found in the roof joint might contribute significantly to total air leakage and, consequently, affect building airtightness.

B. Limitations

This research, however, has some limitations. Since this study analysed results from many other scientific studies, one of the shortcomings of it is the heterogeneity of the results from the included studies can be affected. And this is because there are inherent differences in the individual studies such as method of obtaining data, analysing them and interpreting them. This research uses the term specific leakage rate to refer building airtightness while other studies use different terms to normalize building airtightness and measurement of such concepts could yield different outcomes. Also since this research uses regression to attempt to develop a model, such model method is only applicable if the new data is in range of a dataset from which the model was derived from. This is also a notable limitation to this study. Another limitation of these studies is that there were some missing data in the cases which are important for reliable findings. Studies could make stronger attempts to obtain and presents updated and comprehensive data which future research could reliably built on.

VI. CONCLUSION AND RECOMMENDATIONS

Many studies have attempted to predict airtightness prior to a blower door test. As Relander [26] concluded that no such model can substantially replace the blower door test. However, predicting airtightness is a fruitful effort to achieve a desired level of building airtightness, especially in the case of Dutch regulations, that require a certain value of q_{v10} or w_{10} to calculate the energy performance coefficient. In this study, while total leakage, year of construction, roof type, building method and building typology have a relationship with airtightness, only year of construction and total leakage influence the building airtightness. This supposes that a reliable model cannot be developed from those variables since the overall effect was still relatively moderate. Other probably factors will explain the variance in airtightness. There might be need to further explore this area of interest to discover the cogent variables that could have effect on building airtightness. However, the findings of this work could be a springboard for future researches on airtightness. Particularly the fact that year of construction influences airtightness, which actually encompasses other building typology such as building material, building technology and practise during that time. This calls for testing other variables that are not included in this empirical study such as ventilation system and insulation type. Such building characteristics might influence building airtightness because ventilation system determines the indoor air quality and insulation type determines the quality of building envelope. Other studies have shown that supervision of workmanship and management context have effect on building airtightness. This could be confirmed within the study scope of The Netherlands, as the empirical data showed where the leakage path is and thus, attention to detail and enhancing the supervision in order to improve the quality of workmanship is essential to maintain achieve more airtight buildings.

As this research particularly has studied residential buildings, future studies could be carried out using the same variables of this work to test for relationship with building airtightness and perhaps develop a predictive model for airtightness of service buildings. Furthermore, experimental research could be carried out to find out if interference on variables affects building airtightness. For example retrofitting

can be applied on older buildings by using different material that configure the building envelope to measure the degree of improvement on building airtightness. These could perhaps be the intervention needed to ensure adequate building airtightness in the future and ultimately energy efficiency.

ACKNOWLEDGEMENTS

The author would like to thank The Indonesia Endowment Fund for Education, Ministry of Finance of Republic of Indonesia for providing the Master scholarship and the opportunity to study at the University of Twente. The author would also like to particularly appreciate the efforts of Joop Halman and Bram Entrop, for their guidance and encouragement that refined this study. Lastly, the author is grateful to Acniah Damayanti for the contribution on SPSS and statistical analysis, Adedapo Tunmise Aladegbaiye for giving some significant advice on the writing process and Martin Platenkamp for supporting on Dutch text translations.

REFERENCES

[1] NHBC Foundation, *A practical guide to building airtight dwellings*. Amersham: IHS BRE Press, 2009.

[2] P. Kuindersma and H. M. Nieman, "Luchtdicht bouwen, theorie-ontwerp-praktijk," Rotterdam, 2013.

[3] S. B. Sadineni, S. Madala, and R. F. Boehm, "Passive building energy savings: A review of building envelope components," in *Renewable and Sustainable Energy Reviews*, vol. 15, no. 8, Elsevier Ltd, 2011, pp. 3617–3631.

[4] H. Krstić, Ž. Koški, I. I. Otković, and M. Španić, "Application of neural networks in predicting airtightness of residential units," in *Energy and Buildings*, vol. 84, 2014, pp. 160–168.

[5] J. M. Logue, M. H. Sherman, I. S. Walker, and B. C. Singer, "Energy impacts of envelope tightening and mechanical ventilation for the U.S. residential sector," in *Energy and Buildings*, vol. 65, Elsevier B.V., 2013, pp. 281–291.

[6] S. Nabinger and A. Persily, "Impacts of airtightening retrofits on ventilation rates and energy consumption in a manufactured home," in *Energy and Buildings*, vol. 43, no. 11, Elsevier B.V., 2011, pp. 3059–3067.

[7] J. Jokisalo, J. Kurnitski, M. Korpi, T. Kalamees, and J. Vinha, "Building leakage, infiltration, and energy performance analyses for Finnish detached houses," in *Building and Environment*, vol. 44, no. 2, 2009, pp. 377–387.

[8] W. Pan, "Relationships between air-tightness and its influencing factors of post-2006 new-build dwellings in the UK," in *Building and Environment*, vol. 45, no. 11, Elsevier Ltd, 2010, pp. 2387–2399.

[9] Ü. Alev, L. Eskola, E. Arumägi, J. Jokisalo, A. Donarelli, K. Siren, T. Broström, and T. Kalamees, "Renovation alternatives to improve energy performance of historic rural houses in the Baltic Sea region," in *Energy and Buildings*, vol. 77, Elsevier B.V., 2014, pp. 58–66.

[10] M. H. Sherman and R. Chan, "Building Airtightness : Research and Practice," 2004.

[11] H. R. R. Santos and V. M. S. Leal, “Energy vs. ventilation rate in buildings: A comprehensive scenario-based assessment in the European context,” in *Energy and Buildings*, vol. 54, Elsevier B.V., 2012, pp. 111–121.

[12] D. Mickaël, B. Bruno, C. Valérie, L. Murielle, P. Cécile, R. Jacques, and K. Severine, “Indoor air quality and comfort in seven newly built, energy-efficient houses in France,” in *Building and Environment*, vol. 72, Elsevier Ltd, 2014, pp. 173–187.

[13] EU, “Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings,” *Off. J. Eur. Union*, pp. 13–35, 2010.

[14] BRIS Bouwbesluit Online, “Bouwbesluit 2012.” [Online]. Available: http://www.bouwbesluitonline.nl/Inhoud/docs/wet/bb2012. [Accessed: 25-Feb-2015].

[15] V. Iordache and T. Catalina, “Acoustic approach for building air permeability estimation,” in *Building and Environment*, vol. 57, 2012, pp. 18–27.

[16] D. Sinnott and M. Dyer, “Air-tightness field data for dwellings in Ireland,” in *Building and Environment*, vol. 51, 2012, pp. 269–275.

[17] Centraal Bureau voor de Statistiek, “Voorraad woningen en niet-woningen; mutaties, gebruiksfunctie, regio,” 2014. [Online]. Available: http://statline.cbs.nl/StatWeb/publication/?VW=T&DM=SLNL&PA=81955NED&D1=7&D2=a&D3=0,103-519&D4=33&HD=140711-1613&HDR=G1,T&STB=G2,G3. [Accessed: 26-Aug-2015].

[18] CEN, *EN Standard 13829: Thermal performances of building - determination of air permeability of buildings - fan pressurization method*. Brussels: European Committee for Standardization, 2000.

[19] W. R. Chan, J. Joh, and M. H. Sherman, “Analysis of air leakage measurements of US houses,” in *Energy and Buildings*, vol. 66, Elsevier B.V., 2013, pp. 616–625.

[20] W. R. Chan, W. W. Nazaroff, P. N. Price, M. D. Sohn, and A. J. Gadgil, “Analyzing a database of residential air leakage in the United States,” *Atmos. Environ.*, vol. 39, no. 19, pp. 3445–3455, 2005.

[21] M. I. Montoya, E. Pastor, F. R. Carrié, G. Guyot, and E. Planas, “Air leakage in Catalan dwellings: Developing an airtightness model and leakage airflow predictions,” in *Building and Environment*, vol. 45, no. 6, 2010, pp. 1458–1469.

[22] A. Sfakianaki, K. Pavlou, M. Santamouris, I. Livada, M. N. Assimakopoulos, P. Mantas, and a. Christakopoulos, “Air tightness measurements of residential houses in Athens, Greece,” in *Building and Environment*, vol. 43, no. 4, 2008, pp. 398–405.

[23] T. Kalamees, “Air tightness and air leakages of new lightweight single-family detached houses in Estonia,” in *Building and Environment*, vol. 42, no. 6, 2007, pp. 2369–2377.

[24] M. Pinto, J. Viegas, and V. P. de Freitas, “Air permeability measurements of dwellings and building components in Portugal,” in *Building and Environment*, vol. 46, no. 12, Elsevier Ltd, 2011, pp. 2480–2489.

[25] D. F. R. Alfano, M. Dell'Isola, G. Ficco, and F. Tassini, "Experimental analysis of air tightness in Mediterranean buildings using the fan pressurization method," in *Building and Environment*, vol. 53, Elsevier Ltd, 2012, pp. 16–25.

[26] T. O. Relander, S. Holøs, and J. V. Thue, "Airtightness estimation - A state of the art review and an en route upper limit evaluation principle to increase the chances that wood-frame houses with a vapour- and wind-barrier comply with the airtightness requirements," in *Energy and Buildings*, vol. 54, Elsevier B.V., 2012, pp. 444–452.

[27] N. Van Den Bossche, W. Huyghe, J. Moens, A. Janssens, and M. Depaepe, "Airtightness of the window-wall interface in cavity brick walls," in *Energy and Buildings*, vol. 45, Elsevier B.V., 2012, pp. 32–42.

[28] T. O. Relander, G. Bauwens, S. Roels, J. V. Thue, and S. Uvsløkk, "The influence of structural floors on the airtightness of wood-frame houses," in *Energy and Buildings*, vol. 43, no. 2–3, 2011, pp. 639–652.

[29] T. O. Relander, B. Heiskel, and J. S. Tyssedal, "The influence of the joint between the basement wall and the wood-frame wall on the airtightness of wood-frame houses," in *Energy and Buildings*, vol. 43, no. 6, Elsevier B.V., 2011, pp. 1304–1314.

[30] J. Langmans, R. Klein, M. De Paepe, and S. Roels, "Potential of wind barriers to assure airtightness of wood-frame low energy constructions," in *Energy and Buildings*, vol. 42, no. 12, Elsevier B.V., 2010, pp. 2376–2385.

[31] T. O. Relander, T. Kvande, and J. V. Thue, "The influence of lightweight aggregate concrete element chimneys on the airtightness of wood-frame houses," in *Energy and Buildings*, vol. 42, no. 5, Elsevier B.V., 2010, pp. 684–694.

RESEARCH PROPOSAL

DEVELOPING A MORE RELIABLE MODEL FOR PREDICTING BUILDING AIRTIGHTNESS

ANALYSIS OF BUILDING AIRTIGHTNESS MEASUREMENTS IN DUTCH RESIDENTIAL BUILDINGS

AUGUST 4, 2015

Table of Contents

ABSTRACT

There is an increasing awareness for building airtightness. This is due to the need to save energy, as well as follow dictates of building regulations, which state that contractors and house owners must comply with certain minimum requirements. To determine whether a building meets the minimum requirements or not, they are tested for their air permeability level with a blower door after completion. The uncertainty of meeting these requirements of building airtightness measurements, encouraged stakeholders to attempt to predict results as accurately as possible prior to completion. There have been many researches in the past on measuring building airtightness, but none of them seem to supersede the results of blower door measurements. This research, therefore, aims at improving the existing model to predict building airtightness. This is done by studying the variables of building characteristics, which will be deduced from past studies, that influence the airtightness of building envelope. The plan is to incorporate results in a stronger model that will be derived from linear regression.

1. INTRODUCTION

1.1. Background

The buildings sector incurs a significant portion of energy use in the world. With the issue of sustainability getting more important, several attempts are being made to reduce the energy use of buildings by improving their energy efficiency. Different stakeholders across the world such as governments, scientists and environmentalists recognise the impact of energy efficiency on building. The development and rising demand on zero-energy, energy neutral buildings, high-efficiency buildings and smart buildings have motivated the actors in the construction industry to innovate. The focus is still the same: to reduce the energy needs of buildings. Therefore, innovation in the building technology area has rapidly developed, not only to reduce the energy needs but also to comply with the current regulation.

An energy-efficient building can be achieved either through active or passive strategies. Measures such as improving heating ventilation and air conditioning (HVAC) system, installing a solar panel, etc. are categorized as active strategies, while improving the quality of the building envelope is categorized as passive strategy [3]. Building envelope improvement includes improvement of the wall, window and door penetration, and roofs. An obvious example of passive strategy is the concept of "passive house", which requires certain measures of improving the heat resistance and airtightness of the building envelope (air permeability N_{50} of 0.6 ACH). Moreover, not every household can afford to apply active energy efficient strategies because improvement on building envelope element—such as by improving the thermal insulation and building airtightness to reduce heat loss—is suggested and regulated in the building code.

Airtightness is considered important for improving the energy efficiency of buildings, especially if one is following the passive energy efficient strategy. Building airtightness has been included in the regulations in many countries to achieve energy efficient buildings. It is in most cases usually measured in terms of air permeability level. The term "airtightness" pertains to the intensity of the uncontrolled flow of air through the building envelope as a result of pressure differences between interior and exterior air[4]. Building airtightness is closely related to air infiltration or air leakages within the building as the level of airtightness achieved is often measured as air permeability ($m^3/h.m^2$) at 50 Pa, that is, the quantity of air (in m^3) that leaks into or out of the dwelling per hour, divided by the internal area (in m^2) of the building fabric at 50 Pa [1].

Several studies have shown the importance of ensuring building airtightness in order to reduce air infiltration and thus reducing the cooling load and heat loss of the building [3]. The studies indicated that tightening of the building envelope provides a large energy benefit[5], [6]. By conducting several experimental analyses, most studies showed how building airtightness influences the energy performance within a house. Recent studies suggested the importance of building airtightness with respect to energy efficiency, thermal comfort and indoor air quality of dwellings [7]–[10]. Maintaining building airtightness is also essential for the effectiveness of heat recovery installed in the building

[11], [12]. Therefore, it is important to maintain a certain level of building airtightness to optimize the energy efficiency of buildings.

Recently, European legislation on the energy performance of buildings has become more strict [21]. The ripple effect of this is evident in The Dutch Building Code [14], which requires residential buildings in The Netherlands to comply with a certain level of energy performance, in terms of energy performance coefficient (Article 5.2), and a given limit of airflow rate (Article 5.4). However, there is a minor flaw in the Code. It explicitly mentions total maximum of airflow rate allowed in the building but it does not explicitly mention any other minimum requirements—such as degree of building airtightness. This might initiate some confusion as it is found in some cases that buildings comply with the certain level of energy performance but they do not comply with the minimum value of building airtightness or vice versa.

Furthermore, to ensure that reasonable standards are achieved, blower door tests are taken for newly built houses in order to measure and confirm their airtightness on completion. However, another problem is that contractors only rely on the measurements results done after the completion of the building. The required airtightness is then sometimes not followed. Efforts must be taken to ensure that a certain level of building airtightness and the awareness to apply measures and techniques to achieve this are integrated from the beginning of any new construction project. In addition, plans for the retrofitting or rehabilitation of existing buildings are required to get measured as well [5], [6], [15], [16]. To ensure this, it is strongly advised to use predictive methods of building airtightness to assist the contractor or any other stakeholder involved in the construction project to comply with the minimum requirements of building airtightness, especially prior to carrying out blower door test. However, what really matters to some actors, such as contractors, is not to estimate the building airtightness, but to comply with the given requirements. On the other hand, estimating building airtightness prior to official measurements can offer guidance on which part of buildings to improve in order to meet the minimum value required. If airtightness can be accurately estimated and measured on an acceptable level, contractors can save some costs on performing blower door test. In the end, it could be a solution to achieve less infiltration occurrence, and ultimately more airtight and energy efficient buildings.

1.2. Airtightness of Buildings in the Netherlands

The airtightness of buildings in the Dutch building regulations is expressed as a flow rate at 10 Pa pressure difference (q_{v10}) and the measurement is taken by a blower door test. While in other countries building airtightness is expressed as *air permeability* level at 50 Pa difference (Q_{50}) or *air change rate* at 50 Pa difference (N_{50}). For comparison, the relation between q_{v10} and N_{50} is dependent on the flow coefficient (n) a division by about 25 – 30. The average flow rate (q_{v10}) is about 113 dm^3/s, which equals N_{50} of about 3.5 to 4.5 [32]. However this equality cannot be determined definitely because the normalization used to divide the airflow rate is different between those terms; every airflow rate in different buildings will have different exponential coefficient. Therefore, the conversion between terms, either the pressure difference or the permeability, depends on the exponential coefficient.

Every Dutch house is required to have an energy performance certificate that expresses an energy label. And every new Dutch house to be constructed must have energy performance coefficient that takes the value of q_{v10} into account in the calculation. There are four limits of q_{v10} indicated: 0.15, 0.4, 0.625 and 1.0 (this value is rarely used). One of these values must be taken to calculate the value of energy performance coefficient. However, it is still unclear how this value of q_{v10} is generated and justified for certain EPC.

Since the value of q_{v10} is indicated in the EPC, the new building must obtain this minimum value of q_{v10} as indicated. To assure that this minimum value is fulfilled, a blower door test is conducted to measure the airflow rate of the assigned building. For the last couple of years, this test has been taken prior to completion or the turnkey in order to ensure that any minimum requirement set for the building is fulfilled. Therefore, contractor can still manage to improve the building before it is occupied. This is where the problem lies.

It is unfortunate that contractors cannot harness their resources to provide better overview of estimating building airtightness. The EPC must indicate the minimum value of q_{v10} ; thus, the

engineers or architects must include in their design and calculation the value of q_{v10} that will be assigned to the EPC. However, they cannot be certain whether this value can be achieved. Even though they have the complete specification of the forthcoming building, they might not be able to estimate the exact value of q_{v10} because they cannot estimate the building airtightness from the drawings they provided themselves. Therefore, analysing estimated building airtightness prior to conducting blower door test is highly recommended. Inadvertently, therefore, what matters to contractor is that their building complies with the minimum requirements rather than estimating the exact value of q_{v10}. Figure 1 shows the overview of building airtightness problem lingering in Dutch construction industry.

Figure 10 Cause-Effect Diagram on Building Airtightness Problems in the Construction Industry

There are a limited number of empirical studies regarding estimating airtightness of residential building in The Netherlands. Therefore, this study intends to fill part of this literature gap. The objectives of this paper are to set up a research design to tackle the problems in the building industry regarding building airtightness and provide preliminary answer from the literature by analysing previous studies. This paper is outlined as follows. Chapter 2 will explain the problem statement for this research with the corroborative research questions to be answered in probing this area of interest. Chapter 3 will rivet on the research strategy adopted to answer the research questions, including the implications and limitations of the research. Chapter 4 will present the literature review of previous studies in the field of building airtightness prediction, including the existing method to predict airtightness and the variables utilized in several predictive models.

2. RESEARCH DESIGN

As mentioned earlier, The Netherlands has set a specific energy performance coefficient, and a maximum limit of building airtightness to be met. It is relatively critical that airtightness of buildings meet the standard set by The Dutch Building Code. Consequently, contractors and engineers must consider airtightness at all phases—from initial design, through construction process to final completion—to ensure that compelled performance can be met. However, because it is relatively difficult for contractor and engineers to predict the value of $q_{v10,}$ this problem continues to linger. Therefore, this issue could be collapsed into the following problem statement:

Actors involved in building processes do not know how to relate the building characteristics to the building airtightness.

The correlation between the variables: airtightness and building characteristics will provide better overview on the relationship between the two factors. Afterwards, the predictive power of building characteristics over airtightness will be determined following a regression analysis. Therefore, the objective of this research is:

"To identify and analyse the relationship between building characteristics and building airtightness in order to develop a reliable model to predict building airtightness of Dutch residential buildings."

As stated in the objective, the aim of the research is to develop a model to predict airtightness by exploring variables that influence building airtightness. Many past studies have attempted to estimate airtightness without taking the blower door test, yet the predictive models could not replace the results of blower door test. However, they could still help stakeholders to improve building airtightness. At the least, contractors and designers could use a reliable predictive model to maintain the target of minimum air permeability at the early construction phase. Although not every variables can be useful to develop a predictive model, the findings could contribute to future research in predicting building airtightness of dwellings more consistently.

From the problem statement and research objective above, the main question to be answered within this research is as follows:

"How does the relationship between building characteristics and building airtightness yield a model to predict building airtightness of Dutch residential buildings?"

This research question is broken down into the following sub-questions:

1. What models currently exist to predict ex ante airtightness of residential buildings?
    a. What are the variables included in the prediction model?
    b. How are these variables assessed?
    c. What relations do occur between the variables involved?
2. How are Dutch residential buildings being assessed ex post regarding building airtightness?
    a. What variables apply in the Dutch context?
    b. How is airtightness related to the variables measured?
    c. What model can be developed to predict the airtightness of Dutch residential buildings?
3. How accurate is this predictive model compared to the other predictive models?
    a. Which model is the most accurate to be used prior to building completion?
    b. What is the best method to predict building airtightness prior to building completion?

A. Scope of study

The scope of this research will cover only residential buildings in The Netherlands, based on data from a pressurization test on dwellings gathered by the University of Twente. The reason residential building is in this study's interest is predicated on the following facts.

First, there are much more residential buildings than service buildings in the Netherlands. The 2012 report from Central Bureau of Statistics [17] shows there are more than 7.2 million houses in The Netherlands. Consequently, residential buildings incur the highest energy cost. Second, the inhabitancy of residential buildings and the usage of the structures are different to service buildings, because most people generally live their lives and spend more time at home. Therefore, residential

buildings are more intensely used than service buildings, which have more structured and regular opening and closing hours. Therefore, certain modification could be done to residential buildings to suit the need of the inhabitants, and sometimes this could also affect the structure of the building.

Furthermore, the following section describes the research strategy adopted to answer the research questions.

3. RESEARCH METHOD

In line with the given set of sub-questions, this research will be conducted in three phases. The first phase is literature review of scientific journals and articles on relevant applicable regulations. Reviews of the literature study and current practises in The Netherlands will reveal some of the methods currently used to predict building airtightness prior to the construction phase. They indicated some influencing factors that are taken into account as coefficients in the model's formula. The second phase will be the correlational analysis of the variables: building characteristics and measured building airtightness. Finally, phase 3 will examine whether the current dataset is adequate to be used for developing a predictive model and whether the variables tested in this research are in line with the literature. Each element of the research will now be explained in more detail.

3.1. Phase 1: Literature Review

The literature study will cover the definition of building airtightness, air permeability, and methods to measure and predict airtightness. Past research will be reviewed to determine which important variables have been included in conducting measurements and existing predictive models. Every predictive model in previous studies would have included some variables in the formula or equation. These variables could be type of building with a coefficient of certain value. There have been a lot of researches on factors that influence building airtightness from which predictive models have been developed in different countries. However, these variables differ because of various governmental policies and geographical peculiarities. Therefore, this study will attempt to collect, collate and summarize those variables in the literature and select relevant variables to be utilized. Then the appropriate method to test Dutch residential buildings based on the dataset collected will be determined.

3.2. Phase 2: Analysis

This phase will analyse the correlation between building characteristics and building airtightness by comparing means within variables. The first step is to summarise the variables that influence building airtightness which were used in many models to predict building airtightness without having to carry out a blower door test. To develop a set of variables for the correlational analysis, the variables mentioned in the literature are collected and compared to the variables mentioned in the blower door test results, provided by the Department of Construction Management and Engineering of University of Twente. 320 measurement results of different dwellings in The Netherlands were provided. These results will be compiled on Microsoft Excel for easy categorization. Afterwards, the spread sheets will be exported into statistical software program SPSS v22. Since there is quite an amount of measurement data used in the research, it is necessary to validate the results of pressurization tests. A statistical homogeneity test between regression coefficient pressurization measurements will be performed. Using the air tightness or air permeability level suggested by Sfakianaki, et al. [22], every measured level will be tested to verify whether the data are statistically even. Levene's test will be used to show whether the variance of the data is equal or not[8].

The next step will be to study the correlation between building characteristics variables (derived from the step one) and building airtightness. Adapting the method from Pan[8] and Montoya, et al.[21], ANOVA test will be used to measure the correlation between building airtightness and some influencing variables. This will be conducted using univariate and bivariate analyses. In order to run analyses, the variance between variable has to be equal. However, because different statistical data from different studies will be included in this work, it is important to note that they were treated according to the type of data using different method of analyses. Therefore, reliability might be affected. Moreover, how data are treated and analysed greatly affect the interpretation and deduction of the outcome.

Usually, when examining the relationship between a quantitative outcome and a single quantitative explanatory variable, simple linear regression is the most commonly considered analysis method [33]. However, the ANOVA test will be adopted in this research; therefore, an empirical predictive model will be developed using multiple linear regressions by incorporating only the significant variables from the phase 2.

3.3. Phase 3 Model Testing

Finally, to answer the third set of sub-questions, the third phase of the research will attempt to test the model developed from the analysis.

The first step of this phase is to validate the empirical predictive model with a new set of buildings. There are nine dwellings with detailed building data including the drawing plan and the blower door test results which constitute the data that will be the input in the model to indicate the predicted building airtightness. Nevertheless, since the predictive model cannot be 100% accurate, therefore, this model will be compared with the actual results of blower door.

Finally, the next step will be to compare all models (empirical model and relevant predictive model from literature) suggested in this research and to determine which models best predict the building airtightness. The model with the highest accuracy in comparison to the actual measurements results will be regarded. However, besides the level of accuracy, many other factors might also be involved during this justification.

Figure 2 summarises the research method to be conducted in this research.

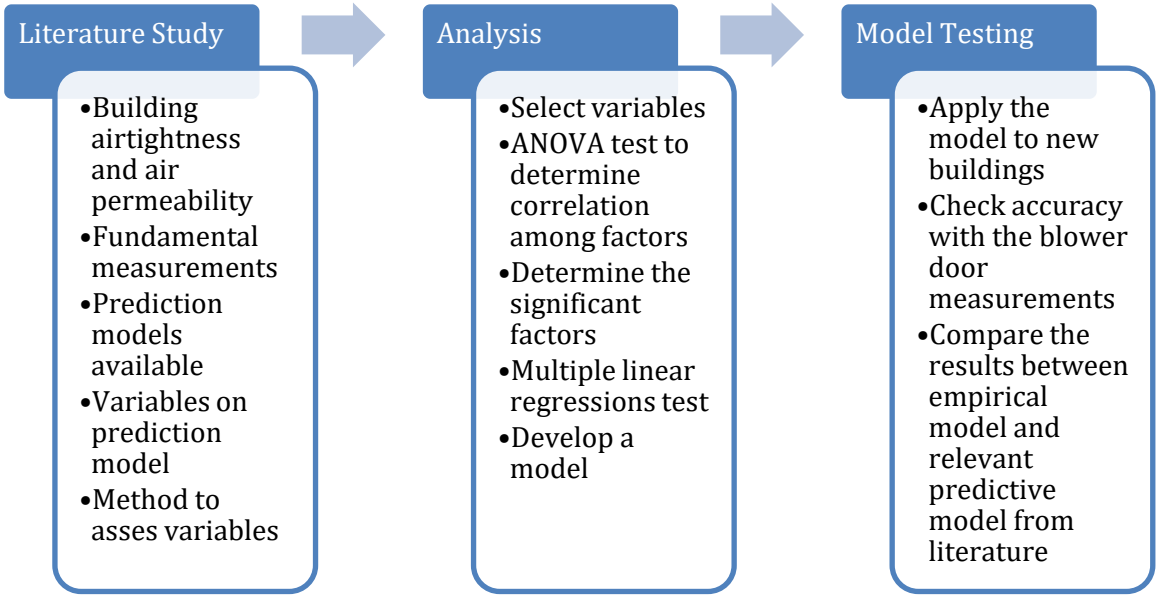


Figure 11 Research Framework

3.4. Implications and Limitations

Building airtightness is considered one of the factors that influence the energy performance of residential buildings, due to its capability to reduce thermal loss. There have been many studies concerning building airtightness, but limited research regarding Dutch buildings. This research will attempt to contribute to literature and theory on improving building airtightness. The findings of this work could be a springboard for future researches on airtightness.

This study could also be practically relevant by determining predictive models for building airtightness itself before doing any retrofitting or improvement in buildings in order to comply with the strict regulation. In reality, even though constructors tried to maintain building airtightness and municipalities tried to control the maximum air permeability, the quality (or quantity) of building airtightness is affected by several other factors. These factors, treated as variables in this research, will be studied to gain more insight on achieving desired level of airtightness and to develop certain models that can help contractors reach their minimum requirements of air permeability before the blower door test is taken.

However, some limitations are anticipated:

- To ensure the reliability of the results, especially regarding the climate factor, the measurement of a house should be taken at different times, under different weather conditions. This important because environmental factors such as, wind speed, pressure and humidity could influence the results of blower door test. However, some measurements in the currently available dataset were done only once. This could have implication on reliability.
- The measurements in the dataset were carried out by different organizations; thus, report formats were different as some were more detailed than others. Therefore, there were a few missing information in the dataset.
- The model would be developed using certain building characteristics from the current dataset available. Therefore, while it has internal validity, it is only applicable to new data in range of the current data set. Hence, external validity could be affected.
- The tested building in this research might be quite small for a validation of a model. Further research with bigger samples might yield more reliable results.

3.5. Scheduling

Below is the designed schedule for the whole research

Task	Start Date	Duration	End Date
Phase 1	12-Mar-15	35	16-Apr-15
Literature Study	12-Mar-15	35	16-Apr-15
Research Proposal	26-Mar-15	21	16-Apr-15
Phase 2	16-Apr-15	56	11-Jun-15
Homogenity test on data	16-Apr-15	7	23-Apr-15
Selecting Variables	23-Apr-15	7	30-Apr-15
ANOVA test	30-Apr-15	14	14-May-15
Selecting Methods	14-May-15	7	21-May-15
Developing model	21-May-15	21	11-Jun-15
Phase 3	11-Jun-15	35	16-Jul-15
Input Building Data	11-Jun-15	14	25-Jun-15
Check Accuracy	25-Jun-15	7	2-Jul-15
Justification and Discussion	2-Jul-15	14	16-Jul-15
Conclusion	16-Jul-15	9	25-Jul-15
Finishing reports (Literature Review + Research)	25-Jul-15	28	22-Aug-15

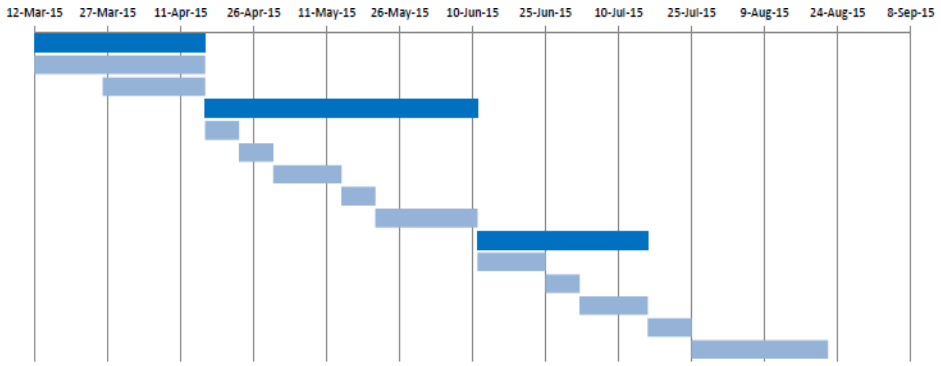


Figure 12 Gantt Chart

4. LITERATURE REVIEW

4.1. Introduction

This paper's literature review begins with studying a collection of articles in scientific journals regarding building airtightness. The articles reviewed were extracted from *ScienceDirect* and *Scopus* databases. The advantage of using these databases search engine is that they made it possible to set parameters to select articles without the results becoming too broad. The parameters chosen to filter the results were: keywords, the year range, the type of publication, the field of study, and the name of journals. Keyword input consists of: building airtightness, air infiltration, air leakage, air permeability and building infiltration. The year range was set for the last decade (2004-2014). The reason for this was to gather more recent articles, without having to review the out-dated ones. The focus on journals only helped extract scientifically relevant resources. Energy and buildings, construction and engineering, were selected as the field of study, while name of journals were restricted to journals within those fields of study, to exclude articles from other specializations in the search results. Abstract of articles were perused to determine the relevance for this study to ensure the focus on residential buildings and no other buildings, such as public service buildings. Finally, 30 articles were selected. The outcomes of the scientific literature review are presented below.

4.2. Relevant Terms in Building Airtightness

Different authors conceptualize building airtightness in their research in different ways. Some included environmental factors and while others normalize the value to generate dimensionless terms in their studies. This section focuses on exploring different terms used when investigating building airtightness.

1) Air infiltration

The unwanted movement of air from inside a building to outside is called infiltration, and while the unwanted movement of air from outside to inside of building is called exfiltration. Air infiltration occurs because of pressure difference between outdoor and indoor caused by temperatures difference. Air infiltration value is usually influenced by environmental factors, while building airtightness value is independent of the environmental factors. Therefore, it is important to include the environmental factors in the measurements to ensure the reliability of the results.

A correlation between building airtightness, air infiltration and energy consumption was discovered in a typical family house in Finland, as the correlation between the increase in air infiltration and the energy consumption for heating and ventilation progresses in a linear manner[7].

In some studies, the air infiltration rate is also determined as "air change rates per hour" (ACH) noted with unit h^{-1} or /h. In building airtightness research, air change rates at reference pressure referred to the air leakage rates per internal volume of the building at the test reference pressure differential across the building envelope. The internal volume is defined as the ventilated active space within buildings, not including the attic, the basement and attached structures [18].

2) Air leakage rate

Building airtightness is often measured in terms of how leaky the building envelope is. The value air leakage measured during the pressurization test also indicated how much air change per hour is passing through the building envelope. The higher the air leakage, the less airtight the building is. In most cases, pressurization tests were carried out to measure leakage in whole buildings, but these tests can also be utilised to measure leakage in separate parts of a building. Pressurization test methods could be used to measure the exterior envelope leakage, the leakage between the living space and the crawl space and the leakage through the air distribution system ductwork [6]. This is termed also as airflow rate through the building envelope symbolized by V_L and the unit is m^3/h.

To define the building airtightness, this value is normalized using different parameters depending on the context and regulation. The explanation of the normalization is presented more elaborately in next section. In the case of US buildings, the term 'normalised leakage' is used to predict the infiltration airflow. Normalised leakage is a dimensionless term used by Logue, et al. [5] and Chan, et al. [19] to

correspond air leakage rates with internal volume of a building by dividing it with floor area and building height. It is used in some analyses due to its convenience, since the area and height are known parameters it ensure consistency in the research[19].

3) Air permeability

The term "airtightness" pertains to the intensity of the uncontrolled flow of air through the building envelope, as a result of pressure differences between the interior and exterior air [4]. The level of building airtightness is often expressed in levels or air permeability. Compared to the air leakage rate (how much unwanted air passes into the internal volume of a building at reference pressure different; usually 50 Pa) [18], air permeability is the capability of a surface to let air pass through – in this case, the capability of the building envelope itself. Therefore, the unit of air permeability is $m^3/h.m^2$. The lower the air permeability is, the more airtight a building is. In research on building airtightness, air permeability and air leakage are frequently used for conducting research, since both refer to the capability of the building envelope to not let unwanted air pass through the building. The air permeability in 50 Pa pressure difference is symbolised as Q_{50}.

4.3. Measuring building airtightness

In order to determine the airtightness of a building, a test is usually carried out to measure the amount of air leaking within building envelope. The level of building airtightness is firstly measured in terms of the amount of air leakage between different indoor and outdoor pressure using two most common standardized methods, which are the tracer gas method and the pressurization test, which uses a blower door. However, more emphasis will be placed on the blower door test because it is more relevant to this study.

Tracer gas is usually used to measure the infiltration rate under natural conditions. There are three different measurements of gas concentration: the concentration decay; the constant injection; and the constant concentration[34]. Since the measurement is carried out under natural conditions, the environmental factors, such as wind speed and humidity, naturally affect the results. There is a high chance that if the measurements are done at a different time, the outcomes of the measurement will be different. Generally, the tracer gas method is more accurate than a blower door test, but it is less repeatable[25]. Therefore, many analyses in building airtightness using the measurement results from fan pressurization tests use the blower door.

The most common method to measure air leakage within building envelope is the fan pressurization test, using a blower door. This method is based on the mechanical pressurization or depressurization of a part of a building, with all adjacency open, using a blower door. The air flow rate through the building envelope is caused by the differences in pressure between the air inside and outside. The airtightness of building components and elements can be measured according to standard NEN-EN 13829 [18]. The further mathematical formulations used in the measurements is explained in the following section. Even though the measurement method is not complicated and can be carried out with little amount of equipment and time, the interpretation of the results requires a certain extent of knowledge.

From a measurement standpoint, airtightness means measuring the air flow through the building envelope as a function of the pressure across the building envelope [10]. When measuring the building airtightness, the occurring air leakage is quantified as the airflow getting through the building envelope, which is symbolised as V (m^3/s), through differences in pressure, expressed in ΔP (Pascal). The pressure-flow relationship, which acts according to the power law, is expressed by the equation:

$$V_L = C_L \cdot \Delta P^n \qquad \text{(Equation 1)}$$

The flow coefficient C_L is a function of the size of building openings, and the pressure exponent is expressed 0.5<=n<=1.0. An exponent of 0.5 denotes fully turbulent and an exponent of 1.0 represents laminar flow. Usually the flow exponent is 0.65 [10]. The air flow is often denoted with the reference pressure as a sub-script (e.g. V_{50} or V_{25}). The reference of 50 Pa in air pressure differences is most often used. Another common reference pressure used is 4 Pa, but 1 Pa, 10 Pa, 25 Pa, and 75 Pa are used as well [10].

To define the building airtightness, there are three quantities commonly used to normalize the air leakage: building volume, envelope area, and floor area [10], [18]. These normalisations are used depending on the context of the regulation either where or for what purpose. Each has advantages and disadvantages and each is useful for evaluating different issues.

Building volume is particularly useful when normalizing air flows. When building volume is used to normalize the airflow rate the result is normally expressed in air changes per hour at the reference pressure; N_{50} is the most common airtightness metric reported in the literature. Many people find this metric convenient since infiltration and ventilation rates are often quoted in air changes per hour. Therefore, the air change rate at 50 Pa pressure difference is calculated by dividing the mean air leakage rate at 50 Pa by the internal volume using equation

$$N_{50} = \frac{V_{50}}{v} \quad \text{(Equation 2)}$$

Envelope area is particularly useful if one is looking to define the quality of the envelope as a uniform "fabric". Kalamees [23] defined building envelope includes building components and ventilation devices. This normalization pertains to the terms 'air permeability'. Although this normalization can sometimes be the hardest to use, it can be particularly useful in attached buildings were some walls are exposed to the outdoors and some are not. The air permeability at 50 Pa difference, Q_{50}, is calculated by dividing the mean airflow rate at 50 Pa by the envelope area using equation:

$$Q_{50} = \frac{V_{50}}{A_E} \quad \text{(Equation 3)}$$

Floor area can often be the easiest to determine from a practical standpoint. Since usable living space scales most closely relate to floor area; normalizing these scales is sometimes viewed as being more equitable. Specific leakage rate at 50 Pa difference, w_{50}, is calculated by dividing the mean air leakage rate at 50 Pa by the floor area using equation:

$$w_{50} = \frac{V_{50}}{A_F} \quad \text{(Equation 4)}$$

Normalization using floor area is used in the EPC following the NEN 13829 standard (*please refer to Appendix 1*). Compared to other country regulation that building airtightness is measured at 50 Pa, in The Netherlands building airtightness is measured at 10 Pa different. Table 1 explains the difference between different building airtightness terms used in different contexts.

However, Dutch Building Code only mentions the permitted total air flow rate of residential including toilet and bathroom must not be bigger than 0.2 m^3/h. The desired specific leakage rate is stated in EPC, depending on the volume of the building. For comparison the relation between q_{v10} and N_{50} is depending on the flow coefficient (n) a division by about 25 – 30. The airflow (q_{v10}) of about 113 dm^3/s, equals to an N_{50} of about 3.5 to 4.5 [32].

Table 6 Different terms used to express building airtightness according to EN 13829:2000

Terms	Normalisation	Symbol	Units
Air change rate (infiltratie voud)	Air leakage rate divided by internal building volume	N	h^{-1}
Air permeability	Air leakage rate divided by building envelope surface	Q	$m^3/h.m^2$
Specific air leakage rate	Air leakage rate divided by usable floor area	w	$m^3/h.m^2$

4.4. Estimating Building Airtightness

It is important to understand the factors that influence the level of building airtightness. These factors can be the cause of the air leakage and that could influence the quality of building airtightness. This section will explore the important factors that influence the quality of building airtightness and the methods that several authors used to develop predictive models for those factors.

4) Airtightness Estimation Research

Some organizations have developed some predictive models such as: Lawrence Berkeley Laboratory (LBL) [35] and Alberta Air Infiltration Model (AIM) 2 [36] that are used to calculate air infiltration and energy loss; and *Stichting Bouwresearch* (SBR) [37] method that uses building characteristics to predict airtightness. the Netherlands uses a model developed by SBRCurNet to calculate building airtightness value based on component leakages and the geometry of the building [2]. Moreover, other studies have also been carried out with the purpose to develop a model to estimate or predict building airtightness. These studies could be divided into two broad research categories: 'experimental' and 'correlational'[8].

'Experimental' research is carried out under controlled experimental conditions with the purpose of measuring the causal effects of independent variables on dependent ones. Experimental studies to develop building airtightness predictive model used building simulations or by test specimens on whole or parts of buildings. An example of this includes the study of airtightness in Portugal [24] and in Italy [25]. The acoustic approach, which is also used in air permeability prediction, is also experimental in design [38][15]. The advantages of this method are that the measurements are not weather dependent and not as expensive as using a blower door. The method is mainly based on using verified physical and acoustical methods.

'Correlational' research is carried out under statistical control with the purpose of understanding the correlation between variables. Correlational research studies are used to develop a predictive model using regression analysis. This method, however, has limitations: the predictive model is only applicable if the new data is in range of dataset from which the model was derived from. Examples of correlational research include the study of airtightness in Croatia [4], in Finland [7], in the UK [8], in the US [10], [20], in Catalonia [21], in Greece [22] and in Estonia [23]. Parallel with these empirical studies, there have been several practical guidelines in literature to achieve airtightness in different countries. For example, in the United Kingdom there are the Energy Saving Trust and the Building Research Establishment (BRE) guidelines. In the United States, there are weatherization assistance programs (WAPs) and residential energy efficiency programs.

The most recent correlational research method on predicting building airtightness uses neural networks. This method, which is often called 'artificial neural networks', was inspired from analogy on the biological neuron system [4]. In this system, a neuron receives a signal sent from another neuron or external source, and processes this information. The neuron then transfers it to the next neuron or external point. The artificial neuron networks have a complex ability to learn from and generalise data based on experience, a process comparable to how the human brain works. The method has been validated by 20 independent measurements, which are, however, assumed to be relatively small and need to be validated further. The basic advantages stated for this predictive model for airtightness in residential buildings is the possibility of a fast assessment of the value of airtightness, without the need to conduct field measurements.

There have been many literary studies which researched the factors that influence building airtightness, as well as the house characteristics that have correlations with airtightness. In most cases, the literary studies are used to estimate the building airtightness a priori to the start of the construction phase of new buildings. Relander, Holøs and Thue [26] categorized three different methods to estimate the building airtightness: (1) estimation based on multiple regressions, (2) estimation based on the rough characteristics of the building and (3) estimation based on the component leakage and geometry of the building.

Table 7 Summary of previous studies

Country	Average permeability	Influencing variables	Number of measurements	Method used to develop model	Source
United Kingdom	Q_{50} of 5.97 $m^3/(h\ m^2)$	• Construction type • Type of residential building • Management context	287	Multi linear regression	[8]
United States		• Year of construction • Climate zone • Floor area	134.000	Multi linear regression	[19]

		• House height • Type of foundation • Location of ventilation system • Energy class of family house			
Finland	N_{50} 3.70 ACH	• Annual infiltration rate	1	Sensitivity analysis simulating building model	[7]
Greece	N_{50} 6.79 ACH	• Total window frame length	20	Regression	[22]
Estonia	Q_{50} 4.2 $m^3/(h\ m^2)$	• number of storeys, • workmanship quality and supervision, • building technology (built in site or prefab), and • the ventilation systems.	32	Experimental analysis	[23]
Spain and France		• building age, • Construction type	251	Multi linear regression	[21]
Ireland	Q_{50} 9.1 $m^3/(h\ m^2)$	• Building age • Design detail • Retrofitting	28	Field study	[16]
Portugal		• Quality of workmanship	5	Field study	[24]
Croatia	Q_{50} 0.76 – 19.64 ACH at 50 Pa	• opaque part of building envelope, its material and structure • transparent part of building envelope, its material and structure	58	Neural network prediction	[4]

5) Variables

In estimating building airtightness, it is important to understand the variables that act as predictors. These variables will then be reviewed and assigned with corrective factors in the predictive model. These variables were derived either from experimental studies or correlational studies as mentioned earlier. Table 1 summarises different methods of research and the variables that constitute the corrective factors in the predictive model. These are summarised below.

Building age

There have been many researches that revealed the correlation between the age of buildings and building airtightness. However, not all researches showed similar results. Ref [9], [19], [21] showed that older buildings tend to be leakier than newer buildings. This might be caused by differences in the building technology used and different regulations applied during the time the buildings were constructed. However, contradictory results were found in other studies which discovered that older buildings yielded the lowest mean of air permeability [16]. It can be concluded that older buildings cannot simply be generalised as leakier, since other factors such as detail of workmanship and geographical location have to be taken into account as well.

Geographical Location

Most researches on building airtightness have been carried out in different countries. This means there are several factors regarding geographical location that obstruct the reproducibility of the research. Some researches proved that climate affects the building air leakages. Many countries have different climates and larger countries even have different climate zones across the country [19]. As climates influences different seasons, in terms of air leakage rate, different seasons cause different amounts or air leakage [8], which means the level building airtightness differs. Rather than monitoring the infiltration rate every season, it is wiser to use the average annual infiltration rate to compare airtightness. Research conducted by Jokisalo, et al. [7] suggested that there is a linear correlation between annual air infiltration rates and the airtightness of building envelope, as well as the annual energy consumption for heating and ventilation. It was found that the average annual infiltration rate and energy consumption increase in almost linear manner.

Structural building characteristics

In most predictive models, building structure is used as a corrective factor for measuring building airtightness. This paper separates building structure factors into two different categories: structural and non-structural ones building characteristics.

Structural building characteristics are defined as building parts that give structure to the building and bear the load of the construction. Parameters included in building structure are: the typology of buildings; the use of masonry or a wooden frame structure (NEN 8088-1); whether the building is considered a light or a heavy structure[21]; the type of foundation [19]; and building technology, taking in account onsite construction, the use of prefabricated building elements, and assembly at the building site[23]. It was found that masonry buildings are more airtight than buildings with a wooden frame. This can be due to the amount of joints in a wooden frame house. Consequently, there are more chances that there will be leakage in the wood adjacency. Generally, buildings with a heavy structure are more airtight than buildings with a light structure. Buildings that were built on site were found leakier [23]. Houses that were built under professional supervision tend to be more airtight. Houses with conditioned basements were found to be leakier than houses with slab foundation[19].

Non-structural building characteristics

The second type of building characteristics are the non-structural characteristics. Variables here are building characteristics that do not bear the load and give construction to the building, but they are nonetheless essential since they determine leakages paths. Variables included in non-structural building characteristics are:

- floor area
- house height and number of storeys
- ventilation type
- insulation type

Together with building age, study conducted in US by Chan, et al. [19] and McWilliams and Jung [39] found that floor area and numbers of storeys are statistically significant in studying normalised leakage. Buildings with one storey tend to be more airtight than two storey buildings [23]. This could be caused by the greater amount of joints in two storey buildings, especially in the joints between the wall and the floor. Consequently, there is higher chance of leakage path formation.

Houses with natural ventilation were found to be leakier than houses with mechanical ventilation [23] or houses with balanced ventilation using heat recovery. The combination of airtight buildings and effective heat recovery resulted in creating more energy efficient buildings. Another factor regarding ventilation is the location of ducts. Houses with ducts located inside conditioned spaces, such active space areas, tend to be more airtight than houses with ducts located in unconditioned spaces, such as attics and basements [19]. Insulation types can be divided in exterior insulation, interior insulation and integrated insulation. Houses with exterior insulation tend to be leakier than others [21].

Workmanship is also a factor to be included in non-structural building characteristics. However, since supervision and the quality of workmanship are essential detail factors to be noted, workmanship is separated from this section as a variable on its own.

Workmanship

It has been proven in many literary studies that the quality of workmanship plays a critical role in achieving building airtightness. Parameters included in workmanship are:

- installation methods
- detail of joints
- Opaqueness and transparency of building envelope.

There is noticeable correlation between airtightness and the structural detail of wooden frame houses. The possible leakage paths on joints were found in the window-wall interface [27], as well as the structural floor [28]; the joints between the basement wall and the wooden frame wall [29]; between the wall and the roof [30]; and in the roof joints [31]; many of which were caused by the method of sealing joints [27]–[29]. Typical leakage found in studied Estonian houses [23] occurred in:

- joints between the ceiling and floor with the external wall
- joints between the internal wall and the external wall and roof
- penetration of electrical installations and plumbing installations
- penetration of the chimney and ventilation ducts
- leakage surrounding electrical sockets
- leakage around windows and doors

Research conducted by Pinto and Viegas [40] showed variation in air permeability values on similar flats with similar building characteristics. This occurred due to variations in the gaps that appear in the roller shutter boxes and the gaps in the lower opening joint of the external doors. Consistent planning and careful workmanship were proved to be essential in achieving desired building airtightness levels [16], [41].

4.5. Preliminary Conclusion

The purpose of this literature study on predicting building airtightness, particularly studied the underlying variables that influence building airtightness. It attempted to determine the significant contribution of different building characteristics variables towards building airtightness.

The study could help not only in developing predictive model but also to get better understanding on which critical variables are needed in achieving better building airtightness. With the understanding that building characteristics can influence building airtightness to certain significance predictive models could be developed. This could also contribute to knowledge in research in understanding building airtightness whether empirical and practical context. In practical context, for example, extra attention should be given to workmanship during construction phase to ensure less leaky building.

Even though estimating or predicting the airtightness cannot simply substitute the airtightness measurements in order to comply with the regulation, it seems to be a parameter to help the contractor in reaching the minimum requirements. A suggestion could be to set upper limit rather than trying to estimate the definite amount of specific leakage rate. Even so, it is still useful to try to get an estimated building airtightness by using the data of building characteristics and known leakage path prior to blower door test. This can minimize the possibility of having costly retrofitting for the building and the need to perform another blower door test. In the end, what matters by increasing building airtightness is to reduce the energy need for space heating system and reduce energy cost, since people might not want to spend most of their budget only on retrofitting without getting long term benefit of it.

REFERENCES

[1] NHBC Foundation, *A practical guide to building airtight dwellings*. Amersham: IHS BRE Press, 2009.

[2] P. Kuindersma and H. M. Nieman, “Luchtdicht bouwen, theorie-ontwerp-praktijk,” Rotterdam, 2013.

[3] S. B. Sadineni, S. Madala, and R. F. Boehm, “Passive building energy savings: A review of building envelope components,” in *Renewable and Sustainable Energy Reviews*, vol. 15, no. 8, Elsevier Ltd, 2011, pp. 3617–3631.

[4] H. Krstić, Ž. Koški, I. I. Otković, and M. Španić, “Application of neural networks in predicting airtightness of residential units,” in *Energy and Buildings*, vol. 84, 2014, pp. 160–168.

[5] J. M. Logue, M. H. Sherman, I. S. Walker, and B. C. Singer, “Energy impacts of envelope tightening and mechanical ventilation for the U.S. residential sector,” in *Energy and Buildings*, vol. 65, Elsevier B.V., 2013, pp. 281–291.

[6] S. Nabinger and A. Persily, “Impacts of airtightening retrofits on ventilation rates and energy consumption in a manufactured home,” in *Energy and Buildings*, vol. 43, no. 11, Elsevier B.V., 2011, pp. 3059–3067.

[7] J. Jokisalo, J. Kurnitski, M. Korpi, T. Kalamees, and J. Vinha, “Building leakage, infiltration, and energy performance analyses for Finnish detached houses,” in *Building and Environment*, vol. 44, no. 2, 2009, pp. 377–387.

[8] W. Pan, “Relationships between air-tightness and its influencing factors of post-2006 new-build dwellings in the UK,” in *Building and Environment*, vol. 45, no. 11, Elsevier Ltd, 2010, pp. 2387–2399.

[9] Ü. Alev, L. Eskola, E. Arumägi, J. Jokisalo, A. Donarelli, K. Siren, T. Broström, and T. Kalamees, “Renovation alternatives to improve energy performance of historic rural houses in the Baltic Sea region,” in *Energy and Buildings*, vol. 77, Elsevier B.V., 2014, pp. 58–66.

[10] M. H. Sherman and R. Chan, “Building Airtightness : Research and Practice,” 2004.

[11] H. R. R. Santos and V. M. S. Leal, “Energy vs. ventilation rate in buildings: A comprehensive scenario-based assessment in the European context,” in *Energy and Buildings*, vol. 54, Elsevier B.V., 2012, pp. 111–121.

[12] D. Mickaël, B. Bruno, C. Valérie, L. Murielle, P. Cécile, R. Jacques, and K. Severine, “Indoor air quality and comfort in seven newly built, energy-efficient houses in France,” in *Building and Environment*, vol. 72, Elsevier Ltd, 2014, pp. 173–187.

[13] EU, “Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings,” *Off. J. Eur. Union*, pp. 13–35, 2010.

[14] BRIS Bouwbesluit Online, “Bouwbesluit 2012.” [Online]. Available: http://www.bouwbesluitonline.nl/Inhoud/docs/wet/bb2012. [Accessed: 25-Feb-2015].

[15] V. Iordache and T. Catalina, “Acoustic approach for building air permeability estimation,” in *Building and Environment*, vol. 57, 2012, pp. 18–27.

[16] D. Sinnott and M. Dyer, “Air-tightness field data for dwellings in Ireland,” in *Building and Environment*, vol. 51, 2012, pp. 269–275.

[17] Centraal Bureau voor de Statistiek, “Voorraad woningen en niet-woningen; mutaties, gebruiksfunctie, regio,” 2014. [Online]. Available: http://statline.cbs.nl/StatWeb/publication/?VW=T&DM=SLNL&PA=81955NED&D1=7&D2=a&D3=0,103-519&D4=33&HD=140711-1613&HDR=G1,T&STB=G2,G3. [Accessed: 26-Aug-2015].

[18] CEN, *EN Standard 13829: Thermal performances of building - determination of air permeability of buildings - fan pressurization method*. Brussels: European Committee for Standardization, 2000.

[19] W. R. Chan, J. Joh, and M. H. Sherman, “Analysis of air leakage measurements of US houses,” in *Energy and Buildings*, vol. 66, Elsevier B.V., 2013, pp. 616–625.

[20] W. R. Chan, W. W. Nazaroff, P. N. Price, M. D. Sohn, and A. J. Gadgil, “Analyzing a database of residential air leakage in the United States,” *Atmos. Environ.*, vol. 39, no. 19, pp. 3445–3455, 2005.

[21] M. I. Montoya, E. Pastor, F. R. Carrié, G. Guyot, and E. Planas, “Air leakage in Catalan dwellings: Developing an airtightness model and leakage airflow predictions,” in *Building and Environment*, vol. 45, no. 6, 2010, pp. 1458–1469.

[22] a. Sfakianaki, K. Pavlou, M. Santamouris, I. Livada, M. N. Assimakopoulos, P. Mantas, and a. Christakopoulos, “Air tightness measurements of residential houses in Athens, Greece,” in *Building and Environment*, vol. 43, no. 4, 2008, pp. 398–405.

[23] T. Kalamees, “Air tightness and air leakages of new lightweight single-family detached houses in Estonia,” in *Building and Environment*, vol. 42, no. 6, 2007, pp. 2369–2377.

[24] M. Pinto, J. Viegas, and V. P. de Freitas, “Air permeability measurements of dwellings and building components in Portugal,” in *Building and Environment*, vol. 46, no. 12, Elsevier Ltd, 2011, pp. 2480–2489.

[25] D. F. R. Alfano, M. Dell’Isola, G. Ficco, and F. Tassini, “Experimental analysis of air tightness in Mediterranean buildings using the fan pressurization method,” in *Building and Environment*, vol. 53, Elsevier Ltd, 2012, pp. 16–25.

[26] T. O. Relander, S. Holøs, and J. V. Thue, “Airtightness estimation - A state of the art review and an en route upper limit evaluation principle to increase the chances that wood-frame houses with a vapour- and wind-barrier comply with the airtightness requirements,” in *Energy and Buildings*, vol. 54, Elsevier B.V., 2012, pp. 444–452.

[27] N. Van Den Bossche, W. Huyghe, J. Moens, A. Janssens, and M. Depaepe, “Airtightness of the window-wall interface in cavity brick walls,” in *Energy and Buildings*, vol. 45, Elsevier B.V., 2012, pp. 32–42.

[28] T. O. Relander, G. Bauwens, S. Roels, J. V. Thue, and S. Uvsløkk, “The influence of structural floors on the airtightness of wood-frame houses,” in *Energy and Buildings*, vol. 43, no. 2–3, 2011, pp. 639–652.

[29] T. O. Relander, B. Heiskel, and J. S. Tyssedal, “The influence of the joint between the basement wall and the wood-frame wall on the airtightness of wood-frame houses,” in *Energy and Buildings*, vol. 43, no. 6, Elsevier B.V., 2011, pp. 1304–1314.

[30] J. Langmans, R. Klein, M. De Paepe, and S. Roels, “Potential of wind barriers to assure airtightness of wood-frame low energy constructions,” in *Energy and Buildings*, vol. 42, no. 12, Elsevier B.V., 2010, pp. 2376–2385.

[31] T. O. Relander, T. Kvande, and J. V. Thue, “The influence of lightweight aggregate concrete element chimneys on the airtightness of wood-frame houses,” in *Energy and Buildings*, vol. 42, no. 5, Elsevier B.V., 2010, pp. 684–694.

[32] W. De Gids, “Ventilation in Dutch Houses – A Study in a Representative Sample of The Dutch Housing Stock,” Delft, 2003.

[33] H. J. Seltman, *Experimental Design and Analysis*. 2009.

[34] ISO, *ISO Standard 12569: Thermal performance of building - determination of air change in buildings - traced gas dilution method*. Geneva: International Organization for Standardization, 2000.

[35] M. Orme, “Applicable Models for Air Infiltration and Ventilation Calculations,” Coventry, 1999.

[36] W. Wang, I. Beausoleil-Morrison, and J. Reardon, “Evaluation of the Alberta air infiltration model using measurements and inter-model comparisons,” in *Building and Environment*, vol. 44, no. 2, 2009, pp. 309–318.

[37] W. F. De Gids, H. J. M. Cornelissen, and P. d. Jong, “Infiltratieverliezen U Bouw,” Delft, 2010.

[38] O. Hassan, “An alternative method for evaluating the air tightness of building components,” in *Building and Environment*, vol. 67, Elsevier Ltd, 2013, pp. 82–86.

[39] J. McWilliams and M. Jung, *Development of a mathematical air-leakage model from measured data*. Lawrence Berkeley National Laboratory, 2006.

[40] M. Pinto and J. Viegas, “The influence of ventilation systems on domestic gas appliances: An experimental study,” in *Building and Environment*, vol. 69, 2013, pp. 1–13.

[41] H. Tommerup, J. Rose, and S. Svendsen, “Energy-efficient houses built according to the energy performance requirements introduced in Denmark in 2006,” in *Energy and Buildings*, vol. 39, no. 10, 2007, pp. 1123–1130.

APPENDIX

B. *Nomenclature*

1) *Symbol and Units*

Symbol	Quantity	Unit
V_m	Measured air flow rate	m^3/h
V_{env}	Air flow rate through the building envelope	m^3/h
V_L	Air leakage rate	m^3/h
V_{50}	Air leakage rate at 50 Pa	m^3/h
C_{env}	Air flow coefficient	$m^3/(.Pa^n)$
C_L	Air leakage coefficient	$m^3/(.Pa^n)$
n	Air flow exponent	-
p	Pressure	Pa
Δp	Induced pressure difference	Pa
A_E	Envelope area	m^2
A_F	Floor area	m^2
v	Internal building volume	m^3
N_{50}	Air change rate at 50 Pa	h^{-1}
Q_{50}	Air permeability at 50 Pa	$m^3/(h.m^2)$
W_{50}	Specific air leakage at 50 Pa	$m^3/(h.m^2)$

2) *Terms and definition*

Source: [18]

Air leakage rate: air flow rate across the building envelope.

Internal volume: deliberately heated, cooled or mechanically ventilated space within a building or part of a building subject to the measurement, generally not including the attic space, basement space and attached structures.

Building envelope: boundary or barrier separating the internal volume subject to the test from the outside environment or another part of the building.

Air change rate at reference pressure: air leakage rate per internal volume at the test reference pressure differential across the building envelope.

Air permeability: air leakage rate per envelope area at the test reference pressure differential across the building envelope (usually at 50 Pa).

Specific leakage rate: air leakage rate per net floor area at the test reference pressure differential across the building envelope.

DOCUMENTATION OF THE RESEARCH

ANALYSING RELATIONSHIP AND INFLUENCE OF BUILDING CHARACTERISTICS ON AIRTIGHTNESS OF DUTCH RESIDENTIAL BUILDINGS

RESULTS OF STATISTICAL ANALYSIS OF BLOWER DOOR TEST RESULTS

I. DIGITAL AVAILABLE DOCUMENTATION

Attached together with this document are the digital versions of the following:

- This document
- Original data in Microsoft Excel spread sheet
- Modified data in Microsoft Excel spread sheet
- Modified data in SPSS

The following sections are the results of Statistic Inferential of DataSet 1 Adjusted.sav from 25 May 2014. Dataset 1 Adjusted.sav is the modified data in SPSS.

II. DESCRIPTIVE STATISTICS

A. Frequencies of Specific Leakage Rate

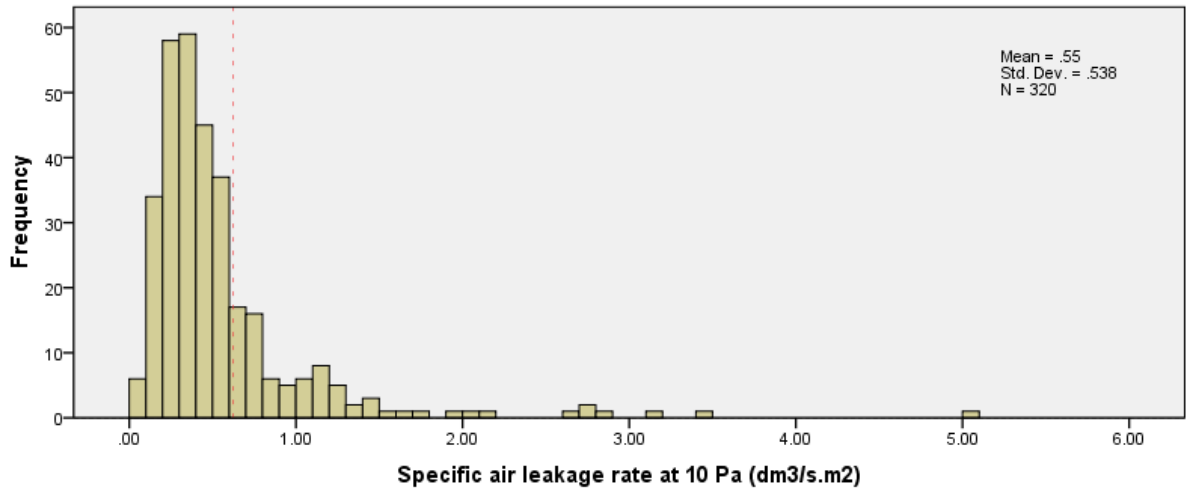
Statistics

Measured specific leakage rate at 10 Pa (dm3/s.m2)

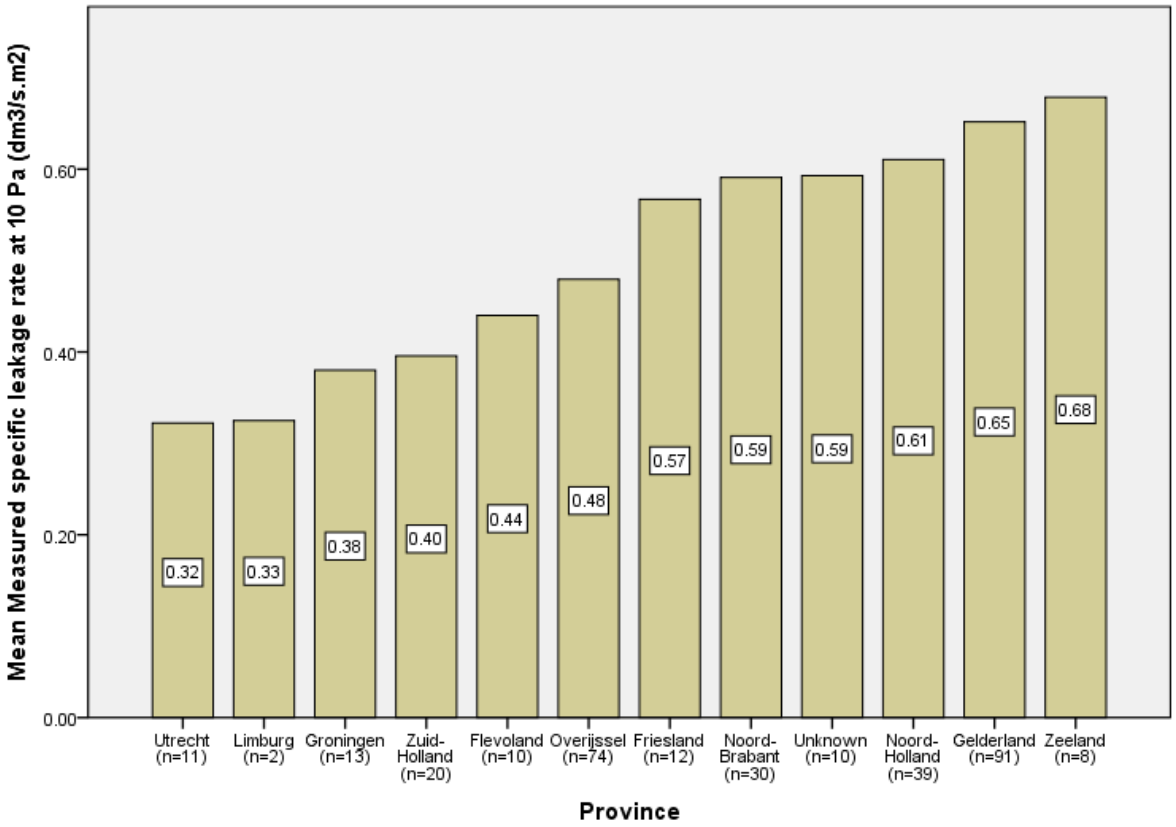
N	Valid	320
	Missing	0

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Measured specific leakage rate at 10 Pa (dm3/s.m2)	320	.06	5.04	.5498	.53787
Valid N (listwise)	320				



B. Dispersion by Province



III. CORRELATIONS ANALYSIS

Correlations

		Design Target (dm3/s.m2)	Measured specific leakage rate at 10 Pa (dm3/s.m2)	Dwelling Type	Building Method	Building Typology	Roof Type	Floor Area	Measured specific leakage rate at 50 Pa (dm3/s.m2)	Total Leakages	Year of Construction
Design Target (dm3/s.m2)	Pearson Correlation	1	.064	-.048	-.171**	-.153**	-.026	.297**	.073	.109	.234**
	Sig. (2-tailed)		.272	.415	.003	.009	.651	.000	.212	.110	.000
	N	293	293	293	293	293	293	293	293	215	292
Measured specific leakage rate at 10 Pa (dm3/s.m2)	Pearson Correlation	.064	1	-.086	-.230**	-.160**	-.088	-.097	.927**	.437**	-.414**
	Sig. (2-tailed)	.272		.125	.000	.004	.117	.083	.000	.000	.000
	N	293	320	320	320	320	320	320	320	230	317
Dwelling Type	Pearson Correlation	-.048	-.086	1	.076	.168**	.594**	.400**	-.060	-.061	-.164**
	Sig. (2-tailed)	.415	.125		.175	.003	.000	.000	.288	.354	.003

	N	293	320	320	320	320	320	320	320	230	317
Building Method	Pearson Correlation	-.171**	-.230**	.076	1	.751**	.259**	-.193**	-.204**	-.358**	-.055
	Sig. (2-tailed)	.003	.000	.175		.000	.000	.001	.000	.000	.330
	N	293	320	320	320	320	320	320	320	230	317
Building Typology	Pearson Correlation	-.153**	-.160**	.168**	.751**	1	.271**	-.024	-.119*	-.380**	-.117*
	Sig. (2-tailed)	.009	.004	.003	.000		.000	.665	.033	.000	.037
	N	293	320	320	320	320	320	320	320	230	317
Roof Type	Pearson Correlation	-.026	-.088	.594**	.259**	.271**	1	.105	-.074	-.144*	-.126*
	Sig. (2-tailed)	.651	.117	.000	.000	.000		.061	.187	.029	.025
	N	293	320	320	320	320	320	320	320	230	317
Floor Area	Pearson Correlation	.297**	-.097	.400**	-.193**	-.024	.105	1	-.073	.138*	.041
	Sig. (2-tailed)	.000	.083	.000	.001	.665	.061		.192	.036	.471
	N	293	320	320	320	320	320	320	320	230	317
Measured specific leakage rate at 50 Pa (dm3/s.m2)	Pearson Correlation	.073	.927**	-.060	-.204**	-.119*	-.074	-.073	1	.426**	-.403**
	Sig. (2-tailed)	.212	.000	.288	.000	.033	.187	.192		.000	.000
	N	293	320	320	320	320	320	320	320	230	317

Total Leakages	Pearson Correlation	.109	.437**	-.061	-.358**	-.380**	-.144*	.138*	.426**	1	-.149*
	Sig. (2-tailed)	.110	.000	.354	.000	.000	.029	.036	.000		.025
	N	215	230	230	230	230	230	230	230	230	227
Year of Construction	Pearson Correlation	.234**	-.414**	-.164**	-.055	-.117*	-.126*	.041	-.403**	-.149*	1
	Sig. (2-tailed)	.000	.000	.003	.330	.037	.025	.471	.000	.025	
	N	292	317	317	317	317	317	317	317	227	317

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

IV. REGRESSION ANALYSIS

For variables total leakage, linear regression analysis is carried out.

A. Total Leakage X W10

Independent Variable: Total Leakage (LK1*1+LK2*2+LK3*3+LK4*4)

Target : W_{10}

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15.417	1	15.417	53.838	.000[b]
	Residual	65.291	228	.286		
	Total	80.708	229			

a. Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

b. Predictors: (Constant), Total Leakage

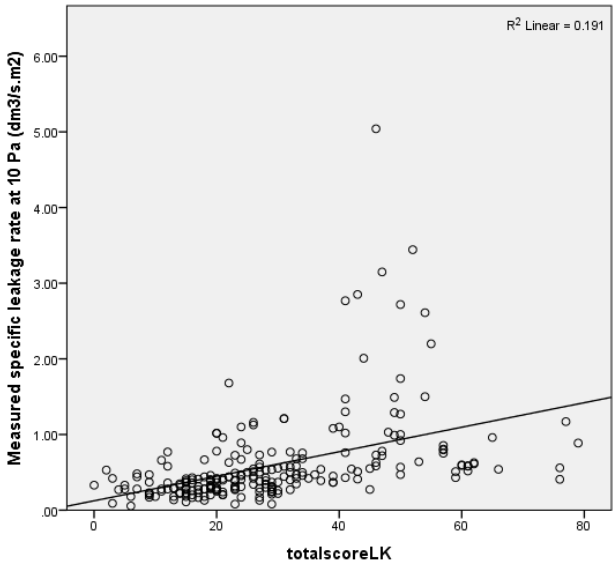
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.437[a]	.191	.187	.53513

a. Predictors: (Constant), totalscoreLK

Statistic shows moderate positive relationships between variable TotalLK and W10 because P value at .437. (If b1>0 shows positive relationships, b1=0 shows no relationship, b1<0 shows negative relationships.).

However, only 19.1% of the variation in W10 can be explained by variable totalLK



B. Total Leakage X W50

Independent Variable: Total Leakage (LK1*1+LK2*2+LK3*3+LK4*4)

Target : W50

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	111.366	1	111.366	50.676	.000[b]
	Residual	501.056	228	2.198		
	Total	612.423	229			

a. Dependent Variable: Measured specific leakage rate at 50 Pa (dm3/s.m2)

b. Predictors: (Constant), totalscoreLK

Statistic shows that total leakage is a good predictor for estimating specific leakage rate at 50 Pa because P-value is less than 0.05. There is a significant relationship between independent variables and dependent variables.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.426[a]	.182	.178	1.48244

a. Predictors: (Constant), totalscoreLK

Statistic shows moderate positive relationships between variable TotalLK and W10 because P value at .426. (If b1>0 shows positive relationships, b1=0 shows no relationship, b1<0 shows negative relationships.).

However, only 18.2% of the variation in W50 can be explained by variable TotalLK

C. Design Target X w10

Independent Variable: QEPC

Target : W10

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.140	1	.140	1.209	.272[b]
	Residual	33.660	291	.116		
	Total	33.800	292			

a. Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

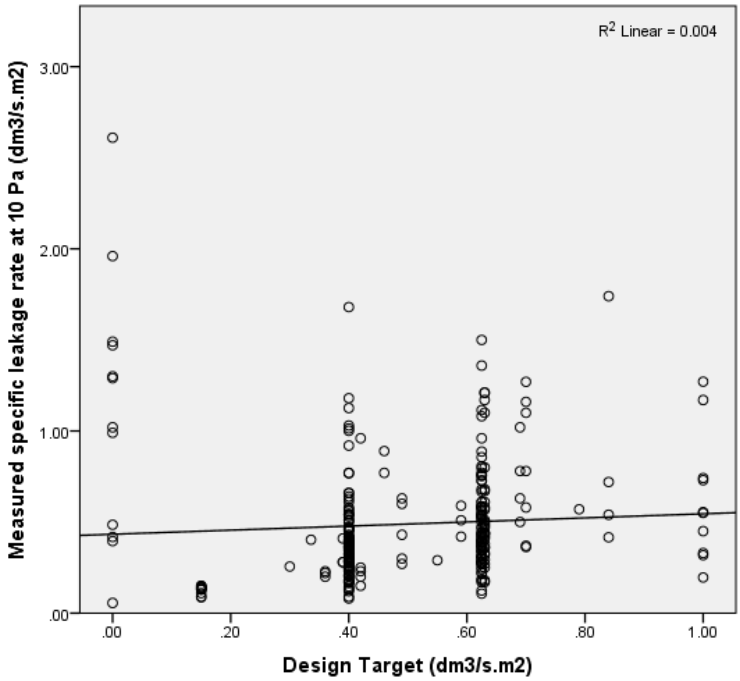
b. Predictors: (Constant), Design Target (dm3/s.m2)

Statistic shows that design target is not a predictor for estimating specific leakage rate at 10 Pa because P-value is less than 0.05. There is no significant relationship between independent variables and dependent variables.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.064[a]	.004	.001	.34011

a. Predictors: (Constant), Design Target (dm3/s.m2)



D. Design Target X w50

Independent Variable: QEPC

Target : W50

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.714	1	1.714	1.562	.212[b]
	Residual	319.281	291	1.097		
	Total	320.995	292			

a. Dependent Variable: Measured specific leakage rate at 50 Pa (dm3/s.m2)

b. Predictors: (Constant), Design Target (dm3/s.m2)

Statistic shows that design target is not a predictor for estimating specific leakage rate at 50 Pa because P-value is less than 0.05. There is no significant relationship between independent variables and dependent variables.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.073[a]	.005	.002	1.04747

a. Predictors: (Constant), Design Target (dm3/s.m2)

E. Floor area x w10

Independent Variable: FLOOR

Target : W10

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.868	1	.868	3.019	.083[b]
	Residual	91.421	318	.287		
	Total	92.289	319			

a. Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

b. Predictors: (Constant), Floor Area

Statistic shows that floor area is not a predictor for estimating specific leakage rate at 10 Pa because P-value is less than 0.05. There is no significant relationship between independent variables and dependent variables.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.097[a]	.009	.006	.53618

a. Predictors: (Constant), Floor Area

F. Floor area x w50

Independent Variable: FLOOR

Target : W50

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.073	1	4.073	1.708	.192[b]
	Residual	758.166	318	2.384		
	Total	762.239	319			

a. Dependent Variable: Measured specific leakage rate at 50 Pa (dm3/s.m2)

b. Predictors: (Constant), Floor Area

Statistic shows that floor area is not a predictor for estimating specific leakage rate at 50 Pa because P-value is less than 0.05. There is no significant relationship between independent variables and dependent variables.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.073[a]	.005	.002	1.54408

a. Predictors: (Constant), Floor Area

V. ONE-WAY ANOVA

A. Year of construction and Specific Leakage Rate

For year variables, one way ANOVA test is carried out to compare means.

1) YEAR X W10

Does the W10 significantly differ between different years (YEAR_C)?

Test of Homogeneity of Variances

Measured specific leakage rate at 10 Pa (dm3/s.m2)

Levene Statistic	df1	df2	Sig.
10.192	3	313	.000

- **Test Statistic** (Levene's): F = 10.192
- **P-value** (Levene's): p = 0.000
- **Statistical Conclusion** (Levene's): Because the p-value (0.000) is lower than the significance level α (0.05), we reject H_0 (equal variances are assumed) instead of the H_a (equal variances is not assumed).
- **Conclusion** (Levene's): The variance of all groups is not equal.

ANOVA

Measured specific leakage rate at 10 Pa (dm3/s.m2)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	34.502	3	11.501	68.876	.000
Within Groups	52.263	313	.167		
Total	86.764	316			

There is at least a group that differs from the other in terms of W50. Then, to find which group differs significantly from each other, we performed 'Scheffe test'.

Multiple Comparisons

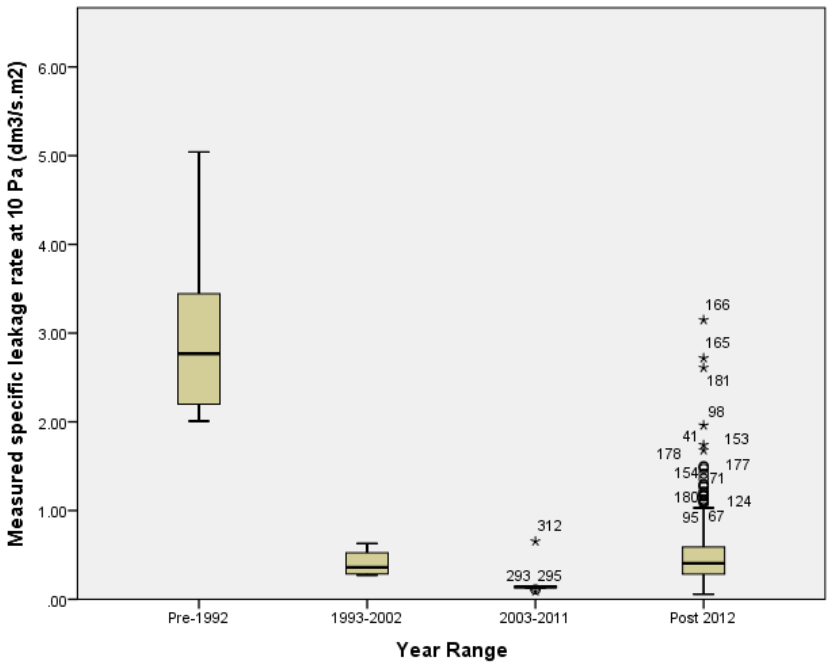
Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

Scheffe

(I) Year Range	(J) Year Range	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-1992	1993-2002	2.68680*	.27411	.000	1.9163	3.4573
	2003-2011	2.91926*	.21503	.000	2.3149	3.5237
	Post 2012	2.57210*	.18428	.000	2.0541	3.0901
1993-2002	Pre-1992	-2.68680*	.27411	.000	-3.4573	-1.9163
	2003-2011	.23246	.23364	.804	-.4242	.8892
	Post 2012	-.11470	.20569	.958	-.6929	.4635
2003-2011	Pre-1992	-2.91926*	.21503	.000	-3.5237	-2.3149
	1993-2002	-.23246	.23364	.804	-.8892	.4242
	Post 2012	-.34716*	.11580	.031	-.6727	-.0217
Post 2012	Pre-1992	-2.57210*	.18428	.000	-3.0901	-2.0541
	1993-2002	.11470	.20569	.958	-.4635	.6929
	2003-2011	.34716*	.11580	.031	.0217	.6727

*. The mean difference is significant at the 0.05 level.

The results suggest that statistically different in mean W10 ($p<0.05$) existed between group buildings from pre 1992 and all other buildings ($p = 0.000$), and building from 2003-2011 and post 2012 ($p = 0.031$).



2) YEAR X W50

Does the W50 significantly differ between different years (YEAR_C)?

Test of Homogeneity of Variances

Measured specific leakage rate at 50 Pa (dm3/s.m2)

Levene Statistic	df1	df2	Sig.
7.468	3	313	.000

- **Test Statistic** (Levene's): F = 7.468
- **P-value** (Levene's): p = 0.000
- **Statistical Conclusion** (Levene's): Because the p-value (0.000) is lower than the significance level α (0.05), we reject H_0 (equal variances are assumed) instead of the H_a (equal variances is not assumed).
- **Conclusion** (Levene's): The variance of all groups is not equal.

ANOVA

Measured specific leakage rate at 50 Pa (dm3/s.m2)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	266.940	3	88.980	61.864	.000
Within Groups	450.192	313	1.438		
Total	717.132	316			

There is at least a group that differs from the other in terms of W50. Then, to find which group differs significantly from each other, we performed 'Scheffe test'.

Multiple Comparisons

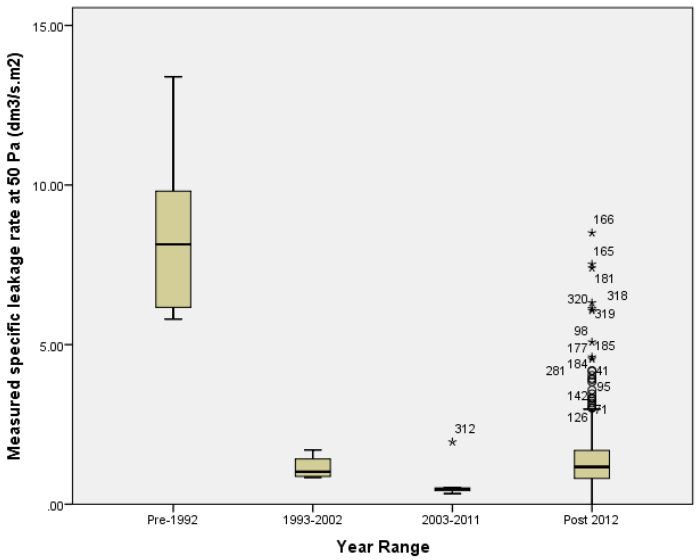
Dependent Variable: Measured specific leakage rate at 50 Pa (dm3/s.m2)

Scheffe

(I) Year Range	(J) Year Range	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-1992	1993-2002	7.51700*	.80451	.000	5.2557	9.7783
	2003-2011	8.09277*	.63111	.000	6.3189	9.8667
	Post 2012	7.16847*	.54087	.000	5.6482	8.6887
1993-2002	Pre-1992	-7.51700*	.80451	.000	-9.7783	-5.2557
	2003-2011	.57577	.68572	.872	-1.3516	2.5032
	Post 2012	-.34853	.60370	.954	-2.0454	1.3483
2003-2011	Pre-1992	-8.09277*	.63111	.000	-9.8667	-6.3189
	1993-2002	-.57577	.68572	.872	-2.5032	1.3516
	Post 2012	-.92429	.33988	.062	-1.8796	.0310
Post 2012	Pre-1992	-7.16847*	.54087	.000	-8.6887	-5.6482
	1993-2002	.34853	.60370	.954	-1.3483	2.0454
	2003-2011	.92429	.33988	.062	-.0310	1.8796

*. The mean difference is significant at the 0.05 level.

The results suggest that statistically different in mean W10 ($p<0.05$) existed between group buildings from pre 1992 and all other buildings ($p = 0.000$).



B. Dwelling Type and Specific Leakage Rate

For dwelling type variables, one way ANOVA test is carried out to compare means.

1) Dwelling Type X W10

Does the W10 significantly differ between different dwelling types (DT)?

Test of Homogeneity of Variances

Measured specific leakage rate at 10 Pa (dm3/s.m2)

Levene Statistic	df1	df2	Sig.
1.948	6	313	.073

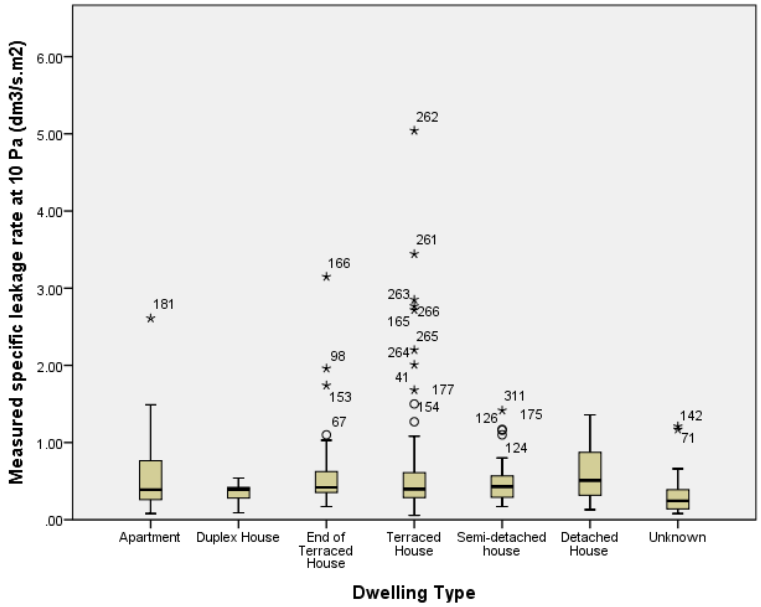
- **Test Statistic** (Levene's): F = 1.948
- **P-value** (Levene's): p = 0.073
- **Statistical Conclusion** (Levene's): Because the p-value (0.073) is bigger than the significance level α (0.05), we don't reject H_0 (equal variances are assumed) in favor of the H_a (equal variances is not assumed).
- **Conclusion** (Levene's): The variance of all 7 groups are equal.

ANOVA

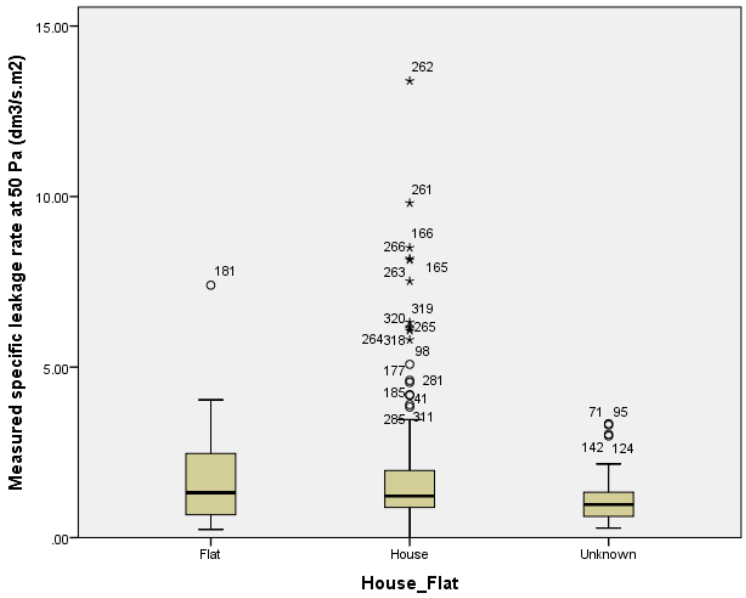
Measured specific leakage rate at 10 Pa (dm3/s.m2)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.106	6	.518	1.817	.095
Within Groups	89.183	313	.285		
Total	92.289	319			

Because p-value (0.95) is bigger than the significance level (0.05), then all groups are statistically equal.



From the boxplot, we can see that there are many extreme cases in terms of dwelling type.



2) Dwelling Type X W50

Does the W50 significantly differ between different dwelling types (DT)?

Test of Homogeneity of Variances

Measured specific leakage rate at 50 Pa (dm3/s.m2)

Levene Statistic	df1	df2	Sig.
2.944	6	313	.008

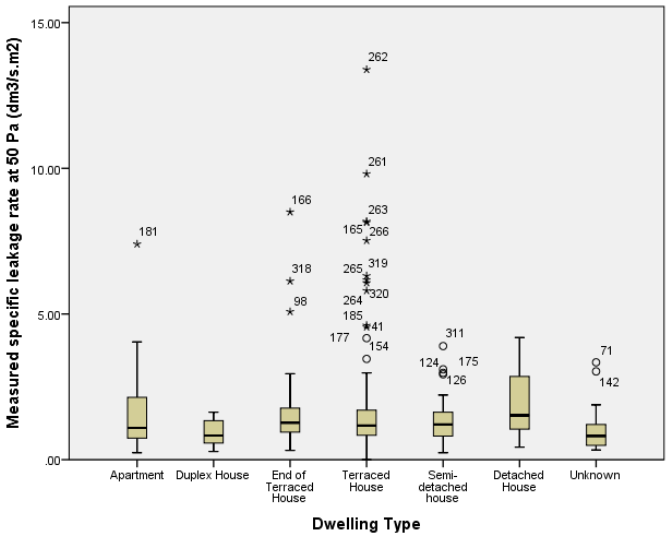
- **Test Statistic** (Levene's): F = 2.944
- **P-value** (Levene's): p = 0.008
- **Statistical Conclusion** (Levene's): Because the p-value (0.008) is lower than the significance level α (0.05), we reject H_0 (equal variances are assumed) instead of the H_a (equal variances is not assumed).
- **Conclusion** (Levene's): The variance of all groups is not equal.

ANOVA

Measured specific leakage rate at 50 Pa (dm3/s.m2)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	29.004	6	4.834	2.064	.057
Within Groups	733.235	313	2.343		
Total	762.239	319			

Because p-value (0.057) is slightly bigger than the significance level (0.05), then all groups are statistically equal.



From the boxplot we can see the extreme cases in terms of dwelling type

C. Roof Type & Specific Leakage Rate

For roof type variables, one way ANOVA test is carried out to compare means.

1) Roof type X W10

Does the W10 significantly differ between different roof types (ROOF)?

Test of Homogeneity of Variances

Measured specific leakage rate at 10 Pa (dm3/s.m2)

Levene Statistic	df1	df2	Sig.
2.551	4	315	.039

- **Test Statistic** (Levene's): F = 2.551
- **P-value** (Levene's): p = 0.039
- **Statistical Conclusion** (Levene's): Because the p-value (0.039) is lower than the significance level α (0.05), we reject H_0 (equal variances are assumed) instead of the H_a (equal variances is not assumed).
- **Conclusion** (Levene's): The variance of all groups is not equal.

ANOVA

Measured specific leakage rate at 10 Pa (dm3/s.m2)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.251	4	1.063	1.817	.005
Within Groups	88.039	315	.279		
Total	92.289	319			

There is at least a group that differs from the other in terms of W50. Then, to find which group differ significantly from each other, we performed 'Scheffe test'.

Multiple Comparisons

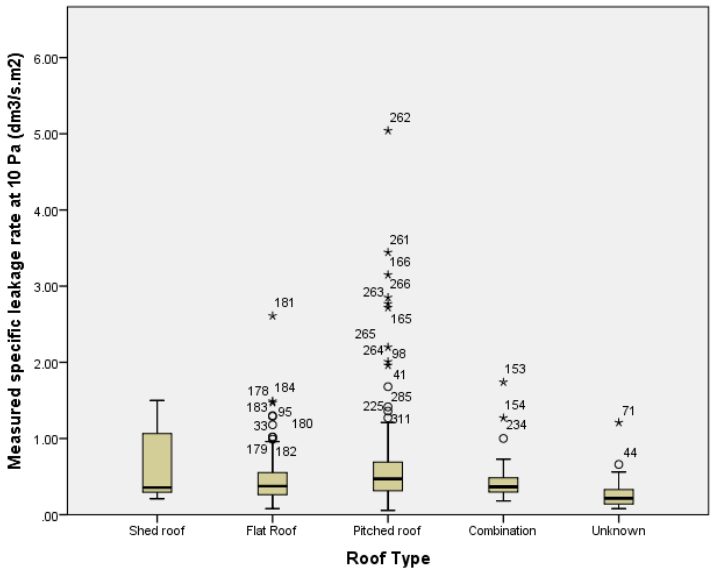
Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

Scheffe

(I) Roof Type	(J) Roof Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Shed roof	Flat Roof	.16642	.19561	.948	-.4397	.7725
	Pitched roof	.00397	.19121	1.000	-.5885	.5965
	Combination	.14992	.21583	.975	-.5188	.8187
	Unknown	.36037	.20897	.563	-.2871	1.0079
Flat Roof	Shed roof	-.16642	.19561	.948	-.7725	.4397
	Pitched roof	-.16245	.07037	.258	-.3805	.0556
	Combination	-.01651	.12236	1.000	-.3957	.3626
	Unknown	.19395	.10982	.539	-.1463	.5343
Pitched roof	Shed roof	-.00397	.19121	1.000	-.5965	.5885
	Flat Roof	.16245	.07037	.258	-.0556	.3805
	Combination	.14594	.11520	.808	-.2110	.5029
	Unknown	.35640*	.10178	.017	.0410	.6718
Combination	Shed roof	-.14992	.21583	.975	-.8187	.5188
	Flat Roof	.01651	.12236	1.000	-.3626	.3957
	Pitched roof	-.14594	.11520	.808	-.5029	.2110
	Unknown	.21046	.14276	.704	-.2319	.6528
Unknown	Shed roof	-.36037	.20897	.563	-1.0079	.2871
	Flat Roof	-.19395	.10982	.539	-.5343	.1463
	Pitched roof	-.35640*	.10178	.017	-.6718	-.0410
	Combination	-.21046	.14276	.704	-.6528	.2319

*. The mean difference is significant at the 0.05 level.

There is significant difference between pitched roof and unknown group, because the alpha level is below 0.05. The results suggest that statistically different in mean W10 ($p<0.05$) only existed between pitched roof and unknown group ($p=0.017$).



2) Roof Type X W50

Does the W50 significantly differ between different roof types (ROOF)?

Test of Homogeneity of Variances

Measured specific leakage rate at 50 Pa (dm3/s.m2)

Levene Statistic	df1	df2	Sig.
5.168	4	315	.000

- **Test Statistic** (Levene's): F = 5.168
- **P-value** (Levene's): p = 0.000
- **Statistical Conclusion** (Levene's): Because the p-value (0.000) is lower than the significance level α (0.05), we reject H_0 (equal variances are assumed) instead of the H_a (equal variances is not assumed).
- **Conclusion** (Levene's): The variance of all groups is not equal.

ANOVA

Measured specific leakage rate at 50 Pa (dm3/s.m2)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	43.094	4	10.773	4.719	.001
Within Groups	719.145	315	2.283		
Total	762.239	319			

There is at least a group that differs from the other in terms of W50. Then, to find which group differ significantly from each other, we performed 'Scheffe test'

Multiple Comparisons

Dependent Variable: Measured specific leakage rate at 50 Pa (dm3/s.m2)

Scheffe

(I) Roof Type	(J) Roof Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Shed roof	Flat Roof	.48048	.55907	.946	-1.2518	2.2128
	Pitched roof	-.11506	.54649	1.000	-1.8084	1.5783
	Combination	.51500	.61685	.952	-1.3964	2.4264
	Unknown	.92281	.59726	.665	-.9278	2.7735
Flat Roof	Shed roof	-.48048	.55907	.946	-2.2128	1.2518
	Pitched roof	-.59553	.20113	.070	-1.2187	.0277
	Combination	.03452	.34972	1.000	-1.0491	1.1182
	Unknown	.44234	.31388	.738	-.5303	1.4149
Pitched roof	Shed roof	.11506	.54649	1.000	-1.5783	1.8084
	Flat Roof	.59553	.20113	.070	-.0277	1.2187
	Combination	.63006	.32924	.455	-.3901	1.6502
	Unknown	1.03787*	.29089	.014	.1365	1.9392
Combination	Shed roof	-.51500	.61685	.952	-2.4264	1.3964
	Flat Roof	-.03452	.34972	1.000	-1.1182	1.0491
	Pitched roof	-.63006	.32924	.455	-1.6502	.3901
	Unknown	.40781	.40801	.910	-.8564	1.6721
Unknown	Shed roof	-.92281	.59726	.665	-2.7735	.9278
	Flat Roof	-.44234	.31388	.738	-1.4149	.5303
	Pitched roof	-1.03787*	.29089	.014	-1.9392	-.1365
	Combination	-.40781	.40801	.910	-1.6721	.8564

*. The mean difference is significant at the 0.05 level.

There is significant difference between pitched roof and unknown group, because the alpha level is below 0.05. The results suggest that statistically different in mean W50 ($p<0.05$) only existed between pitched roof and unknown group ($p=0.014$).

D. Building Method (Prefab or On Site) and Specific Leakage Rate

For building method variables, one way ANOVA test is carried out to compare means.

1) BM X W10

Does the W10 significantly differ between different building methods (BM)?

Test of Homogeneity of Variances

Measured specific leakage rate at 10 Pa (dm3/s.m2)

Levene Statistic	df1	df2	Sig.
12.762	3	316	.000

- **Test Statistic** (Levene's): F = 12.762
- **P-value** (Levene's): p = 0.000
- **Statistical Conclusion** (Levene's): Because the p-value (0.000) is lower than the significance level α (0.05), we reject H_0 (equal variances are assumed) instead of the H_a (equal variances is not assumed).
- **Conclusion** (Levene's): The variance of all groups is not equal.

ANOVA

Measured specific leakage rate at 10 Pa (dm3/s.m2)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.895	3	2.298	8.505	.000
Within Groups	85.394	316	.270		
Total	92.289	319			

There is at least a group that differs from the other in terms of W10. Then, to find which group differs significantly from each other, we performed 'Scheffe test'

Multiple Comparisons

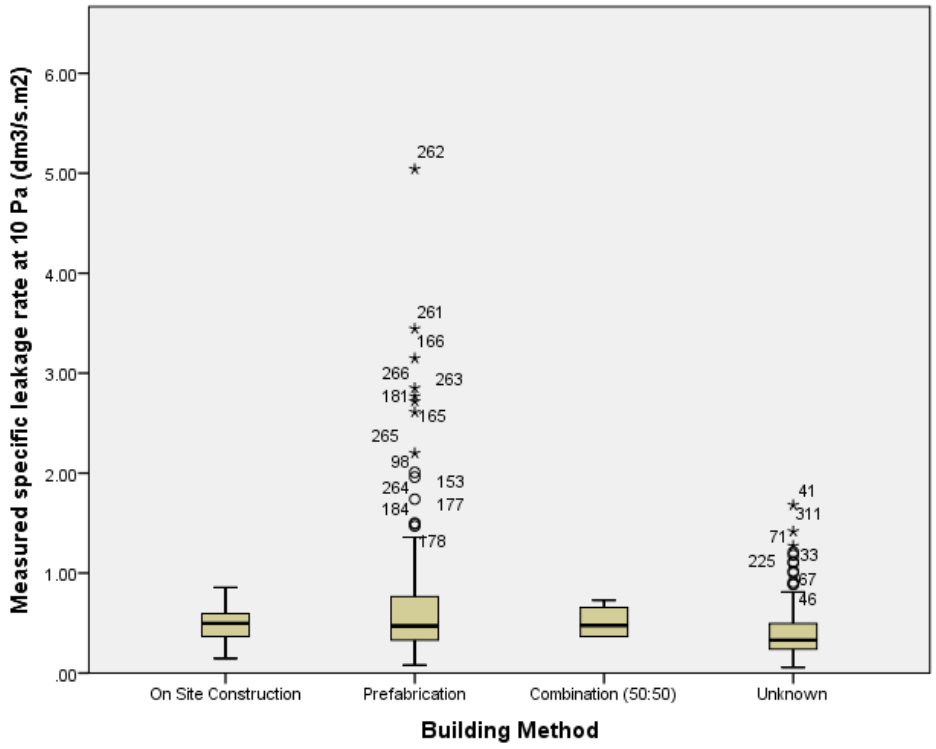
Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

Scheffe

(I) Building Method	(J) Building Method	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
On Site Construction	Prefabrication	-.21536	.12427	.393	-.5646	.1339
	Combination (50:50)	-.01275	.28473	1.000	-.8130	.7875
	Unknown	.08894	.12347	.915	-.2581	.4360
Prefabrication	On Site Construction	.21536	.12427	.393	-.1339	.5646
	Combination (50:50)	.20261	.26361	.898	-.5383	.9435
	Unknown	.30431*	.06052	.000	.1342	.4744
Combination (50:50)	On Site Construction	.01275	.28473	1.000	-.7875	.8130
	Prefabrication	-.20261	.26361	.898	-.9435	.5383
	Unknown	.10169	.26323	.985	-.6382	.8415
Unknown	On Site Construction	-.08894	.12347	.915	-.4360	.2581
	Prefabrication	-.30431*	.06052	.000	-.4744	-.1342
	Combination (50:50)	-.10169	.26323	.985	-.8415	.6382

*. The mean difference is significant at the 0.05 level.

There is significant difference between prefabrication and unknown group, because the alpha level is below 0.05. The results suggest that statistically different in mean W50 ($p<0.05$) only existed between prefabrication and unknown group ($p=0.000$).



2) BM X W50

Does the W50 significantly differ between different building methods (BM)?

Test of Homogeneity of Variances

Measured specific leakage rate at 50 Pa (dm3/s.m2)

Levene Statistic	df1	df2	Sig.
9.323	3	316	.000

- **Test Statistic** (Levene's): F = 9.323
- **P-value** (Levene's): p = 0.000
- **Statistical Conclusion** (Levene's): Because the p-value (0.000) is lower than the significance level α (0.05), we reject H_0 (equal variances are assumed) instead of the H_a (equal variances is not assumed).
- **Conclusion** (Levene's): The variance of all groups is not equal.

ANOVA

Measured specific leakage rate at 50 Pa (dm3/s.m2)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	48.797	3	16.266	7.204	.000
Within Groups	713.442	316	2.258		
Total	762.239	319			

There is at least a group that differs from the other in terms of W10. Then, to find which group differs significantly from each other, we performed 'Scheffe test'

Multiple Comparisons

Dependent Variable: Measured specific leakage rate at 50 Pa (dm3/s.m2)

Scheffe

(I) Building Method	(J) Building Method	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
On Site Construction	Prefabrication	-.66793	.35918	.328	-1.6775	.3416
	Combination (50:50)	-.26700	.82299	.991	-2.5801	2.0461
	Unknown	.13588	.35687	.986	-.8672	1.1389
Prefabrication	On Site Construction	.66793	.35918	.328	-.3416	1.6775
	Combination (50:50)	.40093	.76194	.964	-1.7406	2.5425
	Unknown	.80381*	.17493	.000	.3122	1.2955
Combination (50:50)	On Site Construction	.26700	.82299	.991	-2.0461	2.5801
	Prefabrication	-.40093	.76194	.964	-2.5425	1.7406
	Unknown	.40288	.76086	.964	-1.7356	2.5414
Unknown	On Site Construction	-.13588	.35687	.986	-1.1389	.8672
	Prefabrication	-.80381*	.17493	.000	-1.2955	-.3122
	Combination (50:50)	-.40288	.76086	.964	-2.5414	1.7356

*. The mean difference is significant at the 0.05 level.

There is significant difference between prefabrication and unknown group, because the alpha level is below 0.05. The results suggest that statistically different in mean W50 ($p<0.05$) only existed between prefabrication and unknown group ($p=0.000$).

E. Building Typology & Specific Leakage Rate

For building typology variables, one way ANOVA test is carried out to compare means.

1) BT X W10

Does the W10 significantly differ between different building typologies (BT)?

Test of Homogeneity of Variances

Measured specific leakage rate at 10 Pa (dm3/s.m2)

Levene Statistic	df1	df2	Sig.
9.827	3	315	.000

- **Test Statistic** (Levene's): F = 9.827
- **P-value** (Levene's): p = 0.000
- **Statistical Conclusion** (Levene's): Because the p-value (0.001) is lower than the significance level α (0.05), we reject H_0 (equal variances are assumed) instead of the H_a (equal variances is not assumed).

- **Conclusion** (Levene's): The variance of all groups is not equal

ANOVA

Measured specific leakage rate at 10 Pa (dm3/s.m2)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.091	4	1.273	4.598	.001
Within Groups	87.198	315	.277		
Total	92.289	319			

There is at least a group that differs from the other in terms of W50. Then, to find which group differs significantly from each other, we performed 'Scheffe test'

Warnings

Post hoc tests are not performed for Measured specific leakage rate at 10 Pa (dm3/s.m2) because at least one group has fewer than two cases.

Building Typology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Concrete	23	7.2	7.2	7.2
	Wood frame	4	1.3	1.3	8.4
	Masonry	173	54.1	54.1	62.5
	Steel Construction	1	.3	.3	62.8
	Unknown	119	37.2	37.2	100.0
	Total	320	100.0	100.0	

2) BT X W50

Does the W50 significantly differ between different building typologies (BT)?

Test of Homogeneity of Variances

Measured specific leakage rate at 50 Pa (dm3/s.m2)

Levene Statistic	df1	df2	Sig.
6.008	3	315	.001

- **Test Statistic** (Levene's): F = 6.008

- **P-value** (Levene's): p = 0.000
- **Statistical Conclusion** (Levene's): Because the p-value (0.001) is lower than the significance level α (0.05), we reject H_0 (equal variances are assumed) instead of the H_a (equal variances is not assumed).
- **Conclusion** (Levene's): The variance of all groups is not equal.

ANOVA

Measured specific leakage rate at 50 Pa (dm3/s.m2)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	28.193	4	7.048	3.025	.018
Within Groups	734.046	315	2.330		
Total	762.239	319			

There is at least a group that differs from the other in terms of W50. Then, to find which group differs significantly from each other, we performed 'Scheffe test'

Warnings

Post hoc tests are not performed for Measured specific leakage rate at 50 Pa (dm3/s.m2) because at least one group has fewer than two cases.

Building Typology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Concrete	23	7.2	7.2	7.2
	Wood frame	4	1.3	1.3	8.4
	Masonry	173	54.1	54.1	62.5
	Steel Construction	1	.3	.3	62.8
	Unknown	119	37.2	37.2	100.0
	Total	320	100.0	100.0	

VI. TWO-WAY ANOVA

The analysis above has shown significant factors to building airtightness. There are some possibility that one variable does not have main effect to building airtightness but will have interaction effect when one variable is combined with other variable.

*A. YEAR_C*TotalLK X W10*

Tests of Between-Subjects Effects

Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	59.584[a]	67	.889	8.983	.000
Intercept	35.785	1	35.785	361.485	.000
YEAR_C	15.998	2	7.999	80.803	.000
totalscoreLK	24.581	61	.403	4.071	.000
YEAR_C * totalscoreLK	2.635	4	.659	6.655	.000
Error	15.740	159	.099		
Total	153.878	227			
Corrected Total	75.324	226			

a. R Squared = .791 (Adjusted R Squared = .703)

F-test= 6.655

Statistic shows both variables has main effect on specific leakage rate at 10 Pa (p-value=0.000) and there is interaction effect (p-value=0.000). 79.1% of the variation in W10 can be explained by interaction of year and total leakage.

*B. YEAR_C*DT X W10*

Tests of Between-Subjects Effects

Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	35.964[a]	11	3.269	19.629	.000
Intercept	15.819	1	15.819	94.974	.000
YEAR_C	25.851	3	8.617	51.735	.000
DT	.781	6	.130	.781	.585
YEAR_C * DT	.088	2	.044	.264	.768
Error	50.801	305	.167		
Total	180.777	317			
Corrected Total	86.764	316			

a. R Squared = .414 (Adjusted R Squared = .393)

F-test= 0.264

Statistic shows that year has main effect on specific leakage rate at 10 Pa (0.000) and dwelling type has no main effect on specific leakage rate at 10 Pa (0.585), they do not have significant interaction effect (0.768).

*C. YEAR_C*ROOF X W10*

Tests of Between-Subjects Effects

Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	35.571[a]	8	4.446	26.751	.000
Intercept	26.321	1	26.321	158.356	.000
YEAR_C	25.186	3	8.395	50.510	.000
ROOF	.633	4	.158	.952	.434
YEAR_C * ROOF	.103	1	.103	.617	.433
Error	51.193	308	.166		
Total	180.777	317			
Corrected Total	86.764	316			

a. R Squared = .410 (Adjusted R Squared = .395)

F-test= 0.617

Statistic shows that year has main effect on specific leakage rate at 10 Pa (0.000) and dwelling type has no main effect on specific leakage rate at 10 Pa (0.434), they do not have significant interaction effect (0.433).

*D. YEAR_C*BM X W10*

Tests of Between-Subjects Effects

Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	36.568[a]	6	6.095	37.639	.000
Intercept	33.250	1	33.250	205.341	.000
YEAR_C	30.522	3	10.174	62.831	.000
BM	2.066	3	.689	4.254	.006
YEAR_C * BM	.000	0	.	.	.
Error	50.196	310	.162		
Total	180.777	317			
Corrected Total	86.764	316			

a. R Squared = .421 (Adjusted R Squared = .410)

F-test= --

Statistic shows both variables has main effect on specific leakage rate at 10 Pa (p-value=0.000 and 0.006), and there is no indication of interaction effect occurs between those variables.

*E. YEAR_C*BT X W10*

Tests of Between-Subjects Effects

Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	35.889[a]	7	5.127	31.139	.000
Intercept	21.304	1	21.304	129.393	.000
YEAR_C	31.442	3	10.481	63.657	.000
BT	1.387	4	.347	2.106	.080
YEAR_C * BT	.000	0	.	.	.
Error	50.876	309	.165		
Total	180.777	317			
Corrected Total	86.764	316			

a. R Squared = .414 (Adjusted R Squared = .400)

F-test= --

Statistic shows that year has main effect on specific leakage rate at 10 Pa (0.000) and building typology has no main effect on specific leakage rate at 10 Pa (0.080), and there is no indication of interaction effect occurs between those variables.

*F. TotalLK*DT X W10*

Tests of Between-Subjects Effects

Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	55.418[a]	145	.382	1.269	.116
Intercept	35.828	1	35.828	119.002	.000
totalscoreLK	34.304	61	.562	1.868	.004
DT	.538	6	.090	.298	.936
totalscoreLK * DT	10.861	78	.139	.462	1.000
Error	25.290	84	.301		
Total	162.110	230			
Corrected Total	80.708	229			

a. R Squared = .687 (Adjusted R Squared = .146)

F-test= 0.462

Statistic shows that year has main effect on specific leakage rate at 10 Pa (0.004) and dwelling type has no main effect on specific leakage rate at 10 Pa (0.936), they do not have significant interaction effect (1.000).

*G. TotalLK*ROOF X W10*

Tests of Between-Subjects Effects

Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	60.743[a]	109	.557	3.349	.000
Intercept	26.998	1	26.998	162.270	.000
totalscoreLK	44.429	61	.728	4.378	.000
ROOF	2.198	4	.549	3.303	.013
totalscoreLK * ROOF	15.577	44	.354	2.128	.001
Error	19.965	120	.166		
Total	162.110	230			
Corrected Total	80.708	229			

a. R Squared = .753 (Adjusted R Squared = .528)

F-test= 2.128

Statistic shows both variables has main effect on specific leakage rate at 10 Pa (p-value=0.000 and 0.013) and there is interaction effect (p-value=0.001). 75.3% of the variation in W10 can be explained by interaction of roof and total leakage.

*H. TotalLK*BM X W10*

Tests of Between-Subjects Effects

Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	62.250[a]	95	.655	4.757	.000
Intercept	13.862	1	13.862	100.632	.000
totalscoreLK	38.134	61	.625	4.538	.000
BM	6.359	3	2.120	15.389	.000
totalscoreLK * BM	13.387	31	.432	3.135	.000
Error	18.458	134	.138		
Total	162.110	230			
Corrected Total	80.708	229			

a. R Squared = .771 (Adjusted R Squared = .609)

F-test= 3.135

Statistic shows both variables has main effect on specific leakage rate at 10 Pa (p-value=0.000) and there is interaction effect (p-value=0.000). 77.1% of the variation in W10 can be explained by interaction of building method and total leakage.

*I. TotalLK *BT X W10*

Tests of Between-Subjects Effects

Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	62.142[a]	95	.654	4.721	.000
Intercept	19.487	1	19.487	140.649	.000
totalscoreLK	35.719	61	.586	4.226	.000
BT	4.271	3	1.424	10.276	.000
totalscoreLK * BT	15.787	31	.509	3.676	.000
Error	18.566	134	.139		
Total	162.110	230			
Corrected Total	80.708	229			

a. R Squared = .770 (Adjusted R Squared = .607)

F-test= 3.676

Statistic shows both variables has main effect on specific leakage rate at 10 Pa (p-value=0.000) and there is interaction effect (p-value=0.000). 77.0% of the variation in W10 can be explained by interaction of building typology and total leakage.

*J. DT*ROOF X W10*

Tests of Between-Subjects Effects

Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8.409[a]	20	.420	1.499	.080
Intercept	10.605	1	10.605	37.803	.000
DT	.497	6	.083	.295	.939
ROOF	.635	4	.159	.566	.688
DT * ROOF	3.543	10	.354	1.263	.251
Error	83.880	299	.281		
Total	189.009	320			
Corrected Total	92.289	319			

a. R Squared = .091 (Adjusted R Squared = .030)

Statistic shows that both variables have no main effect on specific leakage rate at 10 Pa and also no interaction effect.

*K. DT*BM X W10*

Tests of Between-Subjects Effects

Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	10.652[a]	20	.533	1.951	.009
Intercept	9.724	1	9.724	35.613	.000
DT	1.979	6	.330	1.208	.302
BM	2.112	3	.704	2.578	.054
DT * BM	1.703	11	.155	.567	.855
Error	81.637	299	.273		
Total	189.009	320			
Corrected Total	92.289	319			

a. R Squared = .115 (Adjusted R Squared = .056)

Statistic shows that both variables have no main effect on specific leakage rate at 10 Pa and also no interaction effect.

*L. DT*BT X W10*

Tests of Between-Subjects Effects

Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	7.470[a]	19	.393	1.390	.129
Intercept	7.014	1	7.014	24.809	.000
DT	1.794	6	.299	1.057	.388
BT	2.031	4	.508	1.796	.130
DT * BT	.660	9	.073	.259	.985
Error	84.820	300	.283		
Total	189.009	320			
Corrected Total	92.289	319			

a. R Squared = .081 (Adjusted R Squared = .023)

Statistic shows that both variables have no main effect on specific leakage rate at 10 Pa and also no interaction effect.

*M. ROOF*BM X W10*

Tests of Between-Subjects Effects

Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	10.061[a]	13	.774	2.880	.001
Intercept	8.210	1	8.210	30.553	.000
ROOF	1.540	4	.385	1.433	.223
BM	1.184	3	.395	1.469	.223
ROOF * BM	1.026	6	.171	.637	.701
Error	82.228	306	.269		
Total	189.009	320			
Corrected Total	92.289	319			

a. R Squared = .109 (Adjusted R Squared = .071)

Statistic shows that both variables have no main effect on specific leakage rate at 10 Pa and also no interaction effect.

*N. ROOF*BT X W10*

Tests of Between-Subjects Effects

Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	9.005[a]	14	.643	2.356	.004
Intercept	5.524	1	5.524	20.229	.000
ROOF	1.651	4	.413	1.511	.199
BT	.744	4	.186	.681	.606
ROOF * BT	1.204	6	.201	.735	.622
Error	83.285	305	.273		
Total	189.009	320			
Corrected Total	92.289	319			

a. R Squared = .098 (Adjusted R Squared = .056)

Statistic shows that both variables have no main effect on specific leakage rate at 10 Pa and also no interaction effect.

*O. BM*BT X W10*

Tests of Between-Subjects Effects

Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	7.879[a]	9	.875	3.215	.001
Intercept	5.340	1	5.340	19.612	.000
BT	.337	4	.084	.310	.871
BM	.044	3	.015	.053	.984
BT * BM	.570	2	.285	1.048	.352
Error	84.410	310	.272		
Total	189.009	320			
Corrected Total	92.289	319			

a. R Squared = .085 (Adjusted R Squared = .059)

Statistic shows that both variables have no main effect on specific leakage rate at 10 Pa and also no interaction effect.

VII. SUMMARY OF EXPLORATORY ANALYSIS

Below are the summary of exploratory analysis on relation, correlation and interaction between variables and to specific air leakage at 10 Pa.

Variables	Analysis Method	p-value*	F-test	Pearson's r	R squared
TotalLK	Linear regression	.000		.437	.191
Design target	Linear regression	.272		.064	.004
Floor area	Linear regression	.083		-.097	.009
Year	One-way ANOVA	.000	68.876		
Dwelling Type	One-way ANOVA	.095	1.817		
Roof Type	One-way ANOVA	.005	1.817		
Building Method	One-way ANOVA	.000	8.505		
Building Typology	One-way ANOVA	.001	4.598		
Year_C x TotalLK	Two-way ANOVA	.000	6.655		.791
Year_C x DT	Two-way ANOVA	.768	0.264		.414
Year_C x ROOF	Two-way ANOVA	.433	0.617		.410
Year_C x BM	Two-way ANOVA	-	-		.421
Year_C x BT	Two-way ANOVA	-	-		.414
TotalLK x DT	Two-way ANOVA	1.000	0.462		.687
TotalLK x ROOF	Two-way ANOVA	.001	2.128		.753
TotalLK x BM	Two-way ANOVA	.000	3.135		.771
TotalLK x BT	Two-way ANOVA	.000	3.676		.770
DT x ROOF	Two-way ANOVA	.251	1.263		.091
DT x BM	Two-way ANOVA	.855	0.567		.115
DT x BT	Two-way ANOVA	.985	0.259		.081
ROOF x BM	Two-way ANOVA	.701	0.637		.109
ROOF x BT	Two-way ANOVA	.622	0.735		.098
BM x BT	Two-way ANOVA	.352	1.048		.085

*significant at 0.05

VIII. MULTI LINEAR REGRESSION

From the analysis above, we assume that variable YEAR_C, TotalLK, ROOF, BM and BT are significant to predict building airtightness in terms of specific leakage rate at 10 Pa. Then we run multi linear regression analysis (with confidence level 95% = 1.960).

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	2.412	.284		8.485	.000	1.852	2.973
	Year Range	-.555	.058	-.490	-9.530	.000	-.670	-.440
	totalscoreLK	.013	.002	.347	6.233	.000	.009	.016
	Building Typology	.051	.045	.110	1.148	.252	-.037	.139
	Building Method	-.102	.052	-.186	-1.963	.051	-.204	.000
	Roof Type	.025	.035	.037	.708	.480	-.044	.093

a. Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	32.947	5	6.589	34.365	.000[b]
	Residual	42.377	221	.192		
	Total	75.324	226			

a. Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

b. Predictors: (Constant), totalscoreLK, Roof Type, Year Range, Building Method, Building Typology

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.661[a]	.437	.425	.43789

a. Predictors: (Constant), totalscoreLK, Roof Type, Year Range, Building Method, Building Typology

As seen from the table, there are some variables which are not significant. Therefore we run again the linear regression analysis, because it will cause in different adjusted R-square value.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	2.362	.242		9.764	.000	1.885	2.838
	Year Range	-.553	.058	-.488	-9.534	.000	-.668	-.439
	totalscoreLK	.013	.002	.366	7.150	.000	.010	.017

a. Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	32.069	2	16.034	83.036	.000[b]
	Residual	43.255	224	.193		
	Total	75.324	226			

a. Dependent Variable: Measured specific leakage rate at 10 Pa (dm3/s.m2)

b. Predictors: (Constant), totalscoreLK, Year Range

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.652[a]	.426	.421	.43943

a. Predictors: (Constant), totalscoreLK, Year Range

Therefore the initial model will be:

$$W10 = \alpha + \beta_{totalLK} \,.\, TotalLK + \beta_{YEAR} \,.\, YEAR\_C$$

IX. ORIGINAL DATA ON SPREAD SHEET

Rapport nummer	Datum meting	Bouwjaar woning	Moment opname	Locatie woning	Provincie woning	Type woning	Bouwwijze	Bouwmethode	Dakconstructie	Energie Prestatie Coëfficiënt	Vloeroppervlak (m^2)	Meetmethode vloeroppervlak	Gebouw-volume (m^3)	Toegestane luchtdoorlatendheid (dm^3/s)	Gemeten luchtdoorlatendheid (dm^3/s)	Max. toelaatbare infiltratie (dm^3/s per m^2)	Gemeten $q_{v;10}$ (dm^3/s per m^2)	Aanwezigheid foto's luchtlekkage	Aanwezigheid infrarood foto's	Eventuele opmerkingen
1	18/06/13	2013	Rond oplevering	Zeewolde	Flevoland	Rijtjeswoning	Onbekend				109		300	200	29	0.400	0.27	Ja	Nee	relatie object 2, 3 en 4
2	18/06/13	2013	Rond oplevering	Zeewolde	Flevoland	Hoekwoning					109		300	200	33	0.400	0.30	Ja	Nee	relatie object 1, 3 en 4
3	18/06/13	2013	Rond oplevering	Zeewolde	Flevoland	Rijtjeswoning					109		300	200	40	0.400	0.37	Ja	Nee	relatie object 1, 2 en 4
4	18/06/13	2013	Rond oplevering	Zeewolde	Flevoland	Hoekwoning					109		301	200	46	0.400	0.42	Ja	Nee	relatie object 1, 2 en 3, Q gemeten meer dan max. toelaatbare infiltratie
5	21/03/13	2013	Rond oplevering	Hardenberg	Overijssel	Rijtjeswoning					110		325	200	24	0.625	0.22	Ja	Nee	
6	20/03/14	2014	Rond oplevering	Neerijnen	Gelderland	Rijtjeswoning					102			200	54	0.400	0.53	Ja	Nee	relatie object 7, afvoer wasemkap lijkt geen probleem te zijn?, Q gemeten meer dan max. toelaatbare infiltratie
7	20/03/14	2014	Rond oplevering	Neerijnen	Gelderland	Hoekwoning					102			200	43	0.400	0.42	Ja	Nee	relatie object 6, afvoer wasemkap lijkt geen probleem te zijn?, Q gemeten meer dan max. toelaatbare infiltratie
8a	03/04/14	2014	Rond oplevering	Hof van Twente	Overijssel	Onbekend					136			200	35	0.400	0.26	Ja	Nee	relatie object 8a-8f
8b	03/04/14	2014	Rond oplevering	Hof van Twente	Overijssel	Onbekend					116			200	32	0.400	0.28	Ja	Nee	relatie object 8a-8f
8c	03/04/14	2014	Rond oplevering	Hof van Twente	Overijssel	Onbekend					116			200	34	0.400	0.29	Ja	Nee	relatie object 8a-8f
8d	01/05/14	2014	Rond oplevering	Hof van Twente	Overijssel	Onbekend					107			200	19	0.400	0.18	Ja	Nee	relatie object 8a-8f, opvallend laag tov andere 5
8e	01/05/14	2014	Rond oplevering	Hof van Twente	Overijssel	Onbekend					138			200	48	0.400	0.35	Ja	Nee	relatie object 8a-8f
8f	01/05/14	2014	Rond oplevering	Hof van Twente	Overijssel	Onbekend					138			200	39	0.400	0.28	Ja	Nee	relatie object 8a-8f
9a	26/06/14	2014	Rond oplevering	Nijkerk	Gelderland	Onbekend			Kap		129.6			200	65.5	0.400	0.51	ja	nee	Relatie object 9b-9c, Q gemeten meer dan max. toelaatbare infiltratie
9b	26/06/14	2014	Rond oplevering	Nijkerk	Gelderland	Onbekend			Kap		129.6			200	50	0.400	0.39	ja	Nee	Relatie object 9a-9c
9c	26/06/14	2014	Rond oplevering	Nijkerk	Gelderland	Onbekend			Kap		138.8			200	65	0.400	0.47	Ja	Nee	Relatie object 9a-9b, Q gemeten meer dan max. toelaatbare infiltratie
10a	01/10/14	2014	Rond oplevering	Noordwijkerhout	Noord-Holland	Onbekend			Platdak		91.8			200	28.5	0.625	0.31	Ja	Nee	Relatie object 10b-10c
10b	01/10/14	2014	Rond oplevering	Noordwijkerhout	Noord-Holland	Onbekend			Platdak		80			200	22.5	0.625	0.28	Ja	Nee	Relatie object 10a-10c

10c	01/10/14	2014	Rond opleveri ng	Noordwijkerhout	Noord-Holland	Onbekend			Platdak		80			200	22	0.625	0.28	Ja	Nee	Relatie object 10a-10b, bijna helemaal gelijk aan 10b
11a	20/08/14	2014	Rond opleveri ng	Leiden	Zuid-Holland	Onbekend			Platdak		159.4			200	67.5	0.590	0.42	Ja	Nee	Relatie object 11b-d
11b	20/08/14	2014	Rond opleveri ng	Leiden	Zuid-Holland	Onbekend			Platdak		146.2			200	44	0.490	0.30	Ja	Nee	Relatie object 11a, 11c-d
11c	20/08/14	2014	Rond opleveri ng	Leiden	Zuid-Holland	Onbekend			Platdak		146.2			200	39.5	0.490	0.27	Ja	Nee	Relatie object 11a-b, 11d
11d	20/08/14	2014	Rond opleveri ng	Leiden	Zuid-Holland	Onbekend			Platdak		146.2			200	92.5	0.490	0.63	Ja	Nee	Relatie object 11a-c, gemeten luchdoorlatendheid en qv,10 gemeten veel hoger dan bij 11b-c
12a	12/08/14	2014	Rond opleveri ng	Amsterdam	Noord-Holland	Onbekend					99			200	23	0.360	0.23	Ja	Nee	Relatie object 12b
12b	12/08/14	2014	Rond opleveri ng	Amsterdam	Noord-Holland	Onbekend					95			200	19	0.360	0.20	Ja	Nee	Relatie object 12a
13a	29/04/14	2014	Rond opleveri ng	Nijkerk	Gelderland	Onbekend					127.4			200	36	0.400	0.28	Ja	Nee	Relatie object 13b
13b	29/04/14	2014	Rond opleveri ng	Nijkerk	Gelderland	Onbekend					85.6			200	8	0.400	0.09	Ja	Nee	Relatie object 13a, opvallend lage gemeten luchtdoorlatendheid en qv,10 gemeten.
14	06/08/14		Rond opleveri ng	Barneveld	Gelderland	Twee onder één kap					176.8			200	74.5	0.630	0.42	Ja	Nee	
15a	23/04/14	2014	Rond opleveri ng	Geldermalsen	Gelderland	Rijtjeswoning					111.7			200	27	0.400	0.24	Ja	Nee	Relatie object 15b
15b	23/04/14	2014	Rond opleveri ng	Geldermalsen	Gelderland	Rijtjeswoning					111.7			200	23	0.400	0.21	Ja	Nee	Relatie object 15a
16a	09/07/14	2014	Rond opleveri ng	Molenwaard	Overijssel	Rijtjeswoning					150			200	41	0.625	0.27	Ja	Nee	Relatie object 16b
16b	09/07/14	2014	Rond opleveri ng	Molenwaard	Overijssel	Hoekwoning					140			200	41.5	0.625	0.30	Ja	Nee	Relatie object 16a
17a	10/06/14	2014	Rond opleveri ng	Wageningen	Gelderland	Appartement			Platdak		68.4			200	69.5	0.690	1.02	Ja	Nee	Relatie object 17b en 17-2a-b, qv,10 gemeten hoog
17b	10/06/14	2014	Rond opleveri ng	Wageningen	Gelderland	Appartement			Platdak		68.4			200	53.5	0.690	0.78	Ja	Nee	Relatie object 17a en 17-2-ab, Q gemeten meer dan max. toelaatbare infiltratie
17-2a	21/08/14	2014	Rond opleveri ng	Wageningen	Gelderland	Appartement			Platdak		39.5			200	25	0.690	0.63	Ja	Nee	Relatie object 17-2b, en 17a-b, vloeroppervlak erg klein
17-2b	21/08/14	2014	Rond opleveri ng	Wageningen	Gelderland	Appartement			Platdak		68.4			200	34.5	0.690	0.50	Ja	Nee	Relatie object 17-2a, en 17a-b
18a	24/06/14	2014	Rond opleveri ng	Montferland	Gelderland	Onbekend					124.7			200	30	0.400	0.24	Ja	Nee	Relatie object 18b-d
18b	24/06/14	2014	Rond opleveri ng	Montferland	Gelderland	Onbekend					106			200	25	0.400	0.24	Ja	Nee	Relatie object 18a,c-d
18c	24/06/14	2014	Rond opleveri ng	Montferland	Gelderland	Onbekend					106			200	19	0.400	0.18	Ja	Nee	Relatie object 18a-b,d
18d	24/06/14	2014	Rond opleveri	Montferland	Gelderland	Onbekend					112.6			200	20	0.400	0.18	Ja	Nee	Relatie object 18a-c

			ng																
19	01/05/14	2014	Tijdens bouw	Montferland	Gelderland	Rijtjeswoning					106			200	178	0.400	1.68	Ja	Nee	Relatie object 18, hoge waardes luchtdoorlatendheid en qv,10 gemeten
20b	07/04/14	2014		Midden-Delfland	Zuid-Holland	Onbekend					126.3			200	36	0.550	0.29	Ja	Nee	Relatie object 20a, foto van woning ontbreekt
20a	07/04/14	2014		Midden-Delfland	Zuid-Holland	Onbekend					118.5			200	39	0.630	0.33	Ja	Nee	Relatie object 20b, foto van woning ontbreekt
21a	11/07/14	2014	Tijdens bouw	Arnhem	Gelderland	Onbekend					97.3			200	64.5	0.400	0.66	Ja	Nee	Relatie object 21a, waardes veel minder hoog dan woning 19, terwijl beide tijdens bouw zijn
21b	11/07/14	2014	Tijdens bouw	Arnhem	Gelderland	Onbekend					131.1			200	73	0.400	0.56	Ja	Nee	Relatie object 21b, waardes veel minder hoog dan woning 19, terwijl beide tijdens bouw zijn
22a	10/09/14	2014	Rond oplevering	Loppersum	Groningen	Appartement					109.2			200	97	0.46	0.89	Ja	Nee	Relatie object 22a-e
22b	10/09/14	2014	Rond oplevering	Loppersum	Groningen	Appartement					74.8			200	18.5	0.420	0.25	Ja	Nee	Relatie object 22a-e
22c	10/09/14	2014	Rond oplevering	Loppersum	Groningen	Appartement					48.8			200	11	0.420	0.23	Ja	Nee	Relatie object 22a-e, klein vloeroppervlak
22d	10/09/14	2014	Rond oplevering	Loppersum	Groningen	Appartement					48.8			200	13.5	0.390	0.28	Ja	Nee	Relatie object 22a-e, klein vloeroppervlak
22e	10/09/14	2014	Rond oplevering	Loppersum	Groningen	Appartement					74.8			200	30.5	0.390	0.41	Ja	Nee	Relatie object 22a-e
23a	25/09/14	2014	Rond oplevering	Aalsmeer	Noord-Holland	Onbekend			Kap		203			200	87.5	0.625	0.43	Ja	Nee	Relatie object 23b
23b	25/09/14	2014	Rond oplevering	Aalsmeer	Noord-Holland	Onbekend			Kap		210.9			200	79	0.625	0.37	Ja	Nee	relatie object 23a
24a	02/10/14	2014	Rond oplevering	Ede	Gelderland	Onbekend			Kap		127.2			200	25.5		0.20	Ja	Nee	Relatie object 24ab-c
24b	02/10/14	2014	Rond oplevering	Ede	Gelderland	Onbekend			Kap		103			200	29.5		0.29	Ja	Nee	Relatie object 24ab-c
24c	02/10/14	2014	Rond oplevering	Ede	Gelderland	Rijtjeswoning			Kap		164			200	37		0.23	Ja	Nee	Relatie object 24ab-c
25	09/04/14	2014	Rond oplevering	Utrecht	Utrecht	Onbekend	Onbekend	Onbekend	Onbekend		130.5	Waarde uit EPC		200	34	0.400	0.26	Ja	Nee	
26a	21/05/14	2014	Rond oplevering	Dongen	Noord-Brabant	Hoekwoning	Bouwplaats	Metselwerk	Kap		101.1	Waarde uit EPC		200	28.5	0.625	0.28	Ja	Nee	
26b	21/05/14	2014	Rond oplevering	Dongen	Noord-Brabant	Onbekend	Bouwplaats	Metselwerk	Kap		144.7	Waarde uit EPC		200	25.5	0.625	0.18	Ja	Nee	
27a	02/10/14	2014	Rond oplevering	Sliedrecht	Zuid-Holland	Appartement	Bouwplaats	Metselwerk	Onbekend		82	Waarde uit EPC		200	9		0.11	Ja	Nee	let wel toegestane luchtdoorlatendheid geldt voor heel gebouw, dus niet alleen dit appartement
27b	02/10/14	2014	Rond oplevering	Sliedrecht	Zuid-Holland	Appartement	Bouwplaats	Metselwerk	Onbekend		103	Waarde uit EPC		200	8		0.08	Ja	Nee	let wel toegestane luchtdoorlatendheid geldt voor heel gebouw, dus niet alleen dit

																			appartement
27c	02/10/14	2014	Rond oplevering	Sliedrecht	Zuid-Holland	Appartement	Bouwplaats	Metselwerk	Onbekend		135	Waarde uit EPC		200	18		0.13	Ja	Nee	let wel toegestane luchtdoorlatendheid geldt voor heel gebouw, dus niet alleen dit appartement
28	13/06/14	2014	Rond oplevering	Halderberge	Noord-Brabant	Twee onder één kap	Bouwplaats	Metselwerk	Kap		126	Waarde uit EPC		200	31.5	0.625	0.25	Ja	Nee	
29	02/04/14	2014	Rond oplevering	Sint-Michielsgestel	Noord-Brabant	Hoekwoning	Bouwplaats	Metselwerk	Kap		115.4	Waarde uit EPC		200	36	0.625	0.31	Ja	Nee	relatie object 30 en 31
30	02/04/14	2014	Rond oplevering	Sint-Michielsgestel	Noord-Brabant	Hoekwoning	Bouwplaats	Metselwerk	Kap		129.1	Waarde uit EPC		200	100	0.625	0.77	Ja	Nee	relatie object 29 en 31
31	02/04/14	2014	Rond oplevering	Sint-Michielsgestel	Noord-Brabant	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		112.4	Waarde uit EPC		200	25	0.625	0.22	Ja	Nee	relatie object 29 en 30
32	07/05/14	2014	Rond oplevering	Oegstgeest	Noord-Holland	Rijtjeswoning	Bouwplaats	Metselwerk	kap		131.7	Waarde uit EPC		200	38	0.400	0.29	Ja	Nee	
33a	04/06/14	2014	Rond oplevering	Gouda	Zuid-Holland	Hoekwoning			Kap		81.4	Waarde uit EPC		200	89.5	0.630	1.10	Ja	Nee	Relatie object 33b, q 10 gemeten hoger dan Q10 in EPC berekening
33b	04/06/14	2014	Rond oplevering	Gouda	Zuid-Holland	Rijtjeswoning			Kap		92.4	Waarde uit EPC		200	29.5	0.630	0.32	Ja	Nee	Relatie object 33a
34a	21/05/14	2014	Rond oplevering	Hulst	Zeeland	Twee onder één kap			Kap		101.3	Waarde uit EPC		200	81.5	0.630	0.80	Ja	Nee	Relatie object 34b, q 10 gemeten hoger dan Q10 in EPC berekening
34b	21/05/14	2014	Rond oplevering	Hulst	Zeeland	Twee onder één kap			Kap		101.3	Waarde uit EPC		200	68	0.630	0.67	Ja	Nee	Relatie object 34a
35	24/04/14	2014	Moment onbekend	Zeevang	Noord-Holland	Onbekend	Onbekend	Onbekend	Onbekend		195.9	Waarde uit EPC		250	237	0.630	1.21	Ja	Nee	Q10 gemeten hoger dan Q10 in EPC berekening
36a	02/05/14	2014	Rond oplevering	Putten	Gelderland	Hoekwoning	Bouwplaats	Metselwerk	Kap		148.5	Waarde uit EPC		200	69	0.400	0.46	Ja	Nee	Relatie object 36b
36b	02/05/14	2014	Rond oplevering	Putten	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		133	Waarde uit EPC		200	53	0.400	0.40	Ja	Nee	Relatie object 36a
37b	23/04/14	2014	Tijdens bouw	Oosterhout	Noord-Brabant	Onbekend	Bouwplaats	Metselwerk	Onbekend		130.5	Waarde uit EPC		200	37	0.625	0.28	Ja	Nee	Woning met maatregelen (Q waarde voldoet aan gestelde ambitie uit e EPC berekening, Relatie object 37 b
38a	02/05/14	2014	Rond oplevering	Molenwaard	Overijssel	Onbekend	Bouwplaats	Metselwerk	Kap		124.6	Waarde uit EPC		200	58	0.625	0.47	Ja	Nee	Relatie object 38b-c
38b	02/05/14	2014	Rond oplevering	Molenwaard	Overijssel	Onbekend	Bouwplaats	Metselwerk	Kap		136.8	Waarde uit EPC		200	53	0.625	0.39	Ja	Nee	Relatie object 38a-c
38c	02/05/14	2014	Rond oplevering	Molenwaard	Overijssel	Onbekend	Bouwplaats	Metselwerk	Kap		136.8	Waarde uit EPC		200	68	0.625	0.50	Ja	Nee	Relatie object 38bc
39a	12/05/14	2014	Rond oplevering	Leeuwarden	Friesland	Onbekend			Kap		103	Waarde uit EPC		200	50	0.630	0.49	Ja	Nee	Relatie object 39abcd
39b	12/05/14	2014	Rond oplevering	Leeuwarden	Friesland	Onbekend			Kap		103	Waarde uit EPC		200	63	0.630	0.61	Ja	Nee	Relatie object 39abcd
39c	12/05/14	2014	Rond oplevering	Leeuwarden	Friesland	Onbekend			Kap		103	Waarde uit EPC		200	45	0.630	0.44	Ja	Nee	Relatie object 39abcd
39d	12/05/	2014	Rond	Leeuwarden	Friesland	Onbekend			Kap		103	Waarde uit		200	53	0.630	0.51	Ja	Nee	Relatie object

	14		opleveri ng		d							EPC							39abcd
40	25/04/ 14	2014	Rond opleveri ng	Diemen	Noord-Holland	Onbekend			Onbekend		153	Waarde uit EPC		200	67	0.625	0.44	Ja	Nee	
41a	26/06/ 14	2014	Rond opleveri ng	Nijkerk	Gelderla nd	Onbekend	Bouwplaats	Metselwer k	Kap		130	Waarde uit EPC		200	88	0.625	0.68	Ja	Nee	Relatie object 41b
41b	26/06/ 14	2014	Rond opleveri ng	Nijkerk	Gelderla nd	Onbekend	Bouwplaats	Metselwer k	Kap		119	Waarde uit EPC		200	62.5	0.625	0.53	Ja	Nee	Relatie object 41a
42	01/10/ 14		Momen t onbeke nd	Den Haag	Zuid-Holland	Onbekend			Platdak		126.9	Waarde uit EPC		200	22	0.625	0.17	Ja	Nee	
43	15/05/ 14	2014	Rond opleveri ng	Nuth	Limburg	Onbekend	Bouwplaats	Metselwer k	Onbekend		79.3	Waarde uit EPC		200	16	0.400	0.20	Ja	Nee	Relatie object 44
44	15/05/ 14	2014	Momen t onbeke nd	Nuth	Limburg	Onbekend	Onbekend	Onbekend	Onbekend		83.7	Waarde uit EPC		200	38	0.400	0.45	Ja	Nee	Relatie object 43
45a	27/06/ 14	2014	Tijdens bewoni ng	Zuidplas	Zuid-Holland	Vrijstaand e woning	Bouwplaats		Kap		233.6	Waarde uit EPC		200	134	0.790	0.57	Ja	Nee	Luiken knieschotten en zolder niet afgeplakt (standaardmeting)
46a	14/05/ 14	2014	Rond opleveri ng	Olst-Wijhe	Overijss el	Onbekend			Kap		117.2	Waarde uit EPC		200	90.5	0.400	0.77	Ja	Nee	Relatie object 46b, 47ab, 48
46b	14/05/ 14	2014	Rond opleveri ng	Olst-Wijhe	Overijss el	Onbekend			Platdak		91	Waarde uit EPC		200	52.5	0.400	0.58	Ja	Nee	Relatie object 46a, 47ab, 48
47a	14/05/ 14	2014	Momen t onbeke nd	Olst-Wijhe	Overijss el	Onbekend					97	Waarde uit EPC		200	14.5	0.420	0.15	Ja	Nee	Relatie object 47b en 46ab, 48
47b	14/05/ 14	2014	Momen t onbeke nd	Olst-Wijhe	Overijss el	Onbekend					94	Waarde uit EPC		200	18.5	0.420	0.20	Ja	Nee	Relatie object 47a en 46ab, 48
48a	16/05/ 14	2014	Momen t onbeke nd	Olst-Wijhe	Overijss el	Onbekend					80	Waarde uit EPC		200	34.5	0.400	0.43	Ja	Nee	Relatie object 47 en 48abcde
48b	16/05/ 14	2014	Momen t onbeke nd	Olst-Wijhe	Overijss el	Onbekend					82	Waarde uit EPC		200	29.5	40.000	0.36	Ja	Nee	Relatie object 47 en 48abcde, waarde Q10 gemeten veel hoger dan QEPC berekening
48c	16/05/ 14	2014	Momen t onbeke nd	Olst-Wijhe	Overijss el	Onbekend					80	Waarde uit EPC		200	94.5	0.400	1.18	Ja	Nee	Relatie object 47 en 48abcde
48d	16/05/ 14	2014	Momen t onbeke nd	Olst-Wijhe	Overijss el	Onbekend					81	Waarde uit EPC		200	24	0.400	0.30	Ja	Nee	Relatie object 47 en 48abcde
48e	16/05/ 14	2014	Momen t onbeke nd	Olst-Wijhe	Overijss el	Onbekend					113	Waarde uit EPC		200	74.5	0.400	0.66	Ja	Nee	Relatie object 47 en 48abcde
49	18/06/ 14	2014	Tijdens bewoni ng	Tholen	Zeeland	Hoekwoni ng	Bouwplaats	Metselwer k			77.6	Methode onbekend		200	152	n/a	1.96	Ja	Nee	Deze meting betreft een nulmeting, vooruitlopende op een schilrenovatie. De huidige luchtdichtheid is slecht te noemen
50a	03/07/ 14	2014	Rond opleveri ng	Almere	Flevolan d	Onbekend	Bouwplaats	Metselwer k	Platdak		85.7	Waarde uit EPC		200	32.5	0.400	0.38	Ja	Nee	Relatie object 50abcd

50b	03/07/14	2014	Rond oplevering	Almere	Flevoland	Onbekend	Bouwplaats	Metselwerk	Platdak		85.7	Waarde uit EPC		200	46	0.400	0.54	Ja	Nee	Relatie object 50abcd
50c	03/07/14	2014	Rond oplevering	Almere	Flevoland	Onbekend	Bouwplaats	Metselwerk	Platdak		69	Waarde uit EPC		200	29	0.400	0.42	Ja	Nee	Relatie object 50abcd
50d	03/07/14	2014	Rond oplevering	Almere	Flevoland	Onbekend	Bouwplaats	Metselwerk	Platdak		69	Waarde uit EPC		200	35.5	0.400	0.51	Ja	Nee	Relatie object 50abcd
51	24/03/14	2014	Moment onbekend	Hendrik-Ido-Ambacht	Noord-Brabant	Onbekend	Onbekend	Onbekend	Onbekend		189	Waarde uit EPC		200	104	1.000	0.55	ja	nee	
52a	02/04/14	2014	Tijdens bouw	Putten	Gelderland	Onbekend	Bouwplaats	Metselwerk	Kap		127	Waarde uit EPC		200	15	0.400	0.12	Ja	Nee	Relatie object 51b
52b	02/04/14	2014	Tijdens bouw	Putten	Gelderland	Onbekend	Bouwplaats	Metselwerk	Kap		127	Waarde uit EPC		200	22	0.400	0.17	Ja	Nee	Relatie object 51a
53	19/09/13	2013	Moment onbekend	Maasdonk	Noord-Brabant	Onbekend	Onbekend	Onbekend	Onbekend		112.4	Waarde uit EPC	n/a	200	54	0.630	0.48	Ja	Nee	Relatie object 55, 88
54	25/03/14	2014	Rond oplevering	Barneveld	Gelderland	Onbekend	Bouwplaats	Metselwerk	Onbekend		119	Waarde uit EPC		200	76	0.400	0.64	Ja	Nee	
55	19/09/13	2013	Rond oplevering	Maasdonk	Noord-Brabant	Onbekend	Bouwplaats	Metselwerk	Kap		121.4	Waarde uit EPC		200	53.5	0.630	0.44	Ja	Nee	Relatie object 53, 88
56	21/03/14	2014	Rond oplevering	Den Haag	Zuid-Holland	Onbekend			Kap		198	Waarde uit EPC		200	43	0.360	0.22	Ja	Nee	
57	23/09/14	2014	Rond oplevering	Asten	Noord-Brabant	Rijtjeswoning	Bouwplaats	Metselwerk	Onbekend		101		279	200	68	0.630	0.68	Ja	Nee	Europese meetmethode EN13829: n50-waarde 2,71 per uur
58	13/03/14	2014	Rond oplevering	Alphen aan den Rijn	Zuid-Holland	Onbekend	Bouwplaats	Metselwerk	Onbekend		80	Waarde uit EPC		200	20	0.630	0.25	Ja	Nee	
59	24/09/14	2014	Tijdens bouw	Dronten	Flevoland	Rijtjeswoning	Bouwplaats	Metselwerk	Onbekend		116	Methode onbekend		200	27	0.400	0.23	Ja	Nee	
60	07/03/14	2014	Rond oplevering	Tholen	Zeeland	Rijtjeswoning	Bouwplaats	Metselwerk	Onbekend		93	Waarde uit EPC		200	54	0.630	0.58	Ja	Nee	Relatie object 62
61	27/09/13	2013	Rond oplevering	Zwolle	Overijssel	Rijtjeswoning	Bouwplaats	Metselwerk	Gecombineerd		125.9	Waarde uit EPC		200	68	0.625	0.54	Ja	Nee	Relatie object 63, 65, 67
62	07/03/14	2014	Rond oplevering	Tholen	Zeeland	Rijtjeswoning	Bouwplaats	Metselwerk	Onbekend		93	Waarde uit EPC		200	25	0.630	0.27	Ja	Nee	Relatie object 60
63	27/09/13	2013	Rond oplevering	Zwolle	Overijssel	Rijtjeswoning	Bouwplaats	Metselwerk	Onbekend		120.9	Waarde uit EPC		200	57	0.625	0.47	Ja	Nee	Relatie object 61, 65, 67
64	10/03/14	2014	Rond oplevering	Neerijnen	Gelderland	Hoekwoning	Bouwplaats	Metselwerk	Onbekend		102	Waarde uit EPC		200	105	0.400	1.03	Ja	Nee	
65	27/09/14	2013	Rond oplevering	Zwolle	Overijssel	Rijtjeswoning	Bouwplaats	Metselwerk	Onbekend		120.9	Waarde uit EPC		200	47	0.625	0.39	Ja	Nee	Relatie object 61, 63, 67
66	10/03/14	2014	Rond oplevering	Neerijnen	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		102	Waarde uit EPC		200	94	0.400	0.92	Ja	Nee	Qv,10 van de woning voldoet niet aan de gestelde ambitie uit de EPC berekening
67	27/09/13	2013	Rond oplevering	Zwolle	Overijssel	Hoekwoning	Bouwplaats	Metselwerk	Kap		125.9	Waarde uit EPC		200	53	0.625	0.42	Ja	Nee	Relatie object 61, 63, 65
68	03/03/14	2014	Rond oplevering	Hengelo	Overijssel	Onbekend	Bouwplaats	Metselwerk	Kap		126	Waarde uit EPC		200	71	0.400	0.57	ja	Nee	Relatie object 70
69	11/10/13	2013	Rond oplevering	Moerdijk	Noord-Brabant	Vrijstaande woning	Bouwplaats	Metselwerk	Platdak		126	Waarde uit EPC	331	200	17	0.400	0.13	Ja	Nee	n50-waarde 0,60 per uur
70	03/03/	2014	Rond	Hengelo	Overijss	Hoekwoni	Bouwplaats	Metselwer	Kap		121	Waarde uit		200	49	0.400	0.41	Ja	Nee	relatie object 68

	14		opleveri ng		el	ng		k				EPC							
71	24/10/ 13	2013	Rond opleveri ng	Best	Noord-Brabant	Onbekend	Bouwplaats	Metselwer k	Kap		112	Waarde uit EPC		200	124	0.700	1.10	Ja	Nee	Relatie object 73, Gemeten Q,v10 waarde is groter dan de ingevoerde waarde in de EPC-berekening
72	29/01/ 14	2014	Rond opleveri ng	Nijmegen	Gelderla nd	Onbekend	Bouwplaats	Metselwer k	Onbekend		118.8			200	49	0.630	0.41	Ja	Nee	Relatie object 74, 75, 78. Gebruiksoppervlakte opgegeven door oprachtgever
73	24/10/ 13	2013	Rond opleveri ng	Best	Noord-Brabant	Twee onder één kap	Bouwplaats	Metselwer k	Kap		136	Waarde uit EPC		200	157	0.700	1.16	Ja	Nee	Relatie object 71
74	29/01/ 14	2014	Rond opleveri ng	Nijmegen	Gelderla nd	Onbekend	Bouwplaats	Metselwer k	Onbekend		146			200	63	0.630	0.43	Ja	Nee	Relatie object 72, 75, 78, 79. Gebruiksoppervlakte opgegeven door opdrachtgever
75	29/01/ 14	2014	Rond opleveri ng	Nijmegen	Gelderla nd	Onbekend	Bouwplaats	Metselwer k	Onbekend		112.6			200	49.5	0.630	0.44	Ja	Nee	Relatie object 72, 74, 78, 79. Gebruiksoppervlakte opgegeven door opdrachtgever
76	04/12/ 13	2013	Rond opleveri ng	Hardenberg	Overijss el	Onbekend	Bouwplaats	Metselwer k	Onbekend		80	Waarde uit EPC		200	22	0.390	0.28	Ja	Nee	relatie object 77
77	04/12/ 13	2013	Rond opleveri ng	Hardenberg	Overijss el	Onbekend	Bouwplaats	Metselwer k	Onbekend		80	Waarde uit EPC		200	61	0.460	0.77	Ja	Nee	Relatie object 76
78	29/01/ 14	2014	Rond opleveri ng	Nijmegen	Gelderla nd	Onbekend	Bouwplaats	Metselwer k	Onbekend		152.1			200	58	0.630	0.38	ja	nee	relatie object 72, 74, 75, 79. Gebruiksoppervlakte opgegeven door opdrachtgever
79	29/01/ 14	2014	Rond opleveri ng	Nijmegen	Gelderla nd	Onbekend	Bouwplaats	Metselwer k	Onbekend		145.6			200	52	0.630	0.36	Ja	Nee	relatie object 72, 74, 75, 78. Gebruiksoppervlakte opgegeven door opdrachtgever
80	19/11/ 13	2013	Rond opleveri ng	Barendrecht	Zuid-Holland	Vrijstaand e woning	Bouwplaats	Metselwer k	Kap		145	Waarde uit EPC		200	106	1.000	0.73	Ja	Nee	
81	04/02/ 14	2014	Momen t onbeke nd	Moerdijk	Noord-Brabant	Onbekend	Onbekend	Onbekend	Onbekend		95	Waarde uit EPC		200	8	0.400	0.08	ja	nee	Qv,10 gemeten zeer laag
82	19/11/ 13	2013	Rond opleveri ng	Wijk bij Duurstede	Utrecht	Onbekend	Bouwplaats	Metselwer k	Kap		154	Waarde uit EPC		200	28	0.630	0.18	Ja	Nee	
83b	23/01/ 14	2014	Rond opleveri ng	Oost Gelre	Gelderla nd	Twee onder één kap	Bouwplaats	Metselwer k	Onbekend		113	Waarde uit EPC		200	42	0.625	0.37	Ja	Nee	Relatie object 83a, 85. Tweede meting (na het afdichten van enkele gevonden gaten)
84	03/12/ 13	2013	Rond opleveri ng	Nijkerk	Gelderla nd	Hoekwoni ng	Bouwplaats	Metselwer k	Kap		125	Waarde uit EPC		200	45	0.630	0.36	Ja	Nee	Relatie object 89
85	23/01/ 14	2014	Rond opleveri ng	Oost Gelre	Gelderla nd	Twee onder één kap	Bouwplaats	Metselwer k	Onbekend		113	Waarde uit EPC		200	49	0.625	0.43	Ja	Nee	relatie object 83
86	05/12/ 13	2013	Rond opleveri ng	Moerdijk	Noord-Brabant	Twee onder één kap	Bouwplaats	Metselwer k	Kap		111	Waarde uit EPC		200	19	0.630	0.17	Ja	Nee	
87a	14/04/ 14	2014	Rond opleveri ng	Hendrik-Ido-Ambacht	Zuid-Holland	Onbekend	Onbekend	Onbekend	Onbekend		188.9	Waarde uit EPC		200	63	1.000	0.33	ja	nee	Relatie object 87b
87b	14/04/ 14	2014	Rond opleveri ng	Hendrik-Ido-Ambacht	Zuid-Holland	Onbekend	Onbekend	Onbekend	Onbekend		151.8	Waarde uit EPC		200	69	1.000	0.45	Ja	Nee	relatie object 87a

88	19/09/13	2013	Rond oplevering	Maasdonk	Noord-Brabant	Onbekend	Bouwplaats	Metselwerk	Kap		125.3	Waarde uit EPC	n/a	200	147	0.630	1.17	Ja	Nee	relatie object 53, 55, gemeten qv,10 groter dan ingevoerde waarde in EPC-berekening
89	03/12/13	2013	Rond oplevering	Nijkerk	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		88	Waarde uit EPC		200	41	0.630	0.47	Ja	nee	relatie object 84
90a	26/03/14	2014	Rond oplevering	Hoogezand-Sappemeer	Groningen	Onbekend	Bouwplaats	Metselwerk	Platdak		87.4	Waarde uit EPC		200	29	0.400	0.33	ja	Nee	relatie object 90bcd
90b	26/03/14	2014	Rond oplevering	Hoogezand-Sappemeer	Groningen	Onbekend	Bouwplaats	Metselwerk	Platdak		87.4	Waarde uit EPC		200	28	0.400	0.32	Ja	Nee	relatie object 90acd
90c	26/03/14	2014	Rond oplevering	Hoogezand-Sappemeer	Groningen	Onbekend	Bouwplaats	Metselwerk	Platdak		93.1	Waarde uit EPC		200	37	0.400	0.40	Ja	Nee	Relatie object 90abd
90d	26/03/14	2014	Rond oplevering	Hoogezand-Sappemeer	Groningen	Onbekend	Bouwplaats	Metselwerk	Platdak		93.1	Waarde uit EPC		200	36	0.400	0.39	Ja	Nee	relatie object 90abc
101a	25/02/14	2014	Tijdens bewoning	Dongen	Noord-Brabant	Vrijstaande woning	Bouwplaats	Metselwerk	Kap		262			200	258	0.400	1.126	ja	nee	relatie object 101bc
101b	25/02/14	2014	Tijdens bewoning	Dongen	Noord-Brabant	Vrijstaande woning	Bouwplaats	Metselwerk	Kap		262			200	233	0.400	1.014	ja	nee	relatie object 101ac
101c	25/02/14	2014	Tijdens bewoning	Dongen	Noord-Brabant	Vrijstaande woning	Bouwplaats	Metselwerk	Kap		188			200	85	0.400	0.455	ja	nee	relatie object 101ab
102a	03/02/14	2014	Rond oplevering	Utrecht	Utrecht	Hoekwoning	Bouwplaats	Metselwerk	Kap		111.1		300	200	45	0.625	0.405	ja	nee	relatie object 102b; relatie 104
102b	03/02/14	2014	Rond oplevering	Utrecht	Utrecht	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		111.1		300	200	36.7	0.625	0.330	ja	nee	relatieobject 102a; relatie 104
103a	28/05/14	2014	Rond oplevering	Rijssen-Holten	Overijssel	Hoekwoning	Bouwplaats	Metselwerk	Gecombineerd		121.2	Waarde uit EPC		200	210	0.840	1.740	ja	ja	relatie object 103bcd
103b	28/05/14	2014	Rond oplevering	Rijssen-Holten	Overijssel	Rijtjeswoning	Bouwplaats	Metselwerk	Gecombineerd		121.2	Waarde uit EPC		200	154	0.700	1.270	ja	ja	relatieo object 103acd
103c	28/05/14	2014	Rond oplevering	Rijssen-Holten	Overijssel	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		117.8	Waarde uit EPC		200	91	0.700	0.780	ja	ja	relatie object 103abd
103d	28/05/14	2014	Rond oplevering	Rijssen-Holten	Overijssel	Hoekwoning	Bouwplaats	Metselwerk	Kap		123.9	Waarde uit EPC		200	89	0.840	0.720	ja	ja	relatie object 103abc
104a	15/04/14	2014		Utrecht	Utrecht	Appartement	Bouwplaats	Metselwerk	Platdak		78.6		206	200	18.9	0.625	0.241	ja	nee	relatie object 104b, 102
104b	15/04/14	2014		Utrecht	Utrecht	Appartement	Bouwplaats	Metselwerk	Platdak		83.5		219	200	25.3	0.625	0.303	ja	nee	relatie object 104a, 102
105a	23/07/14	2014	Rond oplevering	Hattem	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Lessenaar		104	Waarde uit EPC		200	31.9	0.400	0.310	ja	nee	relatie object 105abcd
105b	23/07/14	2014	Rond oplevering	Hattem	Gelderland	Hoekwoning	Bouwplaats	Metselwerk	Lessenaar		104	Waarde uit EPC		200	29.4	0.400	0.280	ja	nee	relatie object 105abcd
105c	23/07/14	2014	Rond oplevering	Hattem	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Lessenaar		104	Waarde uit EPC		200	32.5	0.400	0.310	ja	nee	relatie object 105abcd
105d	23/07/14	2014	Rond oplevering	Hattem	Gelderland	Hoekwoning	Bouwplaats	Metselwerk	Lessenaar		104	Waarde uit EPC		200	21.6	0.400	0.210	ja	nee	relatie object 105abcd
106a	25/06/14	2014		Arnhem	Gelderland	Hoekwoning	Bouwplaats	Metselwerk	Kap		113.5		300	200	30.7	0.625	0.270	ja	nee	relatie object 106b
106b	25/06/14	2014		Arnhem	Gelderland	Hoekwoning	Bouwplaats	Metselwerk	Platdak		113.5		300	200	35	0.625	0.314	ja	nee	relatie object 106a
107e	02/10/14	2014	Tijdens bewoning	Winterswijk	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		88.7				241		2.718	ja	nee	relatie object 107abcd (na renovatie)
107f	02/10/	2014	Tijdens	Winterswijk	Gelderla	Hoekwoni	Bouwplaats	Metselwer	Kap		77.5				244		3.148	ja	nee	relatie object

	14		bewoning		nd	ng		k											107abcd (na renovatie)
108a	10/06/14	2014	Rond opleveri ng			Rijtjeswoning	Prefab	Beton	Platdak		134.8	Waarde uit EPC		200	80	0.490	0.600	ja	nee	relatie object 108b
108b	10/06/14	2014	Rond opleveri ng			Hoekwoning	Prefab	Beton	Platdak		134.8	Waarde uit EPC		200	80	0.590	0.590	ja	nee	relatie object 108a
108c	10/06/14	2014	Rond opleveri ng			Hoekwoning	Prefab	Beton	Platdak		134.8	Waarde uit EPC		200	69	0.590	0.510	ja	nee	
108d	10/06/14	2014	Rond opleveri ng			Rijtjeswoning	Prefab	Beton	Platdak		134.8	Waarde uit EPC		200	57	0.490	0.430	ja	nee	
109a	16/07/14	2014	Rond opleveri ng	Deventer	Overijssel	Twee onder één kap	Prefab	Beton	Kap		120.4		>500	200	68	0.630	0.568	ja	nee	
109b	16/07/14	2014	Rond opleveri ng	Deventer	Overijssel	Twee onder één kap	Prefab	Beton	Kap		151.7		>500	200	45	0.630	0.294	ja	nee	
110a	02/09/14	2014	Rond opleveri ng	Rijssen-Holten	Overijssel	Rijtjeswoning	Prefab	Beton	Kap		109.4	Waarde uit EPC		200	63.9	0.700	0.580	ja	nee	incl plattegrond van woning
110b	02/09/14	2014	Rond opleveri ng	Rijssen-Holten	Overijssel	Hoekwoning	Prefab	Beton	Kap		121.6	Waarde uit EPC		200	65.4	0.840	0.540	ja	nee	incl plattegrond van woning
111a	28/02/12	2012	Moment onbekend	Nijkerk	Gelderland	Twee onder één kap	Bouwplaats	Metselwerk	Lessenaar		182.5		435	200	177.1	1.000	1.170	ja	ja	incl plattegrond van woning, geen fotos van gehele woning
111b	28/02/12	2012	Moment onbekend	Nijkerk	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Lessenaar		170		365	200	124.4	0.625	0.960	ja	ja	incl plattegrond van woning, geen fotos van gehele woning
111c	28/02/12	2012	Moment onbekend	Nijkerk	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Lessenaar		102.5		324	200	161	0.625	1.500	ja	ja	incl plattegrond van woning, geen fotos van gehele woning
112a	09/12/13	2013	Tijdens bewoning	Amsterdam	Noord-Holland	Appartement	Bouwplaats	Metselwerk	Platdak		61.1		160	200	89.6	nvt	1.470	ja	nee	incl plattegrond van woning
112b	09/12/13	2013	Tijdens bewoning	Amsterdam	Noord-Holland	Appartement	Bouwplaats	Metselwerk	Platdak		58.8		155	200	59.7	nvt	1.020	ja	nee	incl plattegrond van woning
112c	09/12/13	2013	Tijdens bewoning	Amsterdam	Noord-Holland	Appartement	Bouwplaats	Metselwerk	Platdak		61.1		160	200	79.2	nvt	1.300	ja	nee	incl plattegrond van woning
113	11/04/13	2013	Moment onbekend	Amsterdam	Noord-Holland	Appartement	Bouwplaats	Metselwerk	Platdak		58.6		158.2	200	153.1	nvt	2.610	ja	nee	incl plattegrond van woning, geen fotos van gehele woning
114a	20/08/13	2013	Tijdens bewoning	Amsterdam	Noord-Holland	Appartement	Bouwplaats	Metselwerk	Platdak		57.9		153.5	200	57.2	nvt	0.990	ja	nee	incl plattegrond van woning
114b	20/08/13	2013	Tijdens bewoning	Amsterdam	Noord-Holland	Appartement	Bouwplaats	Metselwerk	Platdak		57.9		153.5	200	74.9	nvt	1.290	ja	nee	incl plattegrond van woning
114c	20/08/13	2013	Tijdens bewoning	Amsterdam	Noord-Holland	Appartement	Bouwplaats	Metselwerk	Platdak		64		169.5	200	95.6	nvt	1.490	ja	nee	incl plattegrond van woning
115	29/10/12	2012				Rijtjeswoning	Bouwplaats	Metselwerk	Kap		35.3		124.1	200	58	0.400	0.400	ja	nee	geen fotos van gehele woning
117a	13/11/12	2012	Rond opleveri ng	Nijkerk	Gelderland	Twee onder één kap	Bouwplaats	Metselwerk	Kap		168		416	200	98.6	0.625	0.587	ja	nee	
117b	13/11/12	2012	Rond opleveri ng	Nijkerk	Gelderland	Twee onder één kap	Bouwplaats	Metselwerk	Kap		205.8		515	200	103.4	0.625	0.518	ja	nee	
118a	14/02/13	2013	Rond opleveri ng	Nijkerk	Gelderland	Twee onder één kap	Bouwplaats	Metselwerk	Kap		178.4		462.5	200	95.8	0.625	0.559	ja	nee	incl plattegrond van woning

118b	14/02/13	2013	Rond opleveri ng	Nijkerk	Gelderla nd	Twee onder één kap	Bouwplaats	Metselwer k	Kap		171.5		444	200	72.8	0.625	0.408	ja	nee	incl plattegrond van woning
119a	17/10/13	2013	Momen t onbeke nd	Velsen	Gelderla nd	Rijtjeswoni ng	Bouwplaats	Beton	Platdak		111			200	22	0.400	0.202	ja	nee	incl plattegrond van woning, geen fotos van gehele woning
119b	17/10/13	2013	Momen t onbeke nd	Velsen	Gelderla nd	Rijtjeswoni ng	Bouwplaats	Beton	Platdak		122			200	20	0.400	0.166	ja	nee	incl plattegrond van woning, geen fotos van gehele woning
120a	21/11/13	2013		Haarlem	Noord-Holland	Rijtjeswoni ng	Bouwplaats		Platdak		157.9			200	33	0.400	0.207	ja	nee	incl plattegrond van woning en kwaliteitscontrole, geen fotos gehele woning
120b	21/11/13	2013		Haarlem	Noord-Holland	Rijtjeswoni ng	Bouwplaats		Platdak		131			200	22	0.400	0.167	ja	nee	incl plattegrond van woning en kwaliteitscontrole, geen fotos gehele woning
121	24/01/14	2014		Haarlem	Noord-Holland	Rijtjeswoni ng	Bouwplaats	Metselwer k	Platdak		106.6			200	14	0.400	0.135	ja	nee	incl plattegrond van woning en kwaliteitscontrole, geen fotos gehele woning
122a	14/04/14	2014		Haarlem	Noord-Holland	Apparteme nt		Beton	Platdak		74.7			200	22	0.400	0.295	nee	nee	
122b	14/04/14	2014		Haarlem	Noord-Holland	Apparteme nt		Beton	Platdak		179.7			200	26	0.400	0.146	ja	nee	maar 1 luchtlekkage foto
122c	14/04/14	2014		Haarlem	Noord-Holland	Apparteme nt		Beton	Platdak		202.8			200	35	0.400	0.174	ja	nee	maar 1 luchtlekkage foto
123a	15/02/13	2013	Rond opleveri ng	Boxmeer	Noord-Brabant	Rijtjeswoni ng	Bouwplaats	Metselwer k	Kap		114.9		332.4	200	76.7	0.625	0.667	ja	nee	incl plattegrond van woning, relatie 124
123b	15/02/13	2013	Rond opleveri ng	Boxmeer	Noord-Brabant	Rijtjeswoni ng	Bouwplaats	Metselwer k	Kap		125.3		417	200	91	0.625	0.726	ja	nee	incl plattegrond van woning, relatie 124
125a	27/02/13	2013		Boxmeer	Noord-Brabant	Apparteme nt	Bouwplaats	Metselwer k	Kap		67		176	200	35.8	0.625	0.535	ja	nee	b.g., geen fotos gehele woning
125b	27/03/13	2013		Boxmeer	Noord-Brabant	Apparteme nt	Bouwplaats	Metselwer k	Kap		67		176	200	36.5	0.625	0.545	ja	nee	1e verdieping, geen fotos gehele woning
125c	27/03/13	2013		Boxmeer	Noord-Brabant	Apparteme nt	Bouwplaats	Metselwer k	Kap		65.5		172	200	22.6	0.625	0.346	ja	nee	1e verdieping, geen fotos gehele woning
125d	27/03/13	2013		Boxmeer	Noord-Brabant	Apparteme nt	Bouwplaats	Metselwer k	Kap		132.5		340	200	100.7	0.625	0.760	ja	nee	2e en 3e verdieping (luchtdoorlatendheid en qv,10,kar veel hoger dan 125abc,geen fotos gehele woning
126a	09/09/14	2014		Beverwijk	Noord-Holland	Hoekwoni ng	Bouwplaats	Metselwer k	Kap		111.8	Waarde uit EPC	310	200	60.9	0.400	0.544	ja	nee	
126b	09/09/14	2014		Beverwijk	Noord-Holland	Rijtjeswoni ng	Bouwplaats	Metselwer k	Kap		106.9	Waarde uit EPC	300	200	50.1	0.400	0.469	ja	nee	
127a	17/09/14	2014	Rond opleveri ng	Beverwijk	Noord-Holland	Hoekwoni ng	Bouwplaats	Metselwer k	Kap		111.8		310	200	60.9	0.400	0.544	ja	nee	(3-9-2014) relatie 127c, plattegrond geen foto gehele woning
127b	17/09/14	2014	Rond opleveri ng	Beverwijk	Noord-Holland	Rijtjeswoni ng	Bouwplaats	Metselwer k	Kap		106.9		300	200	50.1	0.400	0.469	ja	nee	(3-9-2014) plattegrond geen foto gehele woning
127c	17/09/14	2014	Rond opleveri ng	Beverwijk	Noord-Holland	Hoekwoni ng	Bouwplaats	Metselwer k	Kap		111.8		310	200	44.3	0.400	0.396	ja	nee	(11-9-2014) relatie 127a plattegrond geen foto gehele woning
127d	17/09/14	2014	Rond opleveri ng	Beverwijk	Noord-Holland	Hoekwoni ng	Bouwplaats	Metselwer k	Kap		106.9		300	200	39.2	0.400	0.367	ja	nee	(11-9-2014) plattegrond geen foto gehele woning
128a	17/09/13	2013		Goeree-Overflakkee	Zeeland	Hoekwoni ng	Prefab	Beton	Kap		153		340	200	63	0.840	0.416	ja	nee	incl plattegrond van woning geen fotos gehele woning

128b	17/09/13	2013		Goeree-Overflakkee	Zeeland	Rijtjeswoning	Prefab	Beton	Kap		153		300	200	41	0.700	0.363	ja	nee	incl plattegrond van woning geen fotos gehele woning
128c	17/09/13	2013		Goeree-Overflakkee	Zeeland	Rijtjeswoning	Prefab	Beton	Kap		148		340	200	45	0.700	0.370	ja	nee	incl plattegrond van woning geen fotos gehele woning
129a	21/05/13	2013		Wageningen	Gelderland	Appartement	Bouwplaats		Platdak		58.5		155	200	44.2	0.625	0.756	ja	nee	incl plattegrond van woning geen fotos gehele woning
129b	21/05/13	2013		Wageningen	Gelderland	Appartement	Bouwplaats		Platdak		58.5		155	200	22.7	0.625	0.389	ja	nee	incl plattegrond van woning geen fotos gehele woning
131a	14/05/13	2013	Rond opleveri ng	Nijmegen	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		126.5	Methode onbekend	336.9	200	71.8	0.625	0.568	Ja	Nee	3 woningen gemeten uit project van 36 woningen
131b	14/05/13	2013	Rond opleveri ng	Nijmegen	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		126.5	Methode onbekend	336.9	200	43.2	0.625	0.341	Ja	Nee	3 woningen gemeten uit project van 36 woningen
131c	14/05/13	2013	Rond opleveri ng	Nijmegen	Gelderland	Hoekwoning	Bouwplaats	Metselwerk	Kap		126.5	Methode onbekend	336.9	200	73.8	0.625	0.583	Ja	Nee	3 woningen gemeten uit project van 36 woningen
132a	23/01/14	2014	Rond opleveri ng	Landsmeer	Noord-Holland	Appartement	Onbekend		Kap		99.9			200	19	0.625	0.187	Nee	Nee	Complex 1: 4 vd XX woningen gemeten
132b	23/01/14	2014	Rond opleveri ng	Landsmeer	Noord-Holland	Appartement	Onbekend		Kap		76.7			200	86	0.625	1.115	Nee	Nee	Complex 1: 4 vd XX woningen gemeten
132c	23/01/14	2014	Rond opleveri ng	Landsmeer	Noord-Holland	Appartement	Onbekend		Kap		51.6			200	6	0.625	0.124	Nee	Nee	Complex 1: 4 vd XX woningen gemeten
132d	23/01/14	2014	Rond opleveri ng	Landsmeer	Noord-Holland	Appartement	Onbekend		Kap		78.8			200	9	0.625	0.107	Nee	Nee	Complex 1: 4 vd XX woningen gemeten
132e	03/02/14	2014	Rond opleveri ng	Landsmeer	Noord-Holland	Appartement	Onbekend		Kap		62.7			200	20	1.000	0.318	Nee	Nee	Complex 2: 4 vd 19 woningen gemeten
132f	03/02/14	2014	Rond opleveri ng	Landsmeer	Noord-Holland	Appartement	Onbekend		Kap		60.6			200	12	1.000	0.196	Nee	Nee	Complex 2: 4 vd 19 woningen gemeten
132g	03/02/14	2014	Rond opleveri ng	Landsmeer	Noord-Holland	Appartement	Onbekend		Kap		60.9			200	45	1.000	0.742	Nee	Nee	Complex 2: 4 vd 19 woningen gemeten
132h	03/02/14	2014	Rond opleveri ng	Landsmeer	Noord-Holland	Appartement	Onbekend		Kap		56.9			200	72	1.000	1.271	Nee	Nee	Complex 2: 4 vd 19 woningen gemeten
134	24/10/13	2013	Rond opleveri ng	Rotterdam	Zuid-Holland	Twee onder één kap	Bouwplaats		Kap		226		595	238	125.28	1.000	0.555	Ja	Nee	Gemeten waarde is 125,28 dm3/s, maar deze is gecorrigeerd naar volume en gecommuniceerd als 105 dm3/s
136a	05/09/13	2013	Rond opleveri ng	Haaksbergen	Overijssel	Rijtjeswoning	Bouwplaats		Kap		120.5			200	73.5	0.400	0.611	Ja	Ja	2 vd 38 woningen bemeten
136b	05/09/13	2013	Rond opleveri ng	Haaksbergen	Overijssel	Rijtjeswoning	Bouwplaats		Kap		120.5			200	75.6	0.400	0.627	Ja	Ja	2 vd 38 woningen bemeten
137a	01/05/12	2012	Rond opleveri ng	Súdwest-Fryslân	Friesland	Rijtjeswoning	Gecombineerd (50:50)	Houtskelet	Kap		106			200	38.75	0.625	0.366	Ja	Nee	2 vd 8 woningen bemeten
137b	01/05/12	2012	Rond opleveri ng	Súdwest-Fryslân	Friesland	Rijtjeswoning	Gecombineerd (50:50)	Houtskelet	Kap		106			200	38.92	0.625	0.367	Ja	Nee	2 vd 8 woningen bemeten
138a	04/06/12	2012	Rond opleveri ng	Ede	Gelderland	Rijtjeswoning	Bouwplaats		Kap		107.7			200	62.3	0.625	0.579	Ja	Nee	2 vd 15 woningen bemeten
138b	04/06/12	2012	Rond opleveri ng	Ede	Gelderland	Hoekwoning	Bouwplaats		Kap		145.5			200	64.7	0.625	0.445	Ja	Nee	2 vd 15 woningen bemeten
139a	10/06/13	2013	Tijdens bouw	Zwolle	Overijssel	Rijtjeswoning			Platdak		89.8			200	69	0.400	0.768	Ja	Nee	3 vd 61 woningen bemeten; relatie met

																			140
139b	10/06/13	2013	Tijdens bouw	Zwolle	Overijssel	Hoekwoning			Gecombineerd		84.2			200	84.2	0.400	1.001	Ja	Nee	3 vd 61 woningen bemeten; relatie met 140
139c	10/06/13	2013	Tijdens bouw	Zwolle	Overijssel	Hoekwoning			Platdak		89.8			200	32.7	0.400	0.364	Ja	Nee	3 vd 61 woningen bemeten; relatie met 140i
140a	04/10/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					118.73			200	38.6	0.400	0.325	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139
140b	25/09/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					89.76			200	20.6	0.400	0.229	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139
140c	08/10/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					89.28			200	31	0.400	0.347	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139
140d	08/10/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					94.79			200	35.1	0.400	0.371	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139
140e	16/10/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					91.65			200	34.7	0.400	0.379	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139
140f	26/09/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					94.79			200	34.2	0.400	0.36	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139
140g	25/09/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					89.76			200	26.3	0.400	0.293	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139
140h	26/09/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					94.79			200	34	0.400	0.359	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139
140i	26/09/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					89.76			200	26.3	0.400	0.293	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139c
140j	08/10/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					94.79			200	37	0.400	0.39	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139
140k	01/10/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					89.76			200	30.8	0.400	0.344	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139
140l	15/10/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					94.79			200	36.7	0.400	0.387	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139
140m	15/10/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					89.76			200	22.2	0.400	0.248	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139
140n	29/10/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					89.76			200	27.3	0.400	0.304	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139
140o	29/10/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					89.76			200	22.7	0.400	0.253	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139
140p	29/10/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					89.76			200	22	0.400	0.245	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139
140q	29/10/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					89.26			200	35.7	0.400	0.4	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139
140r	29/10/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					89.76			200	22.9	0.400	0.255	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139
140s	29/10/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					89.76			200	25.7	0.400	0.286	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139
140t	15/10/13	2013	Rond opleveri ng	Zwolle	Overijssel	Onbekend					89.76			200	32.5	0.400	0.362	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139
141a	02/07/13	2013	Rond opleveri ng	Baarn	Utrecht	Duplexwoning					71.2		186.5	200	28.1	N50 0,6	0.395	Ja	Nee	Passiefhuisniveau - aangesloten WTW

141b	02/07/13	2013	Rond oplevering	Baarn	Utrecht	Duplexwoning					77.8		215.4	200	32.55	N50 0,6	0.418	Ja	Nee	Passiefhuisniveau - volumestroom was 17,5 dm3/s hoger met aangesloten WTW
141c	02/07/13	2013	Rond oplevering	Baarn	Utrecht	Rijtjeswoning					103		284	200	5.75	N50 0,6	0.056	Ja	Nee	Passiefhuisniveau - WTW nog niet aangesloten
142	25/06/12	2013	Rond oplevering	Leeuwarden	Friesland	Rijtjeswoning			Kap		156.2			200	138.5	0.625	0.887	Ja	Nee	
143	18/12/12	2012	Rond oplevering	Zutphen	Gelderland	Rijtjeswoning			Lessenaar		119.1			200	48	0.336	0.403	Ja	Nee	
144a	04/12/12	1988	Tijdens bewoning	Nunspeet	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		100.2				344.8		3.443	Ja	Nee	Bestaande bouw getest
144b	04/12/12	1988	Tijdens bewoning	Nunspeet	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		80.8				407.2		5.041	Ja	Nee	Bestaande bouw getest; rondom afsluiten rookgasafvoer leidde tot 380,2 dm3/s
144c	04/12/12	1988	Tijdens bewoning	Nunspeet	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		83.7				231.6		2.768	Ja	Nee	Bestaande bouw getest
144d	05/12/12	1988	Tijdens bewoning	Nunspeet	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		92.2				185.1		2.008	Ja	Nee	Bestaande bouw getest; zonder afgedicht zolderluik 459,9 dm3/s
144e	05/12/12	1988	Tijdens bewoning	Nunspeet	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		82.4				181.3		2.199	Ja	Nee	Bestaande bouw getest; zonder afgedicht zolderluik 688,5 dm3/s
145	21/03/14		Tijdens bewoning	Nunspeet	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		100.2				285.7		2.851	Ja	Nee	Bestaande bouw getest na renovatie; voor renovatie was 344,8 dm3/s
146a	26/10/12	2012	Rond oplevering	Leeuwarden	Friesland	Rijtjeswoning	Bouwplaats		Gecombineerd		108.2			200	79	0.625	0.729	Ja	Nee	
146b	26/10/12	2012	Rond oplevering	Leeuwarden	Friesland	Hoekwoning	Bouwplaats		Gecombineerd		108.2			200	63.2	0.625	0.584	Ja	Nee	Verrassend: Hoekwoning is luchtdichter dan tussenwoning
147	07/11/12	2012	Rond oplevering	Smallingerland	Friesland	Rijtjeswoning	Bouwplaats		Kap		96.95			200	104.8	0.625	1.081	Ja	Nee	
148	16/10/12	2012	Rond oplevering	Smallingerland	Friesland	Rijtjeswoning		Houtskelet	Kap		116.4			200	46.1	0.625	0.396	Ja	Nee	
149	25/09/12	2012	Tijdens bewoning	Haaksbergen	Overijssel	Vrijstaande woning	Onbekend	Staalbouw	Kap		110			200	53.3	N50 0,6	0.485	Nee	Nee	Oppervlak 80,5 conform tekening of 110,0 m2 conform opdrachtgever
150	27/03/14	2014	Rond oplevering	Apeldoorn	Gelderland	Rijtjeswoning			Kap		135			200	35	0.300	0.256	Ja	Ja	Gemiddelde van onder- en overdruk meting
151a	23/08/13	2013	Rond oplevering	Zwolle	Overijssel	Hoekwoning	Prefab	Beton	Kap		109			200	86.6	0.625	0.796	Ja	Ja	
151b	23/08/13	2013	Rond oplevering	Zwolle	Overijssel	Rijtjeswoning	Prefab	Beton	Kap		124			200	93.2	0.625	0.752	Ja	Ja	
151c	23/08/13	2013	Rond oplevering	Zwolle	Overijssel	Rijtjeswoning	Prefab	Beton	Kap		115.1			200	92.1	0.625	0.807	Ja	Ja	
151d	23/08/13	2013	Rond oplevering	Zwolle	Overijssel	Hoekwoning	Prefab	Beton	Kap		121.2			200	103.7	0.625	0.856	Ja	Ja	
152a	09/10/13	2013	Rond oplevering	Amersfoort	Utrecht	Twee onder één kap	Bouwplaats	Metselwerk	Kap		152.8			200	70.1	0.400	0.459	Ja	Nee	

152b	09/10/13	2013	Rond oplevering	Amersfoort	Utrecht	Twee onder één kap	Bouwplaats	Metselwerk	Kap		152.8			200	76.1	0.400	0.498	Ja	Nee	
153	10/12/13	2013	Rond oplevering	Almere	Flevoland	Appartement	Bouwplaats	Metselwerk			48.4			200	46	0.420	0.96	Ja	Nee	
154	12/04/13		Rond oplevering	Haaksbergen	Overijssel	Appartement			Platdak		113			200	30.9		0.273	Ja	Ja	Bestaande bouw
201	17/07/13	2013	Rond oplevering	Leeuwarden	Friesland	Vrijstaande woning	Bouwplaats	Metselwerk	Kap		234.43			200	80.556	0.625	0.344	Nee	Nee	
202	20/11/13	2013	Rond oplevering	Apeldoorn	Gelderland	Vrijstaande woning	Bouwplaats	Metselwerk	Kap		260			200	129	0.63	0.5	Ja	Nee	
203	07/05/14	2014	Rond oplevering	Zeevang	Noord-Holland	Vrijstaande woning	Bouwplaats	Metselwerk	Kap		195.9			250	237	0.63	1.21	Ja	Nee	
204	03/06/13	2013	Rond oplevering	Deventer	Overijssel	Vrijstaande woning	Bouwplaats	Metselwerk	Kap		192.7			200	100.2	0.625	0.520	Ja	Ja	
207	12/04/12	2012	Rond oplevering	Woudrichem	Noord-Brabant	Vrijstaande woning	Bouwplaats	Metselwerk	Kap		166			200	225.6	0.625	1.359	Ja	Ja	
208	15/11/12	2012	Rond oplevering	Borne	Overijssel	Rijtjeswoning			Kap		139.5		358	200	12.1	0.150	0.087	nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk
209	16/07/14	2014	Rond oplevering	Ede	Gelderland	Rijtjeswoning			Kap		120.1			200	34	0.400	0.282	Ja	Ja	relatie met 210; hetzelfde project. Onder- en overdrukmeting
210	16/07/14	2014	Rond oplevering	Ede	Gelderland	Hoekwoning			Kap		120.1			200	42	0.400	0.346	Ja	Ja	relatie met 209; hetzelfde project. Onder- en overdrukmeting
211a	05/07/11	2011	Tijdens bouw	Apeldoorn	Gelderland	Onbekend					92		268	200	13.21	0.150	0.14	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk
211b	05/07/11	2011	Tijdens bouw	Apeldoorn	Gelderland	Onbekend					92		268	200	13.38	0.150	0.15	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk
211c	05/07/11	2011	Tijdens bouw	Apeldoorn	Gelderland	Onbekend					92		268	200	12.59	0.150	0.14	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk
211d	05/07/11	2011	Tijdens bouw	Apeldoorn	Gelderland	Onbekend					92		268	200	12.03	0.150	0.13	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk
211e	05/07/11	2011	Tijdens bouw	Apeldoorn	Gelderland	Onbekend					92		268	200	10.5	0.150	0.11	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk
211f	05/07/11	2011	Tijdens bouw	Apeldoorn	Gelderland	Onbekend					104		300	200	14.34	0.150	0.14	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk
211g	06/07/11	2011	Tijdens bouw	Apeldoorn	Gelderland	Onbekend					104		300	200	9.04	0.150	0.09	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk
211h	06/07/11	2011	Tijdens bouw	Apeldoorn	Gelderland	Onbekend					104		300	200	13.67	0.150	0.13	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk
211i	06/07/11	2011	Tijdens bouw	Apeldoorn	Gelderland	Onbekend					104		300	200	13.08	0.150	0.13	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk

211j	06/07/11	2011	Tijdens bouw	Apeldoorn	Gelderland	Onbekend					104		300	200	15.51	0.150	0.15	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk
211k	06/07/11	2011	Tijdens bouw	Apeldoorn	Gelderland	Onbekend					104		300	200	14.98	0.150	0.14	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk
211l	06/07/11	2011	Tijdens bouw	Apeldoorn	Gelderland	Onbekend					104		300	200	15.04	0.150	0.14	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk
212	29/11/12	2012	Moment onbekend	Zaanstad	Noord-Holland	Onbekend			Kap		118.8		309	200	43.9		0.37	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2
213	26/10/12	2012	Moment onbekend	Renkum	Gelderland	Appartement					83.6		223	200	47.4		0.566	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2
214	17/12/12	2012	Moment onbekend	Dordrecht	Zuid-Holland	Onbekend					98		257	200	64.9		0.66	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2
215a	14/11/14	2014	Tijdens bouw			Appartement					84		221.5	200	19.4		0.23	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2
215b	14/11/14	2014	Tijdens bouw			Appartement					96		254	200	13.7		0.143	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2
216a	19/10/12	2012	Rond oplevering	Tilburg	Noord-Brabant	Rijtjeswoning					129		336	200	104.6		0.81	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2
216b	19/10/12	2012	Rond oplevering	Tilburg	Noord-Brabant	Rijtjeswoning					133.5		352	200	63.75		0.48	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2
217	26/11/12	2012	Rond oplevering	Koggenland	Noord-Holland	Twee onder één kap					141		372	200	35.97		0.25	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2
218a	02/11/12	2012	Rond oplevering			Hoekwoning					110.9		293	200	101.53		0.91	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2
218b	02/11/12	2012	Rond oplevering			Rijtjeswoning					112		293	200	78.89		0.7	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2
218c	02/11/12	2012	Rond oplevering			Hoekwoning					68.7		182	200	97.36		1.416	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2
219	08/11/12	2009	Tijdens bewoning	Bergen op Zoom	Noord-Brabant	Vrijstaande woning					165.3		440	200	108.1		0.653	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2

220	26/04/12	2012	Rond oplevering	Zwolle	Overijssel	Onbekend					94.08		250	200	57	0.625	0.61	Ja	Ja	1 van de 66 woningen uit een project
221a	26/03/14	2014	Rond oplevering	Hoogezand-Sappemeer	Groningen	Onbekend					87.4			200	29	0.400	0.33	Ja	Nee	4 vd 54 woningen zijn bemeten
221b	26/03/14	2014	Rond oplevering	Hoogezand-Sappemeer	Groningen	Onbekend					87.4			200	28	0.400	0.32	Ja	Nee	4 vd 54 woningen zijn bemeten
221c	26/03/14	2014	Rond oplevering	Hoogezand-Sappemeer	Groningen	Onbekend					93.1			200	37	0.400	0.40	Ja	Nee	4 vd 54 woningen zijn bemeten
221d	26/03/14	2014	Rond oplevering	Hoogezand-Sappemeer	Groningen	Onbekend					93.1			200	36	0.400	0.39	Ja	Nee	4 vd 54 woningen zijn bemeten
222a	02/10/13	2013	Rond oplevering	Steenwijkerland	Overijssel	Hoekwoning					128.7			200	69.2	0.625	0.537	Ja	Nee	
222b	02/10/13	2013	Rond oplevering	Steenwijkerland	Overijssel	Rijtjeswoning					123.7			200	72.5	0.625	0.586	Ja	Nee	
222c	02/10/13	2013	Rond oplevering	Steenwijkerland	Overijssel	Rijtjeswoning					123.7			200	75.4	0.625	0.610	Ja	Nee	
Min	05/07/11	1988								0	35.3		124.1		5.75		0.056			
Max	14/11/14	2014								0	262		595		407		5			
Average																				

Aanwezigheid foto's

# Ja	276	32
# Nee	44	288
% Ja	86.3 %	10.0 %
% Nee	13.8 %	90.0 %

Appartement	43	13.4 %
Duplexwoning	2	0.6%
Hoekwoning	41	12.8 %
Rijtjeswoning	75	23.4 %
2^1 kap	19	5.9%
Vrijstaande woning	13	4.1%
Onbekend	127	39.7 %
	320	100.0 %

0.15	13	4.1%
0.4	111	34.7 %
0.625	75	23.4 %
	121	37.8 %

Description	
Rapportnummer	Nummer zoals genoteerd op het fysieke uitgeprintte rapport. Wanneer één rapport meerdere daadwerkelijk uitgevoerde blower-door-tests omvat, dan wordt het rapportnummer gevolgd door de toevoeging A, B, C etc
Datum meting	De dag waarop de meting is uitgevoerd door de luchtdichtheidsmeter
Bouwjaar woning	Het jaar waarin de woning is opgeleverd
Moment opname	De relatie tussen datum meting en de stand van zaken wat betreft het bouw proces. We onderscheiden 1. Tijdens de bouw, 2. Rond oplevering, 3. Tijdens bewoning en 4. Moment onbekend. In de normen wat vaak gesproken van een A of B-meting. De B-meting is een tussentijdse meting waarbij de aannemer in staat is nog de luchtdichtheid verder te verbeteren. Bij een A-meting wordt als het ware het definitieve rapportcijfer vastgesteld.
Locatie woning	De gemeente waarin de woning zich bevindt.
Type woning	Om een beeld te krijgen van de vormfactor van de woning, dient te worden aangegeven of het een appartement, duplexwoning, hoekwoning, rijtjeswoning, twee onder één kap, vrijstaande woning, of het woningtype onbekend is.
Bouwwijze	Er is de keuze uit prefab of bouwplaats, mits bekend.
Bouwmethode	Mits bekend, betreft het betonbouw, houtskeletbouw, metselwerk of staalbouw.
Dakconstructie	Geef aan welk daktype de woning heeft, zijnde een lessenaar, kap of platdak. Wanneer de hoofdbouw een combinatie is van platdak 50% en een schuin dak 50%, kan dit ook worden aangeven.
EnergiePrestatieCoëfficient	De energieprestatiecoëfficiënt van de woning, zoals uitgerekend conform NEN5128 of NEN7120
Vloeroppervlak	Er zijn diverse omschrijvingen van vloeroppervlakken in omloop. In deze kolom wordt het vloeroppervlak in m^2 aangegeven zoals dat in de rapportage van de luchtdichtsmeter is gebruikt.
Meetmethode vloeroppervlak	Er dient te worden aangegeven, zover mogelijk, of het vloeroppervlak door de luchtdichtheidsmeter zelf is bepaald, is overgenomen uit de EP- danwel EPC-berekening, conform NEN 2580 of op een andere wijze is bepaald Mocht de luchtdichtheidsmeter meerdere waarden voor het vloeroppervlak geven, kies dan die waarde waarmee door de luchtdichtheidsmeter is verder gewerkt. Maak hier een opmerking over in de laatste kolom svp.
Gebouwvolume	Er zijn diverse omschrijvingen van gebouwvolumes in omloop. In deze kolom wordt het volume in m^3 aangegeven zoals dat in de rapportage van de luchtdichtsmeter is gebruikt.
Toegestane luchtdoorlatendheid	De maximale luchtdoorlatendheid van de woning uitgedrukt in dm^3 gerelateerd aan de luchtdichtheid van het object en zoals aangewezen in het Bouwbesluit (normaliter max. 200 dm^3/s).
Gemeten luchtdoorlatendheid	De mate van infiltratie voor de gehele woning uitgedrukt in dm^3/s, zoals gemeten door de luchtdichtheidsmeter
Maximaal toelaatbare infiltratie	De ongecontroleerde en onbedoelde luchtvolumestroom die volgens de EP-berekening maximaal toelaatbaar is voor de betreffende woning, meestal een waarde van 0,150, 0,400 of 0,625 dm^3/s per m^2.
Gemeten infiltratie qv;10	Geef hier de in het testrapport gemeten en getoond waarde aan voor de infiltratie in dm3/s per m2 bij 10 Pascal
Gemeten infiltratie qv;10;kar	Geef hier de in het testrapport gemeten en getoond waarde aan voor de infiltratie in dm3/s per m2 bij 10 Pascal. Wanneer gesproken wordt over de "$q_{v,10,kar}$" is dit de tot een gebouw van 500 m^3 herleide q_{v10}. De $q_{v10,kar}$ wordt gebruikt bij grote gebouwen.
Foto's	Geef hier als antwoord ja, wanneer op foto's met de hand of met rook is aangeven waar de luchtlekken zich bevinden.
IR-foto's	Geef hier als antwoord ja, wanneer IR-foto's van luchtlekken zijn opgenomen in het blower door testrapport.

X. MODIFIED DATA ON SPREAD SHEET

Rapportnummer	Datum meting	Bouwjaar woning	Moment opname	Locatie woning	Provincie woning	Type woning	Bouwwijze	Bouwmethode	Dakconstructie	Energie Prestatie Coëfficiënt	Vloeroppervlak (m^2)	Meetmethode vloeroppervlak	Gebouw-volume (m^3)	Toegestane luchtdoorlatendheid (dm^3/s)	Gemeten luchtdoorlatendheid (dm^3/s)	Max. toelaatbare infiltratie (dm^3/s per m^2)	Gemeten $q_{v;10}$ (dm^3/s per m^2)	Aanwezigheid foto's luchtlekkage	Aanwezigheid infrarood foto's	Eventuele opmerkingen	Leakage Level 1 amount	Leakage Level 2 amount	Leakage Level 3 amount	Leakage Level 4 amount	total known leakage point	Remarks	Total Leakage	v50 (dm3/s)	w50 (dm3/s.m2)
1	18/06/13	2013	Rond opleving	Zeewolde	Flevoland	Rijtjeswoning	Onbekend		Kap		109		300	200	29	0.400	0.27	Ja	Nee	relatie object 2, 3 en 4	4	0	0	0	4		4	93.5	0.86
2	18/06/13	2013	Rond opleving	Zeewolde	Flevoland	Hoekwoning			Kap		109		300	200	33	0.400	0.30	Ja	Nee	relatie object 1, 3 en 4	5	1	0	4	10		23	100.0	0.92
3	18/06/13	2013	Rond opleving	Zeewolde	Flevoland	Rijtjeswoning			Kap		109		300	200	40	0.400	0.37	Ja	Nee	relatie object 1, 2 en 4	9	0	0	0	9		9	114.5	1.05
4	18/06/13	2013	Rond opleving	Zeewolde	Flevoland	Hoekwoning			Kap		109		301	200	46	0.400	0.42	Ja	Nee	relatie object 1, 2 en 3, Q gemeten meer dan max. toelaatbare infiltratie	9	2	1	1	13		20	138.0	1.27
5	21/03/13	2013	Rond opleving	Hardenberg	Overijsel	Rijtjeswoning			Kap		110		325	200	24	0.625	0.22	Ja	Nee		7	2	1	0	10		14	72.0	0.65
6	20/03/14	2014	Rond opleving	Neerijnen	Gelderland	Rijtjeswoning			Kap		102			200	54	0.400	0.53	Ja	Nee	relatie object 7, afvoer wasemkap lijkt geen probleem te zijn?, Q gemeten meer dan max. toelaatbare infiltratie	0	1	0	0	1		2	148.0	1.45
7	20/03/14	2014	Rond opleving	Neerijnen	Gelderland	Hoekwoning			Kap		102			200	43	0.400	0.42	Ja	Nee	relatie object 6, afvoer wasemkap lijkt geen probleem te zijn?, Q gemeten meer dan max. toelaatbare infiltratie	3	0	0	0	3		3	132.0	1.29
8a	03/04/14	2014	Rond opleving	Hof van Twente	Overijsel	Twee onder één kap			Gecombineerd		136			200	35	0.400	0.26	Ja	Nee	relatie object 8a-8f	2	8	4	0	14		30	103.5	0.76
8b	03/04/14	2014	Rond opleving	Hof van Twente	Overijsel	Twee onder één kap			Gecombineerd		116			200	32	0.400	0.28	Ja	Nee	relatie object 8a-8f	6	3	0	0	9		12	97.5	0.84
8c	03/04/14	2014	Rond opleving	Hof van Twente	Overijsel	Twee onder één kap			Gecombineerd		116			200	34	0.400	0.29	Ja	Nee	relatie object 8a-8f	3	3	2	0	8		15	103.5	0.89
8d	01/05/14	2014	Rond opleving	Hof van Twente	Overijsel	Twee onder één kap			Gecombineerd		107			200	19	0.400	0.18	Ja	Nee	relatie object 8a-8f, opvallend laag tov andere 5	1	3	1	0	5		10	55.0	0.51
8e	01/05/14	2014	Rond opleving	Hof van Twente	Overijsel	Twee onder één kap			Gecombineerd		138			200	48	0.400	0.35	Ja	Nee	relatie object 8a-8f	1	5	1	0	7		14	133.5	0.97
8f	01/05/14	2014	Rond opleving	Hof van Twente	Overijsel	Twee onder één kap			Gecombineerd		138			200	39	0.400	0.28	Ja	Nee	relatie object 8a-8f	5	3	3	0	11		20	112.0	0.81
9a	26/06/14	2014	Rond opleving	Nijkerk	Gelderland	Rijtjeswoning			Kap		129.6			200	65.5	0.400	0.51	ja	nee	Relatie object 9b-9c, Q gemeten meer dan max. toelaatbare infiltratie	8	7	3	3	21		43	178.5	1.38
9b	26/06/14	2014	Rond opleving	Nijkerk	Gelderland	Rijtjeswoning			Kap		129.6			200	50	0.400	0.39	ja	Nee	Relatie object 9a-9c	3	4	4	0	11		23	135.5	1.05
9c	26/06/14	2014	Rond opleving	Nijkerk	Gelderland	Hoekwoning			Kap		138.8			200	65	0.400	0.47	Ja	Nee	Relatie object 9a-9b, Q gemeten meer dan max. toelaatbare infiltratie	4	15	4	1	24		50	176.5	1.27
10a	01/10/14	2014	Rond opleving	Noordwijkerhout	Noord-Holland	Appartement			Platdak		91.8			200	28.5	0.625	0.31	Ja	Nee	Relatie object 10b-10c	1	5	3	1	10		24	87.0	0.95
10b	01/10/14	2014	Rond opleving	Noordwijkerhout	Noord-Holland	Appartement			Platdak		80			200	22.5	0.625	0.28	Ja	Nee	Relatie object 10a-10c	1	5	3	0	9		20	61.5	0.77
10c	01/10/14	2014	Rond opleving	Noordwijkerhout	Noord-Holland	Appartement			Platdak		80			200	22	0.625	0.28	Ja	Nee	Relatie object 10a-10b, bijna helemaal gelijk aan 10b	1	5	1	1	8		18	61.5	0.77
11a	20/08/14	2002	Tijdens bewoni	Leiden	Zuid-Holland	Hoekwoning			Platdak		159.4			200	67.5	0.590	0.42	Ja	Nee	Relatie object 11b-d	4	6	3	2	15		33	182.0	1.14

			ng																										
11b	20/08/14	2001	Tijdens bewoning	Leiden	Zuid-Holland	Rijtjeswoning			Platdak		146.2			200	44	0.490	0.30	Ja	Nee	Relatie object 11a, 11c-d	6	5	0	1	12		20	132.0	0.90
11c	20/08/14	2001	Tijdens bewoning	Leiden	Zuid-Holland	Rijtjeswoning			Platdak		146.2			200	39.5	0.490	0.27	Ja	Nee	Relatie object 11a-b, 11d	4	4	1	0	9		15	123.5	0.84
11d	20/08/14	2001	Tijdens bewoning	Leiden	Zuid-Holland	Rijtjeswoning			Platdak		146.2			200	92.5	0.490	0.63	Ja	Nee	Relatie object 11a-c, gemeten luchdoorlatendheid en qv,10 gemeten veel hoger dan bij 11b-c	5	8	3	4	20		46	248.5	1.70
12a	12/08/14	2014	Rond oplevering	Amsterdam	Noord-Holland	Rijtjeswoning			Kap		99			200	23	0.360	0.23	Ja	Nee	Relatie object 12b	3	4	1	0	8		14	81.0	0.82
12b	12/08/14	2014	Rond oplevering	Amsterdam	Noord-Holland	Rijtjeswoning			Kap		95			200	19	0.360	0.20	Ja	Nee	Relatie object 12a	3	5	2	0	10		19	63.0	0.66
13a	29/04/14	2014	Rond oplevering	Nijkerk	Gelderland	Duplexwoning			Kap		127.4			200	36	0.400	0.28	Ja	Nee	Relatie object 13b	1	3	0	0	4		7	106.0	0.83
13b	29/04/14	2014	Rond oplevering	Nijkerk	Gelderland	Duplexwoning			Kap		85.6			200	8	0.400	0.09	Ja	Nee	Relatie object 13a, opvallend lage gemeten luchtdoorlatendheid en qv,10 gemeten.	1	1	0	0	2		3	24.0	0.28
14	06/08/14	2013	Rond oplevering	Barneveld	Gelderland	Twee onder één kap			Kap		176.8			200	74.5	0.630	0.42	Ja	Nee		4	3	4	1	12		26	201.5	1.14
15a	23/04/14	2014	Rond oplevering	Geldermalsen	Gelderland	Rijtjeswoning			Kap		111.7			200	27	0.400	0.24	Ja	Nee	Relatie object 15b	0	7	5	0	12		29	80.5	0.72
15b	23/04/14	2014	Rond oplevering	Geldermalsen	Gelderland	Rijtjeswoning			Kap		111.7			200	23	0.400	0.21	Ja	Nee	Relatie object 15a	0	6	1	0	7		15	69.0	0.62
16a	09/07/14	2014	Rond oplevering	Molenwaard	Overijssel	Rijtjeswoning			Kap		150			200	41	0.625	0.27	Ja	Nee	Relatie object 16b	1	11	3	0	15		32	120.0	0.80
16b	09/07/14	2014	Rond oplevering	Molenwaard	Overijssel	Hoekwoning			Kap		140			200	41.5	0.625	0.30	Ja	Nee	Relatie object 16a	1	6	5	0	12		28	114.0	0.81
17a	10/06/14	2014	Rond oplevering	Wageningen	Gelderland	Appartement			Platdak		68.4			200	69.5	0.690	1.02	Ja	Nee	Relatie object 17b en 17-2a-b, qv,10 gemeten hoog	2	3	4	0	9		20	171.0	2.50
17b	10/06/14	2014	Rond oplevering	Wageningen	Gelderland	Appartement			Platdak		68.4			200	53.5	0.690	0.78	Ja	Nee	Relatie object 17a en 17-2-ab, Q gemeten meer dan max. toelaatbare infiltratie	1	3	3	1	8		20	132.5	1.94
17-2a	21/08/14	2014	Rond oplevering	Wageningen	Gelderland	Appartement			Platdak		39.5			200	25	0.690	0.63	Ja	Nee	Relatie object 17-2b, en 17a-b, vloeroppervlak erg klein	0	3	4	1	8		22	66.5	1.68
17-2b	21/08/14	2014	Rond oplevering	Wageningen	Gelderland	Appartement			Platdak		68.4			200	34.5	0.690	0.50	Ja	Nee	Relatie object 17-2a, en 17a-b	4	6	3	0	13		25	96.5	1.41
18a	24/06/14	2014	Rond oplevering	Montferland	Gelderland	Onbekend					124.7			200	30	0.400	0.24	Ja	Nee	Relatie object 18b-d	5	8	2	0	15		27	102.0	0.82
18b	24/06/14	2014	Rond oplevering	Montferland	Gelderland	Onbekend					106			200	25	0.400	0.24	Ja	Nee	Relatie object 18a,c-d	5	5	2	0	12		21	86.0	0.81
18c	24/06/14	2014	Rond oplevering	Montferland	Gelderland	Onbekend					106			200	19	0.400	0.18	Ja	Nee	Relatie object 18a-b,d	5	5	1	0	11		18	57.0	0.54
18d	24/06/14	2014	Rond oplevering	Montferland	Gelderland	Onbekend					112.6			200	20	0.400	0.18	Ja	Nee	Relatie object 18a-c	4	4	1	0	9		15	69.5	0.62
19	01/05/14	2014	Tijdens bouw	Montferland	Gelderland	Rijtjeswoning			Kap		106			200	178	0.400	1.68	Ja	Nee	Relatie object 18, hoge waardes luchtdoorlatendheid en qv,10 gemeten	1	4	3	1	9		22	442.5	4.17
20b	07/04/14	2014		Midden-Delfland	Zuid-Holland	Onbekend					126.3			200	36	0.550	0.29	Ja	Nee	Relatie object 20a, foto van woning ontbreekt	4	7	3	0	14		27	110.5	0.87
20a	07/04/14	2014		Midden-Delfland	Zuid-Holland	Onbekend					118.5			200	39	0.630	0.33	Ja	Nee	Relatie object 20b, foto van woning ontbreekt	1	2	3	0	6		14	113.0	0.95

21a	11/07/14	2014	Tijdens bouw	Arnhem	Gelderland	Onbekend					97.3			200	64.5	0.400	0.66	Ja	Nee	Relatie object 21a, waardes veel minder hoog dan woning 19, terwijl beide tijdens bouw zijn	1	2	2	0	5		11	183.0	1.88
21b	11/07/14	2014	Tijdens bouw	Arnhem	Gelderland	Onbekend					131.1			200	73	0.400	0.56	Ja	Nee	Relatie object 21b, waardes veel minder hoog dan woning 19, terwijl beide tijdens bouw zijn					0	NO INFO	0	195.0	1.49
22a	10/09/14	2014	Rond opleving	Loppersum	Groningen	Appartement			Kap		109.2			200	97	0.46	0.89	Ja	Nee	Relatie object 22a-e	1	8	1	1	11		24	265.5	2.43
22b	10/09/14	2014	Rond opleving	Loppersum	Groningen	Appartement			Kap		74.8			200	18.5	0.420	0.25	Ja	Nee	Relatie object 22a-e	0	2	1	1	4		11	53.0	0.71
22c	10/09/14	2014	Rond opleving	Loppersum	Groningen	Appartement			Kap		48.8			200	11	0.420	0.23	Ja	Nee	Relatie object 22a-e, klein vloeroppervlak	2	2	1	0	5		9	33.5	0.69
22d	10/09/14	2014	Rond opleving	Loppersum	Groningen	Appartement			Kap		48.8			200	13.5	0.390	0.28	Ja	Nee	Relatie object 22a-e, klein vloeroppervlak	1	2	0	0	3		5	38.5	0.79
22e	10/09/14	2014	Rond opleving	Loppersum	Groningen	Appartement			Kap		74.8			200	30.5	0.390	0.41	Ja	Nee	Relatie object 22a-e	1	6	0	1	8		17	87.0	1.16
23a	25/09/14	2014	Rond opleving	Aalsmeer	Noord-Holland	Twee onder één kap			Kap		203			200	87.5	0.625	0.43	Ja	Nee	Relatie object 23b	2	8	5	2	17		41	269.0	1.33
23b	25/09/14	2014	Rond opleving	Aalsmeer	Noord-Holland	Hoekwoning			Kap		210.9			200	79	0.625	0.37	Ja	Nee	relatie object 23a	4	8	2	1	15		30	220.0	1.04
24a	02/10/14	2014	Rond opleving	Ede	Gelderland	Vrijstaande woning			Kap		127.2			200	25.5		0.20	Ja	Nee	Relatie object 24ab-c	9	6	0	0	15		21	78.5	0.62
24b	02/10/14	2014	Rond opleving	Ede	Gelderland	Vrijstaande woning			Kap		103			200	29.5		0.29	Ja	Nee	Relatie object 24ab-c	3	5	2	0	10		19	93.5	0.91
24c	02/10/14	2014	Rond opleving	Ede	Gelderland	Rijtjeswoning			Kap		164			200	37		0.23	Ja	Nee	Relatie object 24ab-c	9	3	0	0	12		15	117.0	0.71
25	09/04/14	2014	Rond opleving	Utrecht	Utrecht	Onbekend	Onbekend	Onbekend	Onbekend		130.5	Waarde uit EPC		200	34	0.400	0.26	Ja	Nee		5	6	1	0	12		20	107.0	0.82
26a	21/05/14	2014	Rond opleving	Dongen	Noord-Brabant	Hoekwoning	Bouwplaats	Metselwerk	Kap		101.1	Waarde uit EPC		200	28.5	0.625	0.28	Ja	Nee		4	0	1	1	6		11	83.5	0.83
26b	21/05/14	2014	Rond opleving	Dongen	Noord-Brabant	Onbekend	Bouwplaats	Metselwerk	Kap		144.7	Waarde uit EPC		200	25.5	0.625	0.18	Ja	Nee		2	2	0	0	4		6	79.5	0.55
27a	02/10/14	2014	Rond opleving	Sliedrecht	Zuid-Holland	Appartement	Bouwplaats	Metselwerk	Platdak		82	Waarde uit EPC		200	9		0.11	Ja	Nee	let wel toegestane luchtdoorlatendheid geldt voor heel gebouw, dus niet alleen dit appartement	4	4	1	0	9		15	29.0	0.35
27b	02/10/14	2014	Rond opleving	Sliedrecht	Zuid-Holland	Appartement	Bouwplaats	Metselwerk	Platdak		103	Waarde uit EPC		200	8		0.08	Ja	Nee	let wel toegestane luchtdoorlatendheid geldt voor heel gebouw, dus niet alleen dit appartement	2	4	1	4	11		29	24.5	0.24
27c	02/10/14	2014	Rond opleving	Sliedrecht	Zuid-Holland	Appartement	Bouwplaats	Metselwerk	Platdak		135	Waarde uit EPC		200	18		0.13	Ja	Nee	let wel toegestane luchtdoorlatendheid geldt voor heel gebouw, dus niet alleen dit appartement	2	5	5	0	12		27	55.0	0.41
28	13/06/14	2014	Rond opleving	Halderberge	Noord-Brabant	Twee onder één kap	Bouwplaats	Metselwerk	Kap		126	Waarde uit EPC		200	31.5	0.625	0.25	Ja	Nee		6	4	5	0	15		29	100.5	0.80
29	02/04/14	2014	Rond opleving	Sint-Michielsgestel	Noord-Brabant	Hoekwoning	Bouwplaats	Metselwerk	Kap		115.4	Waarde uit EPC		200	36	0.625	0.31	Ja	Nee	relatie object 30 en 31	7	6	0	0	13		19	105.5	0.91
30	02/04/14	2014	Rond opleving	Sint-Michielsgestel	Noord-Brabant	Hoekwoning	Bouwplaats	Metselwerk	Kap		129.1	Waarde uit EPC		200	100	0.625	0.77	Ja	Nee	relatie object 29 en 31	2	8	2	2	14		32	270.5	2.10
31	02/04/14	2014	Rond opleving	Sint-Michielsgestel	Noord-Brabant	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		112.4	Waarde uit EPC		200	25	0.625	0.22	Ja	Nee	relatie object 29 en 30	1	4	0	0	5		9	78.0	0.69

32	07/05/14	2014	Rond oplevering	Oegstgeest	Noord-Holland	Rijtjeswoning	Bouwplaats	Metselwerk	kap		131.7	Waarde uit EPC		200	38	0.400	0.29	Ja	Nee		2	4	1	0	7		13	124.5	0.95
33a	04/06/14	2014	Rond oplevering	Gouda	Zuid-Holland	Hoekwoning			Kap		81.4	Waarde uit EPC		200	89.5	0.630	1.10	Ja	Nee	Relatie object 33b, q 10 gemeten hoger dan Q10 in EPC berekening	5	5	3	4	17		40	229.0	2.81
33b	04/06/14	2014	Rond oplevering	Gouda	Zuid-Holland	Rijtjeswoning			Kap		92.4	Waarde uit EPC		200	29.5	0.630	0.32	Ja	Nee	Relatie object 33a	3	7	2	0	12		23	93.5	1.01
34a	21/05/14	2014	Rond oplevering	Hulst	Zeeland	Twee onder één kap			Kap		101.3	Waarde uit EPC		200	81.5	0.630	0.80	Ja	Nee	Relatie object 34b, q 10 gemeten hoger dan Q10 in EPC berekening	2	4	5	0	11		25	224.5	2.22
34b	21/05/14	2014	Rond oplevering	Hulst	Zeeland	Twee onder één kap			Kap		101.3	Waarde uit EPC		200	68	0.630	0.67	Ja	Nee	Relatie object 34a	1	5	3	1	10		24	186.5	1.84
35	24/04/14	2014	Moment onbekend	Zeevang	Noord-Holland	Onbekend	Onbekend	Onbekend	Onbekend		195.9	Waarde uit EPC		250	237	0.630	1.21	Ja	Nee	Q10 gemeten hoger dan Q10 in EPC berekening	2	4	3	3	12		31	653.5	3.34
36a	02/05/14	2014	Rond oplevering	Putten	Gelderland	Hoekwoning	Bouwplaats	Metselwerk	Kap		148.5	Waarde uit EPC		200	69	0.400	0.46	Ja	Nee	Relatie object 36b	4	4	1	1	10		19	188.5	1.27
36b	02/05/14	2014	Rond oplevering	Putten	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		133	Waarde uit EPC		200	53	0.400	0.40	Ja	Nee	Relatie object 36a	5	4	5	1	15		32	145.0	1.09
37b	23/04/14	2014	Tijdens bouw	Oosterhout	Noord-Brabant	Onbekend	Bouwplaats	Metselwerk	Onbekend		130.5	Waarde uit EPC		200	37	0.625	0.28	Ja	Nee	Woning met maatregelen (Q waarde voldoet aan gestelde ambitie uit e EPC berekening, Relatie object 37 b	4	4	2	0	10		18	112.0	0.86
38a	02/05/14	2014	Rond oplevering	Molenwaard	Overijssel	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		124.6	Waarde uit EPC		200	58	0.625	0.47	Ja	Nee	Relatie object 38b-c	6	9	0	0	15		24	159.5	1.28
38b	02/05/14	2014	Rond oplevering	Molenwaard	Overijssel	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		136.8	Waarde uit EPC		200	53	0.625	0.39	Ja	Nee	Relatie object 38a-c	0	6	1	0	7		15	144.5	1.06
38c	02/05/14	2014	Rond oplevering	Molenwaard	Overijssel	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		136.8	Waarde uit EPC		200	68	0.625	0.50	Ja	Nee	Relatie object 38bc	0	7	3	1	11		27	184.0	1.35
39a	12/05/14	2014	Rond oplevering	Leeuwarden	Friesland	Rijtjeswoning			Kap		103	Waarde uit EPC		200	50	0.630	0.49	Ja	Nee	Relatie object 39abcd	2	9	1	0	12		23	147.5	1.43
39b	12/05/14	2014	Rond oplevering	Leeuwarden	Friesland	Hoekwoning			Kap		103	Waarde uit EPC		200	63	0.630	0.61	Ja	Nee	Relatie object 39abcd	2	7	1	2	12		27	171.5	1.67
39c	12/05/14	2014	Rond oplevering	Leeuwarden	Friesland	Rijtjeswoning			Kap		103	Waarde uit EPC		200	45	0.630	0.44	Ja	Nee	Relatie object 39abcd	0	8	2	0	10		22	114.5	1.11
39d	12/05/14	2014	Rond oplevering	Leeuwarden	Friesland	Rijtjeswoning			Kap		103	Waarde uit EPC		200	53	0.630	0.51	Ja	Nee	Relatie object 39abcd	1	8	3	0	12		26	140.5	1.36
40	25/04/14	2014	Rond oplevering	Diemen	Noord-Holland	Twee onder één kap			Kap		153	Waarde uit EPC		200	67	0.625	0.44	Ja	Nee		4	3	4	0	11		22	192.0	1.25
41a	26/06/14	2014	Rond oplevering	Nijkerk	Gelderland	Hoekwoning	Bouwplaats	Metselwerk	Kap		130	Waarde uit EPC		200	88	0.625	0.68	Ja	Nee	Relatie object 41b	4	10	2	1	17		34	249.5	1.92
41b	26/06/14	2014	Rond oplevering	Nijkerk	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		119	Waarde uit EPC		200	62.5	0.625	0.53	Ja	Nee	Relatie object 41a	6	9	0	1	16		28	171.5	1.44
42	01/10/14		Moment onbekend	Den Haag	Zuid-Holland	Duplexwoning			Platdak		126.9	Waarde uit EPC		200	22	0.625	0.17	Ja	Nee		4	1	1	0	6		9	72.5	0.57
43	15/05/14	2014	Rond oplevering	Nuth	Limburg	Onbekend	Bouwplaats	Metselwerk	Onbekend		79.3	Waarde uit EPC		200	16	0.400	0.20	Ja	Nee	Relatie object 44	3	3	0	0	6		9	46.0	0.58
44	15/05/14	2014	Moment onbekend	Nuth	Limburg	Onbekend	Onbekend	Onbekend	Onbekend		83.7	Waarde uit EPC		200	38	0.400	0.45	Ja	Nee	Relatie object 43	2	10	0	1	13		26	108.5	1.30
45a	27/06/14	2014	Tijdens bewoning	Zuidplas	Zuid-Holland	Vrijstaande woning	Bouwplaats		Kap		233.6	Waarde uit EPC		200	134	0.790	0.57	Ja	Nee	Luiken knieschotten en zolder niet afgeplakt (standaardmeting)	2	2	3	0	7		15	324.5	1.39
46a	14/05/14	2014	Rond opleve	Olst-Wijhe	Overijssel	Rijtjeswoning			Kap		117.2	Waarde uit EPC		200	90.5	0.400	0.77	Ja	Nee	Relatie object 46b, 47ab, 48	3	3	5	1	12		28	236.5	2.02

			ring																										
46b	14/05/14	2014	Rondoplevering	Olst-Wijhe	Overijssel	Rijtjeswoning			Platdak		91	Waarde uit EPC		200	52.5	0.400	0.58	Ja	Nee	Relatie object 46a, 47ab, 48	2	3	7	1	13		33	143.0	1.57
47a	14/05/14	2014	Moment onbekend	Olst-Wijhe	Overijssel	Appartement			Platdak		97	Waarde uit EPC		200	14.5	0.420	0.15	Ja	Nee	Relatie object 47b en 46ab, 48	6	0	1	0	7		9	43.0	0.44
47b	14/05/14	2014	Moment onbekend	Olst-Wijhe	Overijssel	Rijtjeswoning			Kap		94	Waarde uit EPC		200	18.5	0.420	0.20	Ja	Nee	Relatie object 47a en 46ab, 48	5	0	0	0	5		5	52.0	0.55
48a	16/05/14	2014	Moment onbekend	Olst-Wijhe	Overijssel	Appartement			Kap		80	Waarde uit EPC		200	34.5	0.400	0.43	Ja	Nee	Relatie object 47 en 48abcde	1	3	3	1	8		20	97.5	1.22
48b	16/05/14	2014	Moment onbekend	Olst-Wijhe	Overijssel	Appartement			Platdak		82	Waarde uit EPC		200	29.5	40.000	0.36	Ja	Nee	Relatie object 47 en 48abcde, waarde Q10 gemeten veel hoger dan QEPC berekening	2	5	0	0	7		12	84.5	1.03
48c	16/05/14	2014	Moment onbekend	Olst-Wijhe	Overijssel	Appartement			Platdak		80	Waarde uit EPC		200	94.5	0.400	1.18	Ja	Nee	Relatie object 47 en 48abcde	2	10	5	0	17		37	264.0	3.30
48d	16/05/14	2014	Moment onbekend	Olst-Wijhe	Overijssel	Appartement			Platdak		81	Waarde uit EPC		200	24	0.400	0.30	Ja	Nee	Relatie object 47 en 48abcde	4	4	1	0	9		15	64.5	0.80
48e	16/05/14	2014	Moment onbekend	Olst-Wijhe	Overijssel	Hoekwoning			Kap		113	Waarde uit EPC		200	74.5	0.400	0.66	Ja	Nee	Relatie object 47 en 48abcde	3	8	6	0	17		37	200.0	1.77
49	18/06/14	2014	Tijdens bewoning	Tholen	Zeeland	Hoekwoning	Bouwplaats	Metselwerk	Kap		77.6	Methode onbekend		200	152	n/a	1.96	Ja	Nee	Deze meting betreft een nulmeting, vooruitlopende op een schilrenovatie. De huidige luchtdichtheid is slecht te noemen	0	11	1	1	13		29	394.5	5.08
50a	03/07/14	2014	Rondoplevering	Almere	Flevoland	Duplexwoning	Bouwplaats	Metselwerk	Platdak		85.7	Waarde uit EPC		200	32.5	0.400	0.38	Ja	Nee	Relatie object 50abcd	3	3	0	2	8		17	102.0	1.19
50b	03/07/14	2014	Rondoplevering	Almere	Flevoland	Duplexwoning	Bouwplaats	Metselwerk	Platdak		85.7	Waarde uit EPC		200	46	0.400	0.54	Ja	Nee	Relatie object 50abcd	1	2	2	3	8		23	139.5	1.63
50c	03/07/14	2014	Rondoplevering	Almere	Flevoland	Duplexwoning	Bouwplaats	Metselwerk	Platdak		69	Waarde uit EPC		200	29	0.400	0.42	Ja	Nee	Relatie object 50abcd	2	4	1	2	9		21	92.5	1.34
50d	03/07/14	2014	Rondoplevering	Almere	Flevoland	Duplexwoning	Bouwplaats	Metselwerk	Platdak		69	Waarde uit EPC		200	35.5	0.400	0.51	Ja	Nee	Relatie object 50abcd	2	2	0	5	9		26	105.5	1.53
51	24/03/14	2014	Moment onbekend	Hendrik-Ido-Ambacht	Noord-Brabant	Onbekend	Onbekend	Onbekend	Onbekend		189	Waarde uit EPC		200	104	1.000	0.55	ja	nee		5	11	3	3	22		48	300.0	1.59
52a	02/04/14	2014	Tijdens bouw	Putten	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		127	Waarde uit EPC		200	15	0.400	0.12	Ja	Nee	Relatie object 51b	2	8	2	0	12		24	47.0	0.37
52b	02/04/14	2014	Tijdens bouw	Putten	Gelderland	Hoekwoning	Bouwplaats	Metselwerk	Kap		127	Waarde uit EPC		200	22	0.400	0.17	Ja	Nee	Relatie object 51a	2	8	2	0	12	equivalent as above	24	63.0	0.50
53	19/09/13	2013	Moment onbekend	Maasdonk	Noord-Brabant	Onbekend	Onbekend	Onbekend	Onbekend		112.4	Waarde uit EPC	n/a	200	54	0.630	0.48	Ja	Nee	Relatie object 55, 88	1	0	0	1	2		5	150.0	1.33
54	25/03/14	2014	Rondoplevering	Barneveld	Gelderland	Hoekwoning	Bouwplaats	Metselwerk	Kap		119	Waarde uit EPC		200	76	0.400	0.64	Ja	Nee		4	11	6	3	24		56	210.5	1.77
55	19/09/13	2013	Rondoplevering	Maasdonk	Noord-Brabant	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		121.4	Waarde uit EPC		200	53.5	0.630	0.44	Ja	Nee	Relatie object 53, 88	7	0	0	0	7		7	146.5	1.21
56	21/03/14	2014	Rondoplevering	Den Haag	Zuid-Holland	Hoekwoning			Kap		198	Waarde uit EPC		200	43	0.360	0.22	Ja	Nee		9	6	0	3	18		33	127.5	0.64
57	23/09/14	2014	Rondoplevering	Asten	Noord-Brabant	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		101		279	200	68	0.630	0.68	Ja	Nee	Europese meetmethode EN13829: n50-waarde 2,71 per uur	14	2	5	0	21		33	207.0	2.05

58	13/03/14	2014	Rond opleving	Alphen aan den Rijn	Zuid-Holland	Onbekend	Bouwplaats	Metselwerk	Onbekend		80	Waarde uit EPC		200	20	0.630	0.25	Ja	Nee		5	6	0	1	12		21	56.0	0.70
59	24/09/14	2014	Tijdens bouw	Dronten	Flevoland	Rijtjeswoning	Bouwplaats	Metselwerk	Onbekend		116	Methode onbekend		200	27	0.400	0.23	Ja	Nee		13	2	0	0	15		17	88.5	0.76
60	07/03/14	2014	Rond opleving	Tholen	Zeeland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		93	Waarde uit EPC		200	54	0.630	0.58	Ja	Nee	Relatie object 62	3	3	0	1	7		13	148.5	1.60
61	27/09/13	2013	Rond opleving	Zwolle	Overijssel	Rijtjeswoning	Bouwplaats	Metselwerk	Gecombineerd		125.9	Waarde uit EPC		200	68	0.625	0.54	Ja	Nee	Relatie object 63, 65, 67	3	11	3	1	18		38	189.0	1.50
62	07/03/14	2014	Rond opleving	Tholen	Zeeland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		93	Waarde uit EPC		200	25	0.630	0.27	Ja	Nee	Relatie object 60	3	7	1	1	12		24	83.0	0.89
63	27/09/13	2013	Rond opleving	Zwolle	Overijssel	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		120.9	Waarde uit EPC		200	57	0.625	0.47	Ja	Nee	Relatie object 61, 65, 67	3	9	4	1	17		37	158.5	1.31
64	10/03/14	2014	Rond opleving	Neerijnen	Gelderland	Hoekwoning	Bouwplaats	Metselwerk	Kap		102	Waarde uit EPC		200	105	0.400	1.03	Ja	Nee		5	8	5	4	22		52	301.0	2.95
65	27/09/14	2013	Rond opleving	Zwolle	Overijssel	Rijtjeswoning	Bouwplaats	Metselwerk	Gecombineerd		120.9	Waarde uit EPC		200	47	0.625	0.39	Ja	Nee	Relatie object 61, 63, 67	3	8	5	1	17		38	139.5	1.15
66	10/03/14	2014	Rond opleving	Neerijnen	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		102	Waarde uit EPC		200	94	0.400	0.92	Ja	Nee	Qv,10 van de woning voldoet niet aan de gestelde ambitie uit de EPC berekening	3	13	2	5	23		55	272.5	2.67
67	27/09/13	2013	Rond opleving	Zwolle	Overijssel	Hoekwoning	Bouwplaats	Metselwerk	Kap		125.9	Waarde uit EPC		200	53	0.625	0.42	Ja	Nee	Relatie object 61, 63, 65	0	10	3	2	15		37	182.5	1.45
68	03/03/14	2014	Rond opleving	Hengelo	Overijssel	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		126	Waarde uit EPC		200	71	0.400	0.57	ja	Nee	Relatie object 70	3	4	5	2	14		34	193.5	1.54
69	11/10/13	2013	Rond opleving	Moerdijk	Noord-Brabant	Vrijstaande woning	Bouwplaats	Metselwerk	Platdak		126	Waarde uit EPC	331	200	17	0.400	0.13	Ja	Nee	n50-waarde 0,60 per uur	6	6	0	0	12		18	54.5	0.43
70	03/03/14	2014	Rond opleving	Hengelo	Overijssel	Hoekwoning	Bouwplaats	Metselwerk	Kap		121	Waarde uit EPC		200	49	0.400	0.41	Ja	Nee	relatie object 68	3	8	6	2	19		45	139.5	1.15
71	24/10/13	2013	Rond opleving	Best	Noord-Brabant	Twee onder één kap	Bouwplaats	Metselwerk	Kap		112	Waarde uit EPC		200	124	0.700	1.10	Ja	Nee	Relatie object 73, Gemeten Q,v10 waarde is groter dan de ingevoerde waarde in de EPC-berekening	5	5	3	0	13		24	334.0	2.98
72	29/01/14	2014	Rond opleving	Nijmegen	Gelderland	Appartement	Bouwplaats	Metselwerk	Platdak		118.8			200	49	0.630	0.41	Ja	Nee	Relatie object 74, 75, 78. Gebruiksoppervlakte opgegeven door oprachtgever	6	4	2	0	12		20	130.0	1.09
73	24/10/13	2013	Rond opleving	Best	Noord-Brabant	Twee onder één kap	Bouwplaats	Metselwerk	Kap		136	Waarde uit EPC		200	157	0.700	1.16	Ja	Nee	Relatie object 71	6	4	4	0	14		26	421.0	3.10
74	29/01/14	2014	Rond opleving	Nijmegen	Gelderland	Appartement	Bouwplaats	Metselwerk	Platdak		146			200	63	0.630	0.43	Ja	Nee	Relatie object 72, 75, 78, 79. Gebruiksoppervlakte opgegeven door opdrachtgever	3	8	2	1	14		29	185.0	1.27
75	29/01/14	2014	Rond opleving	Nijmegen	Gelderland	Appartement	Bouwplaats	Metselwerk	Platdak		112.6			200	49.5	0.630	0.44	Ja	Nee	Relatie object 72, 74, 78, 79. Gebruiksoppervlakte opgegeven door opdrachtgever	3	6	1	0	10		18	141.0	1.25
76	04/12/13	2013	Rond opleving	Hardenberg	Overijssel	Appartement	Bouwplaats	Metselwerk	Kap		80	Waarde uit EPC		200	22	0.390	0.28	Ja	Nee	relatie object 77	7	2	4	0	13		23	64.5	0.81
77	04/12/13	2013	Rond opleving	Hardenberg	Overijssel	Appartement	Bouwplaats	Metselwerk	Kap		80	Waarde uit EPC		200	61	0.460	0.77	Ja	Nee	Relatie object 76	3	3	1	0	7		12	172.5	2.16
78	29/01/14	2014	Rond opleving	Nijmegen	Gelderland	Appartement	Bouwplaats	Metselwerk	Platdak		152.1			200	58	0.630	0.38	ja	nee	relatie object 72, 74, 75, 79. Gebruiksoppervlakte opgegeven door opdrachtgever	3	9	1	1	14		28	165.5	1.09
79	29/01/14	2014	Rond opleving	Nijmegen	Gelderland	Appartement	Bouwplaats	Metselwerk	Platdak		145.6			200	52	0.630	0.36	Ja	Nee	relatie object 72, 74, 75, 78. Gebruiksoppervlakte opgegeven door opdrachtgever	2	5	0	0	7		12	147.0	1.01

80	19/11/13	2013	Rond oplevering	Barendrecht	Zuid-Holland	Vrijstaande woning	Bouwplaats	Metselwerk	Kap		145	Waarde uit EPC		200	106	1.000	0.73	Ja	Nee		3	9	2	0	14		27	287.0	1.98
81	04/02/14	2014	Moment onbekend	Moerdijk	Noord-Brabant	Onbekend	Onbekend	Onbekend	Onbekend		95	Waarde uit EPC		200	8	0.400	0.08	ja	nee	Qv,10 gemeten zeer laag	7	8	0	0	15		23	32.0	0.34
82	19/11/13	2013	Rond oplevering	Wijk bij Duurstede	Utrecht	Vrijstaande woning	Bouwplaats	Metselwerk	Kap		154	Waarde uit EPC		200	28	0.630	0.18	Ja	Nee		1	6	0	0	7		13	91.5	0.59
83b	23/01/14	2014	Rond oplevering	Oost Gelre	Gelderland	Twee onder één kap	Bouwplaats	Metselwerk	Gecombineerd		113	Waarde uit EPC		200	42	0.625	0.37	Ja	Nee	Relatie object 83a, 85. Tweede meting (na het afdichten van enkele gevonden gaten)	4	8	3	0	15		29	123.0	1.09
84	03/12/13	2013	Rond oplevering	Nijkerk	Gelderland	Hoekwoning	Bouwplaats	Metselwerk	Kap		125	Waarde uit EPC		200	45	0.630	0.36	Ja	Nee	Relatie object 89	3	5	1	0	9		16	132.0	1.06
85	23/01/14	2014	Rond oplevering	Oost Gelre	Gelderland	Twee onder één kap	Bouwplaats	Metselwerk	Gecombineerd		113	Waarde uit EPC		200	49	0.625	0.43	Ja	Nee	relatie object 83	3	5	1	0	9		16	143.0	1.27
86	05/12/13	2013	Rond oplevering	Moerdijk	Noord-Brabant	Twee onder één kap	Bouwplaats	Metselwerk	Kap		111	Waarde uit EPC		200	19	0.630	0.17	Ja	Nee		2	8	3	0	13		27	78.0	0.70
87a	14/04/14	2014	Rond oplevering	Hendrik-Ido-Ambacht	Zuid-Holland	Onbekend	Onbekend	Onbekend	Onbekend		188.9	Waarde uit EPC		200	63	1.000	0.33	ja	nee	Relatie object 87b	1	2	0	0	3		5	174.5	0.92
87b	14/04/14	2014	Rond oplevering	Hendrik-Ido-Ambacht	Zuid-Holland	Onbekend	Onbekend	Onbekend	Onbekend		151.8	Waarde uit EPC		200	69	1.000	0.45	Ja	Nee	relatie object 87a	4	10	5	0	19		39	198.0	1.30
88	19/09/13	2013	Rond oplevering	Maasdonk	Noord-Brabant	Hoekwoning	Bouwplaats	Metselwerk	Kap		125.3	Waarde uit EPC	n/a	200	147	0.630	1.17	Ja	Nee	relatie object 53, 55, gemeten qv,10 groter dan ingevoerde waarde in EPC-berekening	10	0	0	0	10	NO INFO	10	380.0	3.03
89	03/12/13	2013	Rond oplevering	Nijkerk	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		88	Waarde uit EPC		200	41	0.630	0.47	Ja	nee	relatie object 84	2	2	1	0	5		9	110.5	1.26
90a	26/03/14	2014	Rond oplevering	Hoogezand-Sappemeer	Groningen	Onbekend	Bouwplaats	Metselwerk	Platdak		87.4	Waarde uit EPC		200	29	0.400	0.33	ja	Nee	relatie object 90bcd	3	8			11	NO INFO	19	91.5	1.05
90b	26/03/14	2014	Rond oplevering	Hoogezand-Sappemeer	Groningen	Onbekend	Bouwplaats	Metselwerk	Platdak		87.4	Waarde uit EPC		200	28	0.400	0.32	Ja	Nee	relatie object 90acd					0	NO INFO	0	85.0	0.97
90c	26/03/14	2014	Rond oplevering	Hoogezand-Sappemeer	Groningen	Onbekend	Bouwplaats	Metselwerk	Platdak		93.1	Waarde uit EPC		200	37	0.400	0.40	Ja	Nee	Relatie object 90abd					0	NO INFO	0	122.5	1.32
90d	26/03/14	2014	Rond oplevering	Hoogezand-Sappemeer	Groningen	Onbekend	Bouwplaats	Metselwerk	Platdak		93.1	Waarde uit EPC		200	36	0.400	0.39	Ja	Nee	relatie object 90abc					0	NO INFO	0	113.0	1.21
101a	25/02/14	2014	Tijdens bewoning	Dongen	Noord-Brabant	Vrijstaande woning	Bouwplaats	Metselwerk	Kap		262			200	258	0.400	1.126	ja	nee	relatie object 101bc	4	5	4	0	13		26	787.4	3.01
101b	25/02/14	2014	Tijdens bewoning	Dongen	Noord-Brabant	Vrijstaande woning	Bouwplaats	Metselwerk	Kap		262			200	233	0.400	1.014	ja	nee	relatie object 101ac	2	3	4	0	9		20	708.1	2.70
101c	25/02/14	2014	Tijdens bewoning	Dongen	Noord-Brabant	Vrijstaande woning	Bouwplaats	Metselwerk	Kap		188			200	85	0.400	0.455	ja	nee	relatie object 101ab	7	7	1	0	15		24	224.4	1.19
102a	03/02/14	2014	Rond oplevering	Utrecht	Utrecht	Hoekwoning	Bouwplaats	Metselwerk	Kap		111.1		300	200	45	0.625	0.405	ja	nee	relatie object 102b; relatie 104	11	5	1	0	17		24	130.4	1.17
102b	03/02/14	2014	Rond oplevering	Utrecht	Utrecht	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		111.1		300	200	36.7	0.625	0.330	ja	nee	relatieobject 102a; relatie 104	0	0	0	0	0		0	111.0	1.00
103a	28/05/14	2014	Rond oplevering	Rijssen-Holten	Overijsel	Hoekwoning	Bouwplaats	Metselwerk	Gecombineerd		121.2	Waarde uit EPC		200	210	0.840	1.740	ja	ja	relatie object 103bcd	6	10	8	0	24		50	321.7	2.65
103b	28/05/14	2014	Rond oplevering	Rijssen-Holten	Overijsel	Rijtjeswoning	Bouwplaats	Metselwerk	Gecombineerd		121.2	Waarde uit EPC		200	154	0.700	1.270	ja	ja	relatieo object 103acd	6	10	8	0	24	equivalent as above	50	419.0	3.46
103c	28/05/14	2014	Rond oplevering	Rijssen-Holten	Overijsel	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		117.8	Waarde uit EPC		200	91	0.700	0.780	ja	ja	relatie object 103abd	8	12	5	0	25		47	243.6	2.07
103d	28/05/14	2014	Rond oplevering	Rijssen-Holten	Overijsel	Hoekwoning	Bouwplaats	Metselwerk	Kap		123.9	Waarde uit EPC		200	89	0.840	0.720	ja	ja	relatie object 103abc	8	12	5	0	25	equivalent as above	47	254.8	2.06
104a	15/04/14	2014		Utrecht	Utrecht	Appartement	Bouwplaats	Metselwerk	Platdak		78.6		206	200	18.9	0.625	0.241	ja	nee	relatie object 104b, 102	9	10	0	0	19		29	59.4	0.76
104b	15/04/14	2014		Utrecht	Utrecht	Appartement	Bouwplaats	Metselwerk	Platdak		83.5		219	200	25.3	0.625	0.303	ja	nee	relatie object 104a, 102	9	10	0	0	19	equivalent as above	29	69.5	0.83

105a	23/07/14	2014	Rond oplevering	Hattem	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Lessenaar		104	Waarde uit EPC		200	31.9	0.400	0.310	ja	nee	relatie object 105abcd	7	11	0	0	18		29	92.0	0.89
105b	23/07/14	2014	Rond oplevering	Hattem	Gelderland	Hoekwoning	Bouwplaats	Metselwerk	Lessenaar		104	Waarde uit EPC		200	29.4	0.400	0.280	ja	nee	relatie object 105abcd	7	11	0	0	18	equivalent as above	29	86.5	0.83
105c	23/07/14	2014	Rond oplevering	Hattem	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Lessenaar		104	Waarde uit EPC		200	32.5	0.400	0.310	ja	nee	relatie object 105abcd	7	11	0	0	18	equivalent as above	29	93.7	0.90
105d	23/07/14	2014	Rond oplevering	Hattem	Gelderland	Hoekwoning	Bouwplaats	Metselwerk	Lessenaar		104	Waarde uit EPC		200	21.6	0.400	0.210	ja	nee	relatie object 105abcd	7	11	0	0	18	equivalent as above	29	62.8	0.60
106a	25/06/14	2014		Arnhem	Gelderland	Hoekwoning	Bouwplaats	Metselwerk	Kap		113.5		300	200	30.7	0.625	0.270	ja	nee	relatie object 106b	5	6	0	0	11		17	89.3	0.79
106b	25/06/14	2014		Arnhem	Gelderland	Hoekwoning	Bouwplaats	Metselwerk	Platdak		113.5		300	200	35	0.625	0.314	ja	nee	relatie object 106a	5	6	0	0	11	equivalent as above	17	91.9	0.81
107e	02/10/14	2014	Tijdens bewoning	Winterswijk	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		88.7				241		2.718	ja	nee	relatie object 107abcd (na renovatie)	1	14	7	0	22		50	667.0	7.52
107f	02/10/14	2014	Tijdens bewoning	Winterswijk	Gelderland	Hoekwoning	Bouwplaats	Metselwerk	Kap		77.5				244		3.148	ja	nee	relatie object 107abcd (na renovatie)	1	17	4	0	22		47	658.8	8.50
108a	10/06/14	2014	Rond oplevering			Rijtjeswoning	Prefab	Beton	Platdak		134.8	Waarde uit EPC		200	80	0.490	0.600	ja	nee	relatie object 108b	8	11	10	0	29		60	227.2	1.69
108b	10/06/14	2014	Rond oplevering			Hoekwoning	Prefab	Beton	Platdak		134.8	Waarde uit EPC		200	80	0.590	0.590	ja	nee	relatie object 108a	8	11	10	0	29	equivalent as above	60	236.0	1.75
108c	10/06/14	2014	Rond oplevering			Hoekwoning	Prefab	Beton	Platdak		134.8	Waarde uit EPC		200	69	0.590	0.510	ja	nee		9	10	10	0	29		59	197.8	1.47
108d	10/06/14	2014	Rond oplevering			Rijtjeswoning	Prefab	Beton	Platdak		134.8	Waarde uit EPC		200	57	0.490	0.430	ja	nee		9	10	10	0	29	equivalent as above	59	178.1	1.32
109a	16/07/14	2014	Rond oplevering	Deventer	Overijssel	Twee onder één kap	Prefab	Beton	Kap		120.4		>500	200	68	0.630	0.568	ja	nee		6	6	3	0	15		27	51.7	0.43
109b	16/07/14	2014	Rond oplevering	Deventer	Overijssel	Twee onder één kap	Prefab	Beton	Kap		151.7		>500	200	45	0.630	0.294	ja	nee		8	1	1	0	10		13	36.0	0.24
110a	02/09/14	2014	Rond oplevering	Rijssen-Holten	Overijssel	Rijtjeswoning	Prefab	Beton	Kap		109.4	Waarde uit EPC		200	63.9	0.700	0.580	ja	nee	incl plattegrond van woning	6	17	7	0	30		61	190.5	1.74
110b	02/09/14	2014	Rond oplevering	Rijssen-Holten	Overijssel	Hoekwoning	Prefab	Beton	Kap		121.6	Waarde uit EPC		200	65.4	0.840	0.540	ja	nee	incl plattegrond van woning	7	13	11	0	31		66	202.0	1.66
111a	28/02/12	2012	Moment onbekend	Nijkerk	Gelderland	Twee onder één kap	Bouwplaats	Metselwerk	Lessenaar		182.5		435	200	177.1	1.000	1.170	ja	ja	incl plattegrond van woning, geen fotos van gehele woning	10	17	11	0	38		77	534.3	2.93
111b	28/02/12	2012	Moment onbekend	Nijkerk	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Lessenaar		170		365	200	124.4	0.625	0.960	ja	ja	incl plattegrond van woning, geen fotos van gehele woning	12	16	7	0	35		65	393.4	2.31
111c	28/02/12	2012	Moment onbekend	Nijkerk	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Lessenaar		102.5		324	200	161	0.625	1.500	ja	ja	incl plattegrond van woning, geen fotos van gehele woning	3	12	9	0	24		54	466.2	4.55
112a	09/12/13	2013	Tijdens bewoning	Amsterdam	Noord-Holland	Appartement	Bouwplaats	Metselwerk	Platdak		61.1		160	200	89.6	nvt	1.470	ja	nee	incl plattegrond van woning	7	11	4	0	22		41	241.0	3.94
112b	09/12/13	2013	Tijdens bewoning	Amsterdam	Noord-Holland	Appartement	Bouwplaats	Metselwerk	Platdak		58.8		155	200	59.7	nvt	1.020	ja	nee	incl plattegrond van woning	7	11	4	0	22		41	157.5	2.68
112c	09/12/13	2013	Tijdens bewoning	Amsterdam	Noord-Holland	Appartement	Bouwplaats	Metselwerk	Platdak		61.1		160	200	79.2	nvt	1.300	ja	nee	incl plattegrond van woning	7	11	4	0	22	equivalent as above	41	218.5	3.58
113	11/04/13	2013	Moment onbekend	Amsterdam	Noord-Holland	Appartement	Bouwplaats	Metselwerk	Platdak		58.6		158.2	200	153.1	nvt	2.610	ja	nee	incl plattegrond van woning, geen fotos van gehele woning	6	12	8	0	26		54	433.6	7.40
114a	20/08/13	2013	Tijdens bewoning	Amsterdam	Noord-Holland	Appartement	Bouwplaats	Metselwerk	Platdak		57.9		153.5	200	57.2	nvt	0.990	ja	nee	incl plattegrond van woning	14	16	1	0	31		49	149.8	2.59
114b	20/08/13	2013	Tijdens bewoning	Amsterdam	Noord-Holland	Appartement	Bouwplaats	Metselwerk	Platdak		57.9		153.5	200	74.9	nvt	1.290	ja	nee	incl plattegrond van woning	14	16	1	0	31		49	187.8	3.24
114c	20/08/13	2013	Tijdens bewoning	Amsterdam	Noord-Holland	Appartement	Bouwplaats	Metselwerk	Platdak		64		169.5	200	95.6	nvt	1.490	ja	nee	incl plattegrond van woning	14	16	1	0	31	equivalent as above	49	258.8	4.04

115	29/10/12	2012				Rijtjeswoning	Bouwplaats	Metselwerk	Kap		35.3		124.1	200	58	0.400	0.400	ja	nee	geen fotos van gehele woning	8	1	2	0	11		16	162.6	4.61
117a	13/11/12	2012	Rond opleving	Nijkerk	Gelderland	Twee onder één kap	Bouwplaats	Metselwerk	Kap		168		416	200	98.6	0.625	0.587	ja	nee		9	14	8	0	31		61	274.5	1.63
117b	13/11/12	2012	Rond opleving	Nijkerk	Gelderland	Twee onder één kap	Bouwplaats	Metselwerk	Kap		205.8		515	200	103.4	0.625	0.518	ja	nee		9	14	8	0	31	equivalent as above	61	293.8	1.43
118a	14/02/13	2013	Rond opleving	Nijkerk	Gelderland	Twee onder één kap	Bouwplaats	Metselwerk	Kap		178.4		462.5	200	95.8	0.625	0.559	ja	nee	incl plattegrond van woning	22	15	8	0	45		76	294.1	1.65
118b	14/02/13	2013	Rond opleving	Nijkerk	Gelderland	Twee onder één kap	Bouwplaats	Metselwerk	Kap		171.5		444	200	72.8	0.625	0.408	ja	nee	incl plattegrond van woning	22	15	8	0	45	equivalent as above	76	275.3	1.61
119a	17/10/13	2013	Moment onbekend	Velsen	Gelderland	Rijtjeswoning	Bouwplaats	Beton	Platdak		111			200	22	0.400	0.202	ja	nee	incl plattegrond van woning, geen fotos van gehele woning	3	3	1	1	8		16	64.7	0.58
119b	17/10/13	2013	Moment onbekend	Velsen	Gelderland	Rijtjeswoning	Bouwplaats	Beton	Platdak		122			200	20	0.400	0.166	ja	nee	incl plattegrond van woning, geen fotos van gehele woning	3	3	1	1	8	equivalent as above	16	61.5	0.50
120a	21/11/13	2013		Haarlem	Noord-Holland	Rijtjeswoning	Bouwplaats	Metselwerk	Platdak		157.9			200	33	0.400	0.207	ja	nee	incl plattegrond van woning en kwaliteitscontrole, geen fotos gehele woning	6	6	1	0	13		21	95.4	0.60
120b	21/11/13	2013		Haarlem	Noord-Holland	Rijtjeswoning	Bouwplaats	Metselwerk	Platdak		131			200	22	0.400	0.167	ja	nee	incl plattegrond van woning en kwaliteitscontrole, geen fotos gehele woning	4	5	1	0	10		17	66.3	0.51
121	24/01/14	2014		Haarlem	Noord-Holland	Rijtjeswoning	Bouwplaats	Metselwerk	Platdak		106.6			200	14	0.400	0.135	ja	nee	incl plattegrond van woning en kwaliteitscontrole, geen fotos gehele woning	7	3	0	0	10		13	40.4	0.38
122a	14/04/14	2014		Haarlem	Noord-Holland	Appartement	Prefab	Beton	Platdak		74.7			200	22	0.400	0.295	nee	nee		1				1	NO INFO	1	45.3	0.61
122b	14/04/14	2014		Haarlem	Noord-Holland	Appartement	Prefab	Beton	Platdak		179.7			200	26	0.400	0.146	ja	nee	maar 1 luchtlekkage foto	1				1	NO INFO	1	101.6	0.57
122c	14/04/14	2014		Haarlem	Noord-Holland	Appartement	Prefab	Beton	Platdak		202.8			200	35	0.400	0.174	ja	nee	maar 1 luchtlekkage foto	1				1	NO INFO	1	90.4	0.45
123a	15/02/13	2013	Rond opleving	Boxmeer	Noord-Brabant	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		114.9		332.4	200	76.7	0.625	0.667	ja	nee	incl plattegrond van woning, relatie 124	11	2	1	0	14		18	186.2	1.62
123b	15/02/13	2013	Rond opleving	Boxmeer	Noord-Brabant	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		125.3		417	200	91	0.625	0.726	ja	nee	incl plattegrond van woning, relatie 124	12	1	3	0	16		23	238.9	1.91
125a	27/02/13	2013		Boxmeer	Noord-Brabant	Appartement	Bouwplaats	Metselwerk	Kap		67		176	200	35.8	0.625	0.535	ja	nee	b.g., geen fotos gehele woning	9	7	2	0	18		29	97.6	1.46
125b	27/03/13	2013		Boxmeer	Noord-Brabant	Appartement	Bouwplaats	Metselwerk	Kap		67		176	200	36.5	0.625	0.545	ja	nee	1e verdieping, geen fotos gehele woning	8	6	2	0	16		26	97.8	1.46
125c	27/03/13	2013		Boxmeer	Noord-Brabant	Appartement	Bouwplaats	Metselwerk	Kap		65.5		172	200	22.6	0.625	0.346	ja	nee	1e verdieping, geen fotos gehele woning	8	7	2	0	17		28	61.8	0.94
125d	27/03/13	2013		Boxmeer	Noord-Brabant	Appartement	Bouwplaats	Metselwerk	Kap		132.5		340	200	100.7	0.625	0.760	ja	nee	2e en 3e verdieping (luchtdoorlatendheid en qv,10,kar veel hoger dan 125abc,geen fotos gehele woning	10	8	5	0	23		41	281.1	2.12
126a	09/09/14	2014		Beverwijk	Noord-Holland	Hoekwoning	Bouwplaats	Metselwerk	Kap		111.8	Waarde uit EPC	310	200	60.9	0.400	0.544	ja	nee		6	9	6	0	21		42	169.1	1.51
126b	09/09/14	2014		Beverwijk	Noord-Holland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		106.9	Waarde uit EPC	300	200	50.1	0.400	0.469	ja	nee		4	7	5	0	16		33	139.8	1.31
127a	17/09/14	2014	Rond opleving	Beverwijk	Noord-Holland	Hoekwoning	Bouwplaats	Metselwerk	Kap		111.8		310	200	60.9	0.400	0.544	ja	nee	(3-9-2014) relatie 127c, plattegrond geen foto gehele woning					0	NO INFO	0	169.1	1.51
127b	17/09/14	2014	Rond opleving	Beverwijk	Noord-Holland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		106.9		300	200	50.1	0.400	0.469	ja	nee	(3-9-2014) plattegrond geen foto gehele woning					0	NO INFO	0	139.8	1.31
127c	17/09/14	2014	Rond opleving	Beverwijk	Noord-Holland	Hoekwoning	Bouwplaats	Metselwerk	Kap		111.8		310	200	44.3	0.400	0.396	ja	nee	(11-9-2014) relatie 127a plattegrond geen foto gehele woning					0	NO INFO	0	130.5	1.17
127d	17/09/14	2014	Rond opleving	Beverwijk	Noord-Holland	Hoekwoning	Bouwplaats	Metselwerk	Kap		106.9		300	200	39.2	0.400	0.367	ja	nee	(11-9-2014) plattegrond geen foto gehele woning					0	NO INFO	0	112.6	1.05

128a	17/09/13	2013		Goeree-Overflakkee	Zeeland	Hoekwoning	Prefab	Beton	Kap		153		340	200	63	0.840	0.416	ja	nee	incl plattegrond van woning geen fotos gehele woning	3	3	2	0	8		15	169.8	1.11
128b	17/09/13	2013		Goeree-Overflakkee	Zeeland	Rijtjeswoning	Prefab	Beton	Kap		153		300	200	41	0.700	0.363	ja	nee	incl plattegrond van woning geen fotos gehele woning	3	3	2	0	8		15	101.1	0.66
128c	17/09/13	2013		Goeree-Overflakkee	Zeeland	Rijtjeswoning	Prefab	Beton	Kap		148		340	200	45	0.700	0.370	ja	nee	incl plattegrond van woning geen fotos gehele woning	3	3	2	0	8	equivalent as above	15	132.5	0.90
129a	21/05/13	2013		Wageningen	Gelderland	Appartement	Bouwplaats	Beton	Platdak		58.5		155	200	44.2	0.625	0.756	ja	nee	incl plattegrond van woning geen fotos gehele woning	12	11	0	0	23		34	128.7	2.20
129b	21/05/13	2013		Wageningen	Gelderland	Appartement	Bouwplaats	Beton	Platdak		58.5		155	200	22.7	0.625	0.389	ja	nee	incl plattegrond van woning geen fotos gehele woning	12	8	0	0	20		28	71.1	1.22
131a	14/05/13	2013	Rond opleve ring	Nijmegen	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		126.5	Methode onbekend	336.9	200	71.8	0.625	0.568	Ja	Nee	3 woningen gemeten uit project van 36 woningen	16	11	4	0	31		50	188.9	1.49
131b	14/05/13	2013	Rond opleve ring	Nijmegen	Gelderland	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		126.5	Methode onbekend	336.9	200	43.2	0.625	0.341	Ja	Nee	3 woningen gemeten uit project van 36 woningen	12	7	0	0	19		26	148.6	1.17
131c	14/05/13	2013	Rond opleve ring	Nijmegen	Gelderland	Hoekwoning	Bouwplaats	Metselwerk	Kap		126.5	Methode onbekend	336.9	200	73.8	0.625	0.583	Ja	Nee	3 woningen gemeten uit project van 36 woningen	12	6	3	0	21		33	200.8	1.59
132a	23/01/14	2014	Rond opleve ring	Landsmeer	Noord-Holland	Appartement	Onbekend	Metselwerk	Kap		99.9			200	19	0.625	0.187	Nee	Nee	Complex 1: 4 vd XX woningen gemeten					0	NO INFO	0	49.4	0.49
132b	23/01/14	2014	Rond opleve ring	Landsmeer	Noord-Holland	Appartement	Onbekend	Metselwerk	Kap		76.7			200	86	0.625	1.115	Nee	Nee	Complex 1: 4 vd XX woningen gemeten			1		1	NO INFO	3	220.7	2.88
132c	23/01/14	2014	Rond opleve ring	Landsmeer	Noord-Holland	Appartement	Onbekend	Metselwerk	Kap		51.6			200	6	0.625	0.124	Nee	Nee	Complex 1: 4 vd XX woningen gemeten					0	NO INFO	0	20.6	0.40
132d	23/01/14	2014	Rond opleve ring	Landsmeer	Noord-Holland	Appartement	Onbekend	Metselwerk	Kap		78.8			200	9	0.625	0.107	Nee	Nee	Complex 1: 4 vd XX woningen gemeten					0	NO INFO	0	24.5	0.31
132e	03/02/14	2014	Rond opleve ring	Landsmeer	Noord-Holland	Appartement	Onbekend	Metselwerk	Kap		62.7			200	20	1.000	0.318	Nee	Nee	Complex 2: 4 vd 19 woningen gemeten					0	NO INFO	0	56.0	0.89
132f	03/02/14	2014	Rond opleve ring	Landsmeer	Noord-Holland	Appartement	Onbekend	Metselwerk	Kap		60.6			200	12	1.000	0.196	Nee	Nee	Complex 2: 4 vd 19 woningen gemeten					0	NO INFO	0	39.5	0.65
132g	03/02/14	2014	Rond opleve ring	Landsmeer	Noord-Holland	Appartement	Onbekend	Metselwerk	Kap		60.9			200	45	1.000	0.742	Nee	Nee	Complex 2: 4 vd 19 woningen gemeten					0	NO INFO	0	118.9	1.95
132h	03/02/14	2014	Rond opleve ring	Landsmeer	Noord-Holland	Appartement	Onbekend	Metselwerk	Kap		56.9			200	72	1.000	1.271	Nee	Nee	Complex 2: 4 vd 19 woningen gemeten					0	NO INFO	0	180.5	3.17
134	24/10/13	2013	Rond opleve ring	Rotterdam	Zuid-Holland	Twee onder één kap	Bouwplaats		Kap		226		595	238	125.28	1.000	0.555	Ja	Nee	Gemeten waarde is 125,28 dm3/s, maar deze is gecorrigeerd naar volume en gecommuniceerd als 105 dm3/s	6	4	4	1	15		30	331.7	1.47
136a	05/09/13	2013	Rond opleve ring	Haaksbergen	Overijssel	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		120.5			200	73.5	0.400	0.611	Ja	Ja	2 vd 38 woningen bemeten	2	18	8	0	28		62	214.3	1.78
136b	05/09/13	2013	Rond opleve ring	Haaksbergen	Overijssel	Rijtjeswoning	Bouwplaats	Metselwerk	Kap		120.5			200	75.6	0.400	0.627	Ja	Ja	2 vd 38 woningen bemeten	2	18	8	0	28	equivalent as above	62	204.5	1.70
137a	01/05/12	2012	Rond opleve ring	Súdwest-Fryslân	Friesland	Rijtjeswoning	Gecombineerd (50:50)	Houtskelet	Kap		106			200	38.75	0.625	0.366	Ja	Nee	2 vd 8 woningen bemeten	9	12	2	0	23		39	129.4	1.22
137b	01/05/12	2012	Rond opleve ring	Súdwest-Fryslân	Friesland	Rijtjeswoning	Gecombineerd (50:50)	Houtskelet	Kap		106			200	38.92	0.625	0.367	Ja	Nee	2 vd 8 woningen bemeten	9	12	2	0	23		39	132.7	1.25
138a	04/06/12	2012	Rond opleve ring	Ede	Gelderland	Rijtjeswoning	Bouwplaats	Beton	Kap		107.7			200	62.3	0.625	0.579	Ja	Nee	2 vd 15 woningen bemeten	12	5	3	0	20		31	59.3	0.55
138b	04/06/12	2012	Rond opleve ring	Ede	Gelderland	Hoekwoning	Bouwplaats	Beton	Kap		145.5			200	64.7	0.625	0.445	Ja	Nee	2 vd 15 woningen bemeten	12	5	3	0	20		31	64.1	0.44
139a	10/06/13	2013	Tijdens bouw	Zwolle	Overijssel	Rijtjeswoning		Metselwerk	Platdak		89.8			200	69	0.400	0.768	Ja	Nee	3 vd 61 woningen bemeten; relatie met 140	0	7	5	0	12		29	54.0	0.60

139b	10/06/13	2013	Tijdensbouw	Zwolle	Overijssel	Hoekwoning		Metselwerk	Gecombineerd		84.2			200	84.2	0.400	1.001	Ja	Nee	3 vd 61 woningen bemeten; relatie met 140	0	13	8	0	21		50	71.2	0.85
139c	10/06/13	2013	Tijdensbouw	Zwolle	Overijssel	Hoekwoning		Metselwerk	Platdak		89.8			200	32.7	0.400	0.364	Ja	Nee	3 vd 61 woningen bemeten; relatie met 140i	1	8	1	0	10		20	28.6	0.32
140a	04/10/13	2013	Rondoplevering	Zwolle	Overijssel	Rijtjeswoning		Metselwerk	Gecombineerd		118.73			200	38.6	0.400	0.325	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139					0	NO INFO	0	115.2	0.97
140b	25/09/13	2013	Rondoplevering	Zwolle	Overijssel	Rijtjeswoning		Metselwerk	Platdak		89.76			200	20.6	0.400	0.229	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139					0		0	66.4	0.74
140c	08/10/13	2013	Rondoplevering	Zwolle	Overijssel	Hoekwoning		Metselwerk	Gecombineerd		89.28			200	31	0.400	0.347	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139					0		0	93.3	1.04
140d	08/10/13	2013	Rondoplevering	Zwolle	Overijssel	Rijtjeswoning		Metselwerk	Gecombineerd		94.79			200	35.1	0.400	0.371	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139					0		0	106.9	1.13
140e	16/10/13	2013	Rondoplevering	Zwolle	Overijssel	Hoekwoning		Metselwerk	Kap		91.65			200	34.7	0.400	0.379	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139					0		0	101.5	1.11
140f	26/09/13	2013	Rondoplevering	Zwolle	Overijssel	Rijtjeswoning		Metselwerk	Gecombineerd		94.79			200	34.2	0.400	0.36	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139					0		0	106.5	1.12
140g	25/09/13	2013	Rondoplevering	Zwolle	Overijssel	Hoekwoning		Metselwerk	Platdak		89.76			200	26.3	0.400	0.293	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139					0		0	82.7	0.92
140h	26/09/13	2013	Rondoplevering	Zwolle	Overijssel	Rijtjeswoning		Metselwerk	Gecombineerd		94.79			200	34	0.400	0.359	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139					0		0	106.1	1.12
140i	26/09/13	2013	Rondoplevering	Zwolle	Overijssel	Hoekwoning		Metselwerk	Platdak		89.76			200	26.3	0.400	0.293	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139c					0		0	87.0	0.97
140j	08/10/13	2013	Rondoplevering	Zwolle	Overijssel	Rijtjeswoning		Metselwerk	Gecombineerd		94.79			200	37	0.400	0.39	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139					0		0	107.5	1.13
140k	01/10/13	2013	Rondoplevering	Zwolle	Overijssel	Rijtjeswoning		Metselwerk	Platdak		89.76			200	30.8	0.400	0.344	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139					0		0	95.2	1.06
140l	15/10/13	2013	Rondoplevering	Zwolle	Overijssel	Rijtjeswoning		Metselwerk	Gecombineerd		94.79			200	36.7	0.400	0.387	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139					0		0	110.5	1.17
140m	15/10/13	2013	Rondoplevering	Zwolle	Overijssel	Rijtjeswoning		Metselwerk	Platdak		89.76			200	22.2	0.400	0.248	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139					0		0	68.8	0.77
140n	29/10/13	2013	Rondoplevering	Zwolle	Overijssel	Rijtjeswoning		Metselwerk	Platdak		89.76			200	27.3	0.400	0.304	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139					0		0	88.3	0.98
140o	29/10/13	2013	Rondoplevering	Zwolle	Overijssel	Rijtjeswoning		Metselwerk	Platdak		89.76			200	22.7	0.400	0.253	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139					0		0	74.0	0.82
140p	29/10/13	2013	Rondoplevering	Zwolle	Overijssel	Rijtjeswoning		Metselwerk	Platdak		89.76			200	22	0.400	0.245	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139					0		0	72.4	0.81
140q	29/10/13	2013	Rondoplevering	Zwolle	Overijssel	Hoekwoning		Metselwerk	Gecombineerd		89.26			200	35.7	0.400	0.4	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139					0		0	103.7	1.16
140r	29/10/13	2013	Rondoplevering	Zwolle	Overijssel	Rijtjeswoning		Metselwerk	Platdak		89.76			200	22.9	0.400	0.255	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139					0		0	71.3	0.79
140s	29/10/13	2013	Rondoplevering	Zwolle	Overijssel	Rijtjeswoning		Metselwerk	Platdak		89.76			200	25.7	0.400	0.286	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139					0		0	76.7	0.85
140t	15/10/13	2013	Rondoplevering	Zwolle	Overijssel	Rijtjeswoning		Metselwerk	Platdak		89.76			200	32.5	0.400	0.362	Nee	Nee	20 vd 61 woningen bemeten; relatie met 139					0	NO INFO	0	97.7	1.09
141a	02/07/13	2013	Rondoplevering	Baarn	Utrecht	Duplexwoning		Metselwerk	Kap		71.2		186.5	200	28.1	N50 0,6	0.395	Ja	Nee	Passiefhuisniveau - aangesloten WTW	7	7	0	0	14		21	28.1	0.39
141b	02/07/13	2013	Rondoplevering	Baarn	Utrecht	Duplexwoning		Metselwerk	Kap		77.8		215.4	200	32.55	N50 0,6	0.418	Ja	Nee	Passiefhuisniveau - volumestroom was 17,5 dm3/s hoger met aangesloten WTW	7	7	0	0	14		21	50.7	0.65
141c	02/07/13	2013	Rondoplevering	Baarn	Utrecht	Rijtjeswoning		Metselwerk	Kap		103		284	200	5.75	N50 0,6	0.056	Ja	Nee	Passiefhuisniveau - WTW nog niet aangesloten	6	0	0	0	6		6	18.3	0.18
142	25/06/12	2013	Rondoplevering	Leeuwarden	Friesland	Rijtjeswoning		Houtskelet	Kap		156.2			200	138.5	0.625	0.887	Ja	Nee		7	18	12	0	37		79	392.5	2.51
143	18/12	2012	Rond	Zutphen	Gelderl	Rijtjeswo	Prefab	Beton	Lessenaar		119.1			200	48	0.336	0.403	Ja	Nee		0	8	1	0	9		19	142.	1.19

	/12		opleve ring		and	ning																						1	
144a	04/12 /12	1988	Tijdens bewoni ng	Nunspeet	Gelderl and	Rijtjeswo ning	Bouwplaa ts	Metselwe rk	Kap		100.2				344.8		3.443	Ja	Nee	Bestaande bouw getest	1	12	9	0	22		52	983. 1	9.81
144b	04/12 /12	1988	Tijdens bewoni ng	Nunspeet	Gelderl and	Rijtjeswo ning	Bouwplaa ts	Metselwe rk	Kap		80.8				407.2		5.041	Ja	Nee	Bestaande bouw getest; rondom afsluiten rookgasafvoer leidde tot 380,2 dm3/s	1	9	9	0	19		46	1081 .7	13.39
144c	04/12 /12	1988	Tijdens bewoni ng	Nunspeet	Gelderl and	Rijtjeswo ning	Bouwplaa ts	Metselwe rk	Kap		83.7				231.6		2.768	Ja	Nee	Bestaande bouw getest	0	4	11	0	15		41	681. 0	8.14
144d	05/12 /12	1988	Tijdens bewoni ng	Nunspeet	Gelderl and	Rijtjeswo ning	Bouwplaa ts	Metselwe rk	Kap		92.2				185.1		2.008	Ja	Nee	Bestaande bouw getest; zonder afgedicht zolderluik 459,9 dm3/s	0	10	8	0	18		44	535. 1	5.80
144e	05/12 /12	1988	Tijdens bewoni ng	Nunspeet	Gelderl and	Rijtjeswo ning	Bouwplaa ts	Metselwe rk	Kap		82.4				181.3		2.199	Ja	Nee	Bestaande bouw getest; zonder afgedicht zolderluik 688,5 dm3/s	0	14	9	0	23		55	508. 5	6.17
145	21/03 /14		Tijdens bewoni ng	Nunspeet	Gelderl and	Rijtjeswo ning	Bouwplaa ts	Metselwe rk	Kap		100.2				285.7		2.851	Ja	Nee	Bestaande bouw getest na renovatie; voor renovatie was 344,8 dm3/s	6	11	5	0	22		43	819. 3	8.18
146a	26/10 /12	2012	Rond opleve ring	Leeuwarde n	Friesla nd	Rijtjeswo ning	Gecombin eerd (50:50)	Beton	Gecombin eerd		108.2			200	79	0.625	0.729	Ja	Nee		6	11	6	0	23		46	239. 2	2.21
146b	26/10 /12	2012	Rond opleve ring	Leeuwarde n	Friesla nd	Hoekwoni ng	Gecombin eerd (50:50)	Beton	Gecombin eerd		108.2			200	63.2	0.625	0.584	Ja	Nee	Verrassend: Hoekwoning is luchtdichter dan tussenwoning	6	11	6	0	23		46	193. 6	1.79
147	07/11 /12	2012	Rond opleve ring	Smallingerl and	Friesla nd	Rijtjeswo ning	Bouwplaa ts	Metselwe rk	Kap		96.95			200	104.8	0.625	1.081	Ja	Nee		3	12	4	0	19		39	288. 6	2.98
148	16/10 /12	2012	Rond opleve ring	Smallingerl and	Friesla nd	Rijtjeswo ning		Houtskele t	Kap		116.4			200	46.1	0.625	0.396	Ja	Nee		9	7	0	0	16		23	147. 8	1.27
149	25/09 /12	2012	Tijdens bewoni ng	Haaksberge n	Overijs sel	Vrijstaan de woning	Prefab	Staalbou w	Kap		110			200	53.3	N50 0,6	0.485	Nee	Nee	Oppervlak 80,5 conform tekening of 110,0 m2 conform opdrachtgever	1				1	NO INFO	1	154. 1	1.40
150	27/03 /14	2014	Rond opleve ring	Apeldoorn	Gelderl and	Rijtjeswo ning		Metselwe rk	Kap		135			200	35	0.300	0.256	Ja	Ja	Gemiddelde van onder- en overdruk meting	10	3	0	0	13		16	112. 2	0.83
151a	23/08 /13	2013	Rond opleve ring	Zwolle	Overijs sel	Hoekwoni ng	Prefab	Beton	Kap		109			200	86.6	0.625	0.796	Ja	Ja		5	20	4	0	29		57	281. 6	2.58
151b	23/08 /13	2013	Rond opleve ring	Zwolle	Overijs sel	Rijtjeswo ning	Prefab	Beton	Kap		124			200	93.2	0.625	0.752	Ja	Ja		5	20	4	0	29		57	285. 8	2.30
151c	23/08 /13	2013	Rond opleve ring	Zwolle	Overijs sel	Rijtjeswo ning	Prefab	Beton	Kap		115.1			200	92.1	0.625	0.807	Ja	Ja		5	20	4	0	29		57	277. 1	2.41
151d	23/08 /13	2013	Rond opleve ring	Zwolle	Overijs sel	Hoekwoni ng	Prefab	Beton	Kap		121.2			200	103.7	0.625	0.856	Ja	Ja		5	20	4	0	29		57	307. 2	2.53
152a	09/10 /13	2013	Rond opleve ring	Amersfoort	Utrecht	Twee onder één kap	Bouwplaa ts	Metselwe rk	Kap		152.8			200	70.1	0.400	0.459	Ja	Nee		2	10	4	0	16		34	172. 9	1.13
152b	09/10 /13	2013	Rond opleve ring	Amersfoort	Utrecht	Twee onder één kap	Bouwplaa ts	Metselwe rk	Kap		152.8			200	76.1	0.400	0.498	Ja	Nee		2	10	4	0	16		34	185. 0	1.21
153	10/12 /13	2013	Rond opleve ring	Almere	Flevola nd	Appartem ent	Bouwplaa ts	Metselwe rk	Platdak		48.4			200	46	0.420	0.96	Ja	Nee		0	3	5	0	8		21	133. 9	2.77
154	12/04 /13		Rond opleve ring	Haaksberge n	Overijs sel	Appartem ent			Platdak		113			200	30.9		0.273	Ja	Ja	Bestaande bouw	2	20	1	0	23		45	102. 9	0.91
201	17/07 /13	2013	Rond opleve ring	Leeuwarde n	Friesla nd	Vrijstaan de woning	Bouwplaa ts	Metselwe rk	Kap		234.43			200	80.556	0.625	0.344	Nee	Nee						0	NO INFO	0	982. 3	4.19
202	20/11 /13	2013	Rond opleve ring	Apeldoorn	Gelderl and	Vrijstaan de woning	Bouwplaa ts	Metselwe rk	Kap		260			200	129	0.63	0.5	Ja	Nee		3	7	5	0	15		32	368. 2	1.42
203	07/05 /14	2014	Rond opleve ring	Zeevang	Noord-Holland	Vrijstaan de woning	Bouwplaa ts	Metselwe rk	Kap		195.9			250	237	0.63	1.21	Ja	Nee		2	4	3	3	12		31	652. 0	3.33

204	03/06/13	2013	Rondoplevering	Deventer	Overijssel	Vrijstaande woning	Bouwplaats	Metselwerk	Kap		192.7			200	100.2	0.625	0.520	Ja	Ja						0	NO INFO	0	311.3	1.62
207	12/04/12	2012	Rondoplevering	Woudrichem	Noord-Brabant	Vrijstaande woning	Bouwplaats	Metselwerk	Kap		166			200	225.6	0.625	1.359	Ja	Ja				6		6	NO INFO	18	636.2	3.83
208	15/11/12	2012	Rondoplevering	Borne	Overijssel	Rijtjeswoning			Kap		139.5		358	200	12.1	0.150	0.087	nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk					0	NO INFO	0	49.4	0.35
209	16/07/14	2014	Rondoplevering	Ede	Gelderland	Rijtjeswoning			Kap		120.1			200	34	0.400	0.282	Ja	Ja	relatie met 210; hetzelfde project. Onder- en overdrukmeting	0	8	1	0	9		19	105.5	0.88
210	16/07/14	2014	Rondoplevering	Ede	Gelderland	Hoekwoning			Kap		120.1			200	42	0.400	0.346	Ja	Ja	relatie met 209; hetzelfde project. Onder- en overdrukmeting	2	8	5	0	15		33	133.6	1.11
211a	05/07/11	2011	Tijdensbouw	Apeldoorn	Gelderland	Onbekend					92		268	200	13.21	0.150	0.14	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk					0		0	44.0	0.48
211b	05/07/11	2011	Tijdensbouw	Apeldoorn	Gelderland	Onbekend					92		268	200	13.38	0.150	0.15	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk					0		0	44.7	0.49
211c	05/07/11	2011	Tijdensbouw	Apeldoorn	Gelderland	Onbekend					92		268	200	12.59	0.150	0.14	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk					0		0	39.4	0.43
211d	05/07/11	2011	Tijdensbouw	Apeldoorn	Gelderland	Onbekend					92		268	200	12.03	0.150	0.13	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk					0		0	39.3	0.43
211e	05/07/11	2011	Tijdensbouw	Apeldoorn	Gelderland	Onbekend					92		268	200	10.5	0.150	0.11	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk					0		0	48.9	0.53
211f	05/07/11	2011	Tijdensbouw	Apeldoorn	Gelderland	Onbekend					104		300	200	14.34	0.150	0.14	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk					0		0	43.1	0.41
211g	06/07/11	2011	Tijdensbouw	Apeldoorn	Gelderland	Onbekend					104		300	200	9.04	0.150	0.09	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk					0		0	34.5	0.33
211h	06/07/11	2011	Tijdensbouw	Apeldoorn	Gelderland	Onbekend					104		300	200	13.67	0.150	0.13	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk					0		0	36.9	0.36
211i	06/07/11	2011	Tijdensbouw	Apeldoorn	Gelderland	Onbekend					104		300	200	13.08	0.150	0.13	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk					0		0	50.7	0.49
211j	06/07/11	2011	Tijdensbouw	Apeldoorn	Gelderland	Onbekend					104		300	200	15.51	0.150	0.15	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk					0		0	52.7	0.51
211k	06/07/11	2011	Tijdensbouw	Apeldoorn	Gelderland	Onbekend					104		300	200	14.98	0.150	0.14	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk					0		0	48.5	0.47
211l	06/07/11	2011	Tijdensbouw	Apeldoorn	Gelderland	Onbekend					104		300	200	15.04	0.150	0.14	Nee	Nee	De N50 waarde wordt ook gegeven in deze rapportage; passiefhuis namelijk					0	NO INFO	0	54.4	0.52
212	29/11/12	2012	Momentonbeke	Zaanstad	Noord-Holland	Onbekend			Kap		118.8		309	200	43.9		0.37	Ja	Ja	Waarde uit EP-berekening onbenoemd,					0	NO INFO	0	135.1	1.14

			nd																	misschien 0,625 l/s m2										
213	26/10 /12	2012	Moment onbekend	Renkum	Gelderland	Appartement			Platdak		83.6		223	200	47.4		0.566	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2					0	NO INFO	0	124.4	1.49
214	17/12 /12	2012	Moment onbekend	Dordrecht	Zuid-Holland	Appartement			Platdak		98		257	200	64.9		0.66	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2					0	NO INFO	0	166.1	1.69
215a	14/11 /14	2014	Tijdens bouw			Appartement			Platdak		84		221.5	200	19.4		0.23	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2					0	NO INFO	0	60.8	0.72
215b	14/11 /14	2014	Tijdens bouw			Appartement			Platdak		96		254	200	13.7		0.143	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2					0	NO INFO	0	45.3	0.47
216a	19/10 /12	2012	Rond oplevering	Tilburg	Noord-Brabant	Rijtjeswoning			Kap		129		336	200	104.6		0.81	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2					0	NO INFO	0	315.9	2.45
216b	19/10 /12	2012	Rond oplevering	Tilburg	Noord-Brabant	Hoekwoning			Platdak		133.5		352	200	63.75		0.48	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2					0	NO INFO	0	191.7	1.44
217	26/11 /12	2012	Rond oplevering	Koggenland	Noord-Holland	Twee onder één kap			Kap		141		372	200	35.97		0.25	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2					0	NO INFO	0	112.0	0.79
218a	02/11 /12	2012	Rond oplevering			Hoekwoning		Metselwerk	Kap		110.9		293	200	101.53		0.91	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2					0	NO INFO	0	262.6	2.37
218b	02/11 /12	2012	Rond oplevering			Rijtjeswoning		Metselwerk	Kap		112		293	200	78.89		0.7	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2					0	NO INFO	0	211.8	1.89
218c	02/11 /12	2012	Rond oplevering			Twee onder één kap		Metselwerk	Kap		68.7		182	200	97.36		1.416	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2					0	NO INFO	0	268.1	3.90
219	08/11 /12	2009	Tijdens bewoning	Bergen op Zoom	Noord-Brabant	Vrijstaande woning			Kap		165.3		440	200	108.1		0.653	Ja	Ja	Waarde uit EP-berekening onbenoemd, misschien 0,625 l/s m2					0	NO INFO	0	322.9	1.95
220	26/04 /12	2012	Rond oplevering	Zwolle	Overijsel	Rijtjeswoning		Metselwerk	Platdak		94.08		250	200	57	0.625	0.61	Ja	Ja	1 van de 66 woningen uit een project					0	NO INFO	0	0.0	0.00
221a	26/03 /14	2014	Rond oplevering	Hoogezand-Sappemeer	Groningen	Rijtjeswoning			Platdak		87.4			200	29	0.400	0.33	Ja	Nee	4 vd 54 woningen zijn bemeten	3	8	0	0	11		19	91.8	1.05
221b	26/03 /14	2014	Rond oplevering	Hoogezand-Sappemeer	Groningen	Rijtjeswoning			Platdak		87.4			200	28	0.400	0.32	Ja	Nee	4 vd 54 woningen zijn bemeten	3	8	0	0	11		19	84.5	0.97
221c	26/03 /14	2014	Rond oplevering	Hoogezand-Sappemeer	Groningen	Rijtjeswoning			Platdak		93.1			200	37	0.400	0.40	Ja	Nee	4 vd 54 woningen zijn bemeten	3	8	0	0	11		19	122.2	1.31
221d	26/03 /14	2014	Rond oplevering	Hoogezand-Sappemeer	Groningen	Rijtjeswoning			Platdak		93.1			200	36	0.400	0.39	Ja	Nee	4 vd 54 woningen zijn bemeten	3	8	0	0	11	equivalent as above	19	112.3	1.21
222a	02/10 /13	2013	Rond oplevering	Steenwijkerland	Overijsel	Hoekwoning			Kap		128.7			200	69.2	0.625	0.537	Ja	Nee						0	NO INFO	0	788.4	6.13
222b	02/10 /13	2013	Rond oplevering	Steenwijkerland	Overijsel	Rijtjeswoning			Kap		123.7			200	72.5	0.625	0.586	Ja	Nee						0	NO INFO	0	780.0	6.31
222c	02/10 /13	2013	Rond oplevering	Steenwijkerland	Overijsel	Rijtjeswoning			Kap		123.7			200	75.4	0.625	0.610	Ja	Nee						0	NO INFO	0	750.7	6.07

Min	05/07/11	1988		0	35.3	124.1	5.75	0.056	# Ja	276	32	**Aanwezigheid foto's**		0
Max	14/11/14	2014		0	262	595	407	5	# Nee	44	288			0
Average									% Ja	86.3%	10.0%			0
									% Nee	13.8%	90.0%			0
									Appartement	59	18.4%			
									Duplexwoning	9	2.8%			
									Hoekwoning	56	17.5%			
									Rijtjeswoning	114	35.6%			
									2^1 kap	29	9.1%			
									Vrijstaande woning	16	5.0%			
									Onbekend	37	11.6%			
										320	100.0%			
									0.15	13	4.1%			
									0.4	111	34.7%			
									0.625	75	23.4%			
										121	37.8%			