PLEIAQ

Webinar Introduction: VIP series on Building & Ductwork Airtightness

AIVC & TIGHTVENT WEBINAR

BUILDING AND DUCTWORK AIRTIGHTNESS TRENDS AND REGULATIONS IN FRANCE, BELGIUM AND GREECE

NOLWENN HUREL
PLEIAQ/INIVE

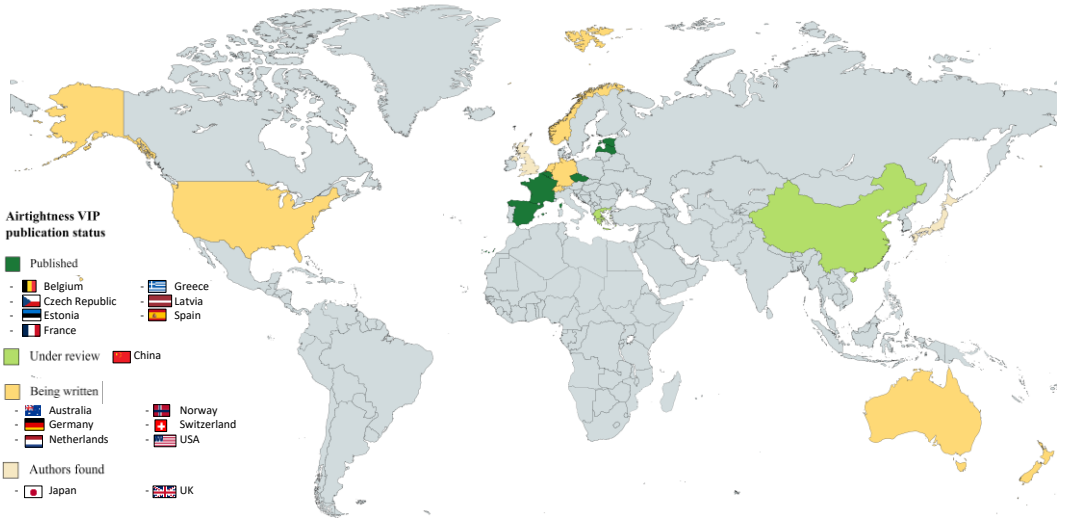
MAY 4TH 2023

VIP series on Building & Ductwork Airtightness

Series of Ventilation Information Papers (VIP) published by the AIVC

- Title: *"Building and ductwork airtightness - National trends and requirements"*
- Template prepared: **similar structure** for all papers
- Authors found in various countries via the TightVent Airtightness Associations Committee (**TAAC**) and the **AIVC** board members
- Already **7 published papers**:
  - Estonia (VIP 45.1)
  - Spain (VIP 45.2)
  - Czech Republic (VIP 45.3)
  - Belgium (VIP 45.4)
  - Latvia (VIP 45.5)
  - France (VIP 45.6)
  - Greece (VIP 45.7)
- Available on the **AIVC website**: https://www.aivc.org/collection-keys/vip
- Overview summary in preparation

VIP series on Building & Ductwork Airtightness



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Webinar Programme

- 10:00 | Introduction: Presentation of the series of AIVC VIPs on building and ductwork airtightness regulations
  Nolwenn Hurel (INIVE, France)
- 10:05 | Building and ductwork airtightness in France: national trends and requirements
  Bassam Moujalled and Adeline Mélois (Cerema / LOCIE, France)
- 10:20 | Questions and answers
- 10:30 | Building and ductwork airtightness in Belgium: national trends and requirements
  Liesje Van Gelder (BCCA, Belgium)
- 10:45 | Questions and answers
- 10:55 | Building and ductwork airtightness in Greece: national trends and requirements
  Theodoros Sotirios Tountas (F.U.V., Greece)
- 11:10 | Questions and answers
- 11:30 | End of webinar

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BUILDING AND DUCTWORK AIRTIGHTNESS IN FRANCE NATIONAL TRENDS AND REQUIREMENTS

Bassam Moujalled, Adeline Mélois, *Cerema*

4th May 2023

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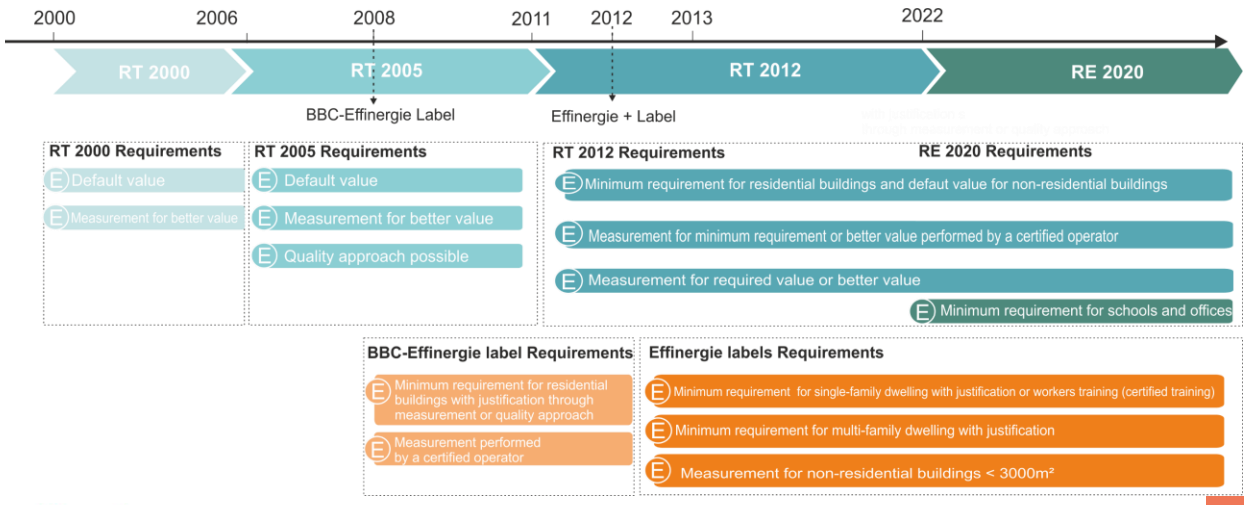
FRENCH CONTEXT OF BUILDING AIRTIGHTNESS



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FRENCH CONTEXT OF BUILDING AIRTIGHTNESS

French airtightness indicator

- The French air permeability indicator **$Q_{4Pa\text{-}surf}$ (i.e. q_{E4})** is the **specific leakage rate at 4 Pa** per unit of envelope surface area excluding lowest floor *[$m^3.h^{-1}.m^{-2}$]*

- Order of magnitude of **$Q_{4Pa\text{-}surf}$ vs. q_{E50} and n_{50} (n = 0.67)**
  - All buildings: **q_{E50} ~ 5.2* $Q_{4Pa\text{-}surf}$**
  - Single-family houses: **n_{50} ~ 4.2* $Q_{4Pa\text{-}surf}$**
  - Multi-family dwellings: **n_{50} ~ 1.8* $Q_{4Pa\text{-}surf}$**
  - Non-residential buildings: **n_{50} ~ 3.0* $Q_{4Pa\text{-}surf}$**

FRENCH CONTEXT OF BUILDING AIRTIGHTNESS

Requirements in new residential buildings

- Since 2013, a **mandatory requirement** with a limit airtightness level:
  - **0.6 $m^3.h^{-1}.m^{-2}$** for **single-family houses**
  - **1.0 $m^3.h^{-1}.m^{-2}$** for **multi-family buildings**

- Since 2022, **penalties** are applied when the tests are carried out under the following conditions:
  - A multiplying factor of **1.2** in case of measurement on a **sample of dwellings**
  - An increase by **0.3 $m^3.h^{-1}.m^{-2}$** when the test is performed **before the completion of all work** impacting the envelope air permeability

FRENCH CONTEXT OF BUILDING AIRTIGHTNESS

Requirements in new non-residential buildings

- Since 2022, a **new mandatory requirement** with a limit airtightness level:
  - **1.7 $m^3.h^{-1}.m^{-2}$** for **new schools and office buildings < 3,000 m^2**

- For **other non-residential buildings**, no minimum requirement:
  - either a **default value** (1.7 or 3.0 $m^3.h^{-1}.m^{-2}$ depending on the building use)
  - or by a better-than-default value that must be justified

FRENCH CONTEXT OF BUILDING AIRTIGHTNESS

Incentive for building airtightness

- The **EP-labels of French association Effinergie** set higher requirements for buildings with the following limits for $Q_{4Pa\text{-}surf}$:
  - **Single-family houses**: **0.4 $m^3.h^{-1}.m^{-2}$**
  - **Multi-family dwellings**: **0.8 $m^3.h^{-1}.m^{-2}$** in case of measurement by sampling, and **1 $m^3.h^{-1}.m^{-2}$** in case of measurement on the whole building.
  - **Non-residential buildings**: **no target value**, but an airtightness test is compulsory for all non-residential buildings of less than 3,000 m^2.

FRENCH CONTEXT OF BUILDING AIRTIGHTNESS

Building airtightness justifications

- The French EP regulation requires **to justify the building airtightness** level either by:
  - **Airtightness test performed by a qualified tester** according to ISO 9972 and the French application guide FD P50-784
  - Application of a **certified quality management approach** on building airtightness
- Airtightness tests must be performed by a **qualified third-party tester**:
  - A French **qualification scheme for airtightness testers** managed by the certification body Qualibat:
    - *state approved **training**, **examination**, and **sufficient testing** experience to obtain the qualification*
    - ***yearly follow-up checks** with analysis of some reports and provision of a professional standard form giving information on all airtightness measurements performed within the year (**professional measurement register**)*

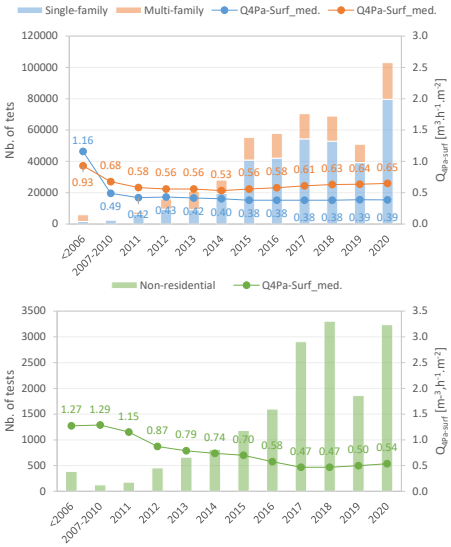
FRENCH CONTEXT OF BUILDING AIRTIGHTNESS

Building airtightness test protocol

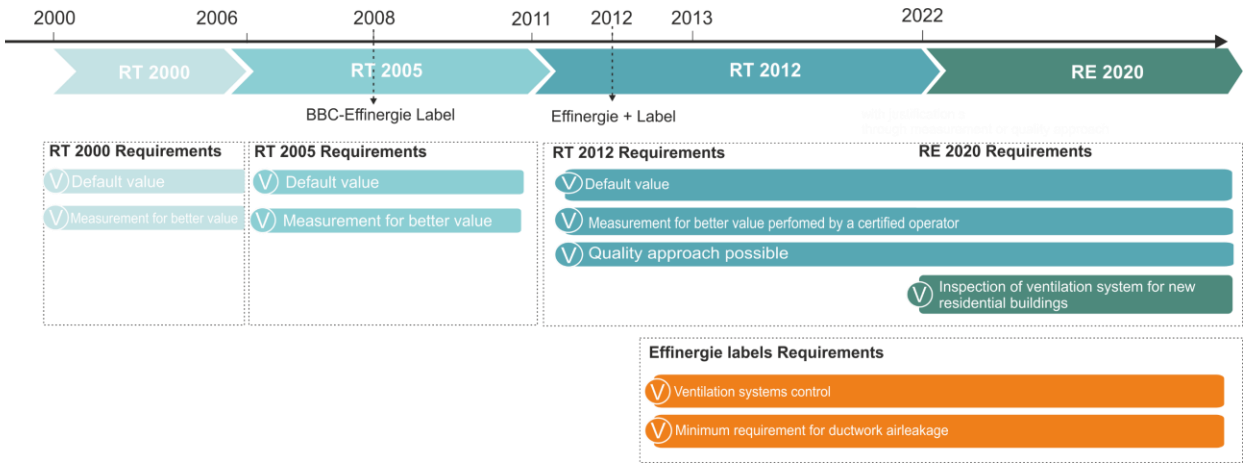
- Airtightness tests must be performed according to **EN ISO 9972** and the national guideline **FD P50-784** (application guide of the standard)
  - The **fan pressurisation method is the only method used** in France
  - Measurements are performed according to **method 3 of EN ISO 9972**
    - Only the **ventilation openings included in the EP-calculation are sealed**, and all windows, doors, and trapdoors on the envelope are closed.
  - For **multi-family buildings** of more than 500 m², **sampling method** can be used:
    - **3 dwellings** for buildings with **less than 30 dwellings**
    - **6 dwellings** for buildings with **more than 30 dwellings**
    - Dwellings from the sample must be located **on the first, intermediate and the higher levels**

FRENCH CONTEXT OF BUILDING AIRTIGHTNESS

- **842** qualified testers
- **570,000** tests in the national database
- More than **60,000** tests per year
- **96%** of tests in new residential buildings
- In single-family houses, the yearly median $Q_{4Pa\text{-}surf}$ around **0.40 $m^3.h^{-1}.m^{-2}$**
- In multi-family buildings, the yearly median $Q_{4Pa\text{-}surf}$ around **0.65 $m^3.h^{-1}.m^{-2}$**
- In non-residential buildings, **93%** of the tested buildings better than the default value



FRENCH CONTEXT OF DUCTWORK AIRTIGHTNESS



FRENCH CONTEXT OF DUCTWORK AIRTIGHTNESS

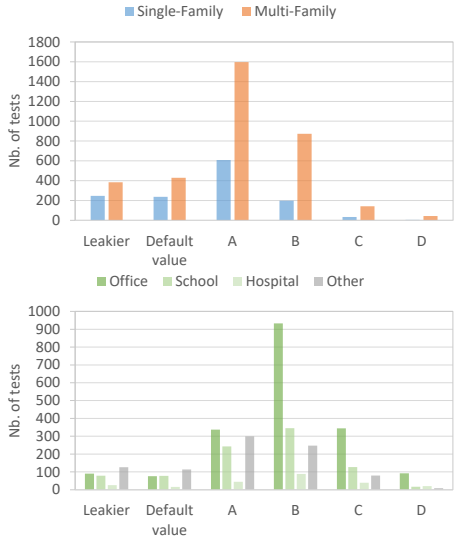
Regulatory context

- **Tests only for class A, B or C in EP-calculation**, otherwise a **default value (2.5*A)** is used
- Mandatory tests and minimum class for Effinergie labels
- **Justification**:
  - Airtightness measurement performed by a **qualified tester**
  - **National qualification scheme** for testers:
    - reference: French standard (**FD E51-767**)
    - qualifying State-approved **training + examination + testing experience** (minimum 10 tests)
    - **yearly follow-up** checks including a national database

FRENCH CONTEXT OF DUCTWORK AIRTIGHTNESS

Some key figures

- **133** qualified testers
- **8,770** tests in the national database
- More than **1,000** tests per year
- **55%** of tests in non-residential buildings
- In residential buildings, **46%** of tested ductworks obtained **class A**
- In non-residential buildings, **42%** of tested ductworks obtained **class B**



FRENCH CONTEXT OF DUCTWORK AIRTIGHTNESS

Inspection of ventilation system

- The new EP-regulation **RE 2020** introduces a **new requirement for the inspection of ventilation system** for:
  - New residential buildings (**Single family dwellings & Multi family dwellings)**
  - And with mechanical ventilation system (**single exhaust or balanced ventilation system)**

- Inspection must be performed by **a qualified inspector**

FRENCH CONTEXT OF DUCTWORK AIRTIGHTNESS

Inspection of ventilation system

- The inspection includes **three parts:**
  - **Pre-inspection**: analysis of documents and preparation of the in situ audit
  - **Ventilation diagnostic (in situ):** diagnostic in situ
  - **Ventilation measurements (in situ):** Flow rates and/or air pressures depending on the system

- Optional ductwork airtightness only if the value introduced in the EP regulation is better than the default value

CONCLUSIONS

	Building airtightness	Ducts airtightness	Ventilation system
Single-family buildings	Limit Value: 0.6 $m^3.h^{-1}.m^{-2}$	Default Value: 2.5 * Class A	Energy Consumption Limit
	Better Value	Better Value	Minimum exhaust airflows
	Better requirement: 0.4 $m^3.h^{-1}.m^{-2}$ or workers training	Class A required	Control of the ventilation system
Multi-family buildings	Limit Value: 1 $m^3.h^{-1}.m^{-2}$	Default Value: 2.5 * Class A	Energy Consumption Limit
	Better Value	Better Value	Minimum exhaust airflows
	Better requirement 0.8 $m^3.h^{-1}.m^{-2}$ if sampling testing	Class A required	Control of the ventilation system
Non-residential buildings	Default Value*	Default Value: 2.5 * Class A	Energy Consumption Limit
	Better Value	Better Value	Healthy airflows /person (from 15 to 60 $L.s^{-1}$)
	Measurement for buildings < 3000m²	Class A required	Control of the ventilation system

EP and airing regulation requirements

Regulation Possibility

Effinergie+ label

Justification required

** Since 2022, mandatory requirement of 1.7 $m^3.h^{-1}.m^{-2}$ for new schools and office buildings < 3,000m²*

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Thank you!

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FRENCH CONTEXT OF BUILDING AIRTIGHTNESS

Building airtightness in the EP calculation

- Building air permeability **$Q_{4PaSurf}$ is an input of the energy performance calculation** of the French EP regulations:
  - A **network zonal model** is integrated in the calculation method to estimate the **air change rates induced by air infiltration and ventilation** in each zone
  - For each zone, the method considers **two leakages on the leeward walls** (at 0.25 and 0.75 of the ceiling height of the zone), **two leakages on the windward walls** (at 0.25 and 0.75 of the ceiling height of the zone), and **one leakage on the ceiling** (at the ceiling height).
  - The flow coefficient of each leakage is estimated from $Q_{4PaSurf}$ with **an exponent coefficient of 2/3 in proportion to the wall surface** in relation to the total surface of the envelope (excluding lower floor).

Building and ductwork airtightness in Belgium: National trends and requirements

Liesje Van Gelder, Maarten De Strycker (BCCA), Christophe Delmotte (Buildwise), Arnold Janssens (UGent)

AIVC & TightVent Webinar | Building and ductwork airtightness trends and regulations in France, Belgium and Greece | 4 May 2023

BCCA

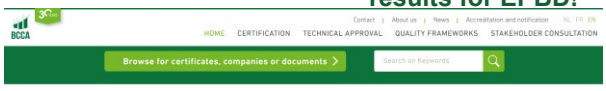
BCCA – WHAT WE ARE – WHAT WE DO

BENOR CE ETA EUROPEAN TECHNICAL ASSESSMENT ATG

- Belgian Construction Certification Association = non-profit organisation founded in 1992
- Third party for construction sector – independent, impartial and competent
- Criteria based on cooperation with and consensus within stakeholders
- Accreditation from BELAC (the official Belgian Accreditation Agency) and Notified Body
- Internationally active, international network, participation in standardisation

- Approval, assessment and certification of products and systems
- Certification of management systems
- Certification of construction enterprises
- Quality Frameworks: surveillance processes
- …

Reliable measurement results for EPBD!

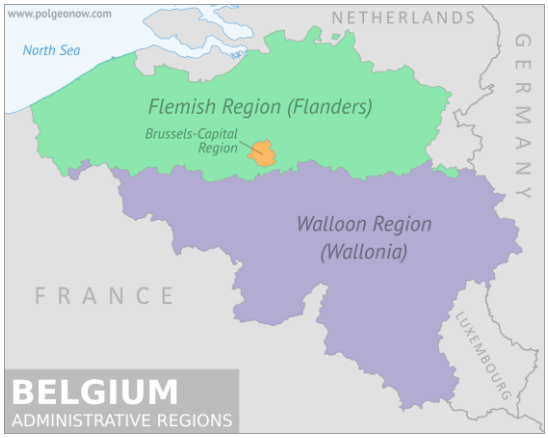


BCCA npo safeguards and strengthens the quality, confidence and performances in the construction sector. Independent, impartial and competent.

www.bcca.be

BELGIUM

- Three Regions



- Building energy performance regulation is regional matter – similar but some deviations
- Standards and technical guidelines are on national level

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BUILDING AIRTIGHTNESS TESTS IN FLEMISH REGION

- No minimum requirement for airtightness, 2 options in EPBD regulation:
  - Default value of 12 m³/h per m² heat loss area (v_{50}) ≠ q_{e50}
  - Leakage rate measured in quality framework (since 1 january 2015)
- Quality framework organised by BCCA
  - Reference document in Belgium: STS-P 71-3 (referring to European standard)
  - Initial qualification of testers:
    - Optional theoretical course (1 day – building physical background, STS-P 71-3 and operational aspects of quality framework)
    - Theoretical exam (1.5h – 50 questions multiple choice)
    - Practical exam (3 h – full test on site and measurement report)
  - Random inspections:
    - 10 % inspections on site to verify correctness and reliability of measurements
    - 10 % inspections of test reports to verify correctness and completeness of test report

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BUILDING AIRTIGHTNESS TESTS IN OTHER REGIONS

- No minimum requirement for airtightness, 2 options in EPBD regulation:
  - Default value of 12 m³/h per m² heat loss area (v_{50})
  - Leakage rate measured
- No quality framework
- Brussels Region: independance of testers since 1 january 2018

BUILDING AIRTIGHTNESS IN THE EPC - HEATING

- Monthly heat losses through ventilation in an energy sector [MJ]:

$$Q_{V,heat,seci,m} = H_{V,heat,seci} \cdot (18 - \theta_{e,m}) \cdot t_m$$

- Heat transfer coefficient [W/K]:

$$H_{V,heat,seci} = H_{V,inf/exfilt,heat,seci} + H_{V,hyg,heat,seci} + H_{V,over,heat,seci}$$

- Heat transfer coefficient through in- and exfiltration [W/K]:

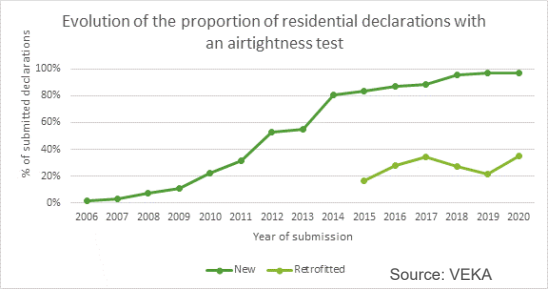
$$H_{V,in/exfilt,heat,seci} = 0{,}34 \cdot \dot{V}_{in/exfilt,heat,seci}$$

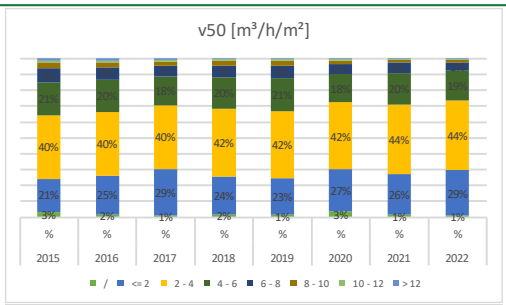
- In- and exfiltration flow [m³/h]:

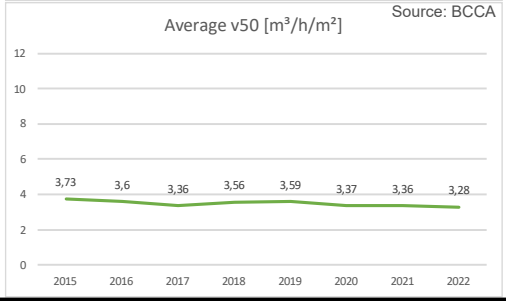
$$\dot{V}_{in/exfilt,heat,seci} = 0{,}04 \cdot \dot{V}_{50,heat} \cdot A_{T,E,seci}$$

  - v_{50} measured airtightness indicator [m³/(h.m²)] – or default value
  - A_T heat loss area [m³]
  - 0,04 depends on wind exposure, but conservative value for built environment in Belgium

TESTS PERFORMED IN FLANDERS REGION







DUCTWORK AIRTIGHTNESS TESTS

- Impact of ductwork airtightness is limited in Energy Performance Regulation
- No differences between Regions
- Only few ductwork airtightness measurements (<1% of residential ductwork)
- NBN EN 14134: total leakage flow for all ducts [m³/h]

- However, quality framework on residential ventilation in Flanders. Flow measurements are obligated.
  - Belgian reference document STS-P 73-1

- No data available

DUCTWORK AIRTIGHTNESS IN THE EPC - HEATING

- Only valorised for residential buildings
- Monthly heat losses through ventilation in an energy sector [MJ]:

$$Q_{v,heat,seci,m} = H_{v,heat,seci} \cdot (18 - \theta_{e,m}) \cdot t_m$$

- Heat transfer coefficient [W/K]:

$$H_{v,heat,seci} = H_{v,inf/exfilt,heat,seci} + H_{v,hyg,heat,seci} + H_{v,over,heat,seci}$$

- Heat transfer coefficient through hygienic ventilation [W/K]:

$$H_{v,hyg,heat,seci} = 0,34 \cdot r_{preh,heat,seci} \cdot \dot{V}_{hyg,heat,seci}$$

- Hygienic ventilation flow [m³/h]:

$$\dot{V}_{hyg,heat,seci} = \left[0,2 + 0,5 \cdot e^{\left(\frac{-V_{EPR}}{500}\right)}\right] \cdot f_{reduc,vent,heat,seci} \cdot m_{heat,seci} \cdot V_{seci}$$

  - V_{EPR} total volume calculated unit [m³]
  - f_{reduc} reduction factor ventilation due to demand-controlled ventilation [-]
  - V volume of the considered energy zone [m³]

multiplication factor [-] related to the type of ventilation system and its installation quality

BCCA

DUCTWORK AIRTIGHTNESS IN THE EPC - HEATING

- Multiplication factor m dependent of
  - adjustment of valves
  - the degree of self-regulation of the natural inlets and/or outlets
  - the airtightness of the ducts
- Default value 1,5
- Minimal value 1

BCCA

CONCLUSIONS

- Building airtightness
  - Disadvantageous default value
  - Implementation of quality framework in Flanders in 2015
  - Tests in Brussels Region by independent testers since 2018
  - No further improvements in number of tests
  - No significant improvement of airtightness (v_{50} values) seen last years

- Ductwork airtightness
  - Less promoted
  - No requirements
  - Only few tests
  - No evolution expected
  - Only valorised in EPC for residential buildings

MORE INFORMATION

- VIP paper is online

Thank you for your attention
Questions?

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V entilation
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Trends in building and ductwork airtightness in Greece

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1. Introduction to the building market in Greece

According to the Hellenic Statistical Authority (www.statistics.gr), in 2 years, from 2018 to 2020, the number of building permits increased from 15,342 to 18,928 (approximately **23.4%**) while the new buildable areas for the same period increased from 3,532,675 m² to 4,129,281 m² (approximately **18%**).

From 2018 to 2020 = **23 %** increase in building permits

From 3,532,675 m² to 4,129,281 m² = **18 %** increase in new building areas

At the same time there is a large building stock **4,105,637 buildings** (last recorded in 2011) of which **2,990,324** are residential.

The rest are public buildings (schools, hospitals), shops and business premises, hotels, churches, etc.

1. Introduction on the building market in Greece

The average primary energy consumption in Greek residential buildings is 306.55 KWh/m², in temporary accommodation buildings (hotels) it is 451.06 KWh/m², while in public buildings it is 791.32 KWh/m².

Average primary energy consumption in Greece

Residential buildings:	**306,55 kWh/m²**
Hotels:	**451,06 kWh/m²**
Public buildings:	**791,32 kWh/m²**

New buildings under construction are required to issue an energy certificate but there is **no prevention**, **specification** or **requirement**

to check the airtightness of the building envelope

2. Building airtightness

2.1 Introduction

In Greece, **actual airtightness is not taken into account** and the **official instructions** consider it as a given number around the perimeter of the envelope.

Here is the **description** mentioned in the **official form of Energy Inspection of Buildings of the Ministry of Environment**, paragraph: 2.4.1.6

2.4.1.6. Αεροστεγανότητα κτιρίου

Η αεροστεγανότητα ενός κτιρίου εξαρτάται από το είδος των κουφωμάτων (ανοιγόμενα, συρόμενα επάλληλα, συρόμενα χωνευτά), την ποιότητα των χαραμάδων των ανοιγμάτων (ύπαρξη ψυκτρών), τη συναρμογή των κουφωμάτων με την τοιχοποιία, το είδος του πλαισίου (μεταλλικό, συνθετικό, ξύλινο), την επιφάνεια και τον προσανατολισμό των κουφωμάτων, καθώς επίσης και από τις θυρίδες αερισμού (π.χ. εστιών καύσης) που πιθανόν υπάρχουν στο κτίριο. Ο αθέλητος αερισμός που προκύπτει λόγω διείσδυσης του αέρα με τους παραπάνω τρόπους εξαρτάται από πολλές συνιστώσες και για το λόγο αυτό δεν μπορεί εύκολα να εκτιμηθεί. Στην πράξη, για τον υπολογισμό της διείσδυσης αέρα χρησιμοποιούνται διάφορες εμπειρικές σχέσεις παραμετροποιημένες.

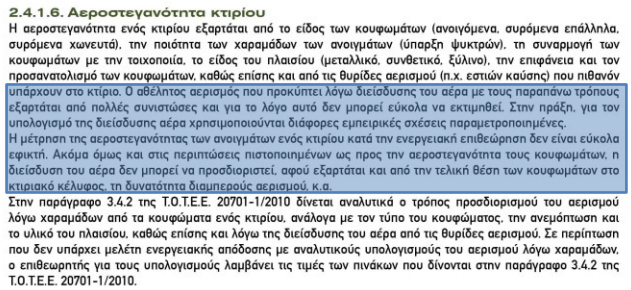
Η μέτρηση της αεροστεγανότητας των ανοιγμάτων ενός κτιρίου κατά την ενεργειακή επιθεώρηση δεν είναι εύκολα εφικτή. Ακόμα όμως και στις περιπτώσεις πιστοποιημένων ως προς την αεροστεγανότητα τους κουφωμάτων, η διείσδυση του αέρα δεν μπορεί να προσδιοριστεί, αφού εξαρτάται και από την τελική θέση των κουφωμάτων στο κτιριακό κέλυφος, τη δυνατότητα διαμπερούς αερισμού, κ.α.

Στην παράγραφο 3.4.2 της Τ.Ο.Τ.Ε.Ε. 20701-1/2010 δίνεται αναλυτικά ο τρόπος προσδιορισμού του αερισμού λόγω χαραμάδων από τα κουφώματα ενός κτιρίου, ανάλογα με τον τύπο του κουφώματος, την ανεμόπτωση και το υλικό του πλαισίου, καθώς επίσης και λόγω της διείσδυσης του αέρα από τις θυρίδες αερισμού. Σε περίπτωση που δεν υπάρχει μελέτη ενεργειακής απόδοσης με αναλυτικούς υπολογισμούς του αερισμού λόγω χαραμάδων, ο επιθεωρητής για τους υπολογισμούς λαμβάνει τις τιμές των πινάκων που δίνονται στην παράγραφο 3.4.2 της Τ.Ο.Τ.Ε.Ε. 20701-1/2010.

*"The airtightness of a building depends on the **type of frames** (opening, sliding, sliding, recessed), the **quality of the cracks** in the openings (presence of chillers), the assembly of the frames with the masonry, the type of frame (metal, synthetic, wood), the surface and **orientation of the frames**, as well as the vents (eg combustion chambers) that may be present in the building.*

2. Building airtightness

2.1 Introduction



2.4.1.6. Αεροστεγανότητα κτιρίου

Η αεροστεγανότητα ενός κτιρίου εξαρτάται από το είδος των κουφωμάτων (ανοιγόμενα, συρόμενα επάλληλα, συρόμενα χωνευτά), την ποιότητα των χαραμάδων των ανοιγμάτων (ύπαρξη ψυκτρών), τη συναρμογή των κουφωμάτων με την τοιχοποιία, το είδος του πλαισίου (μεταλλικό, συνθετικό, ξύλινο), την επιφάνεια και τον προσανατολισμό των κουφωμάτων, καθώς επίσης και από τις θυρίδες αερισμού (π.χ. εστιών καύσης) που πιθανόν υπάρχουν στο κτίριο. Ο αθέλητος αερισμός που προκύπτει λόγω διείσδυσης του αέρα με τους παραπάνω τρόπους εξαρτάται από πολλές συνιστώσες και για το λόγο αυτό δεν μπορεί εύκολα να εκτιμηθεί. Στην πράξη, για τον υπολογισμό της διείσδυσης αέρα χρησιμοποιούνται διάφορες εμπειρικές σχέσεις παραμετροποιημένες.

Η μέτρηση της αεροστεγανότητας των ανοιγμάτων ενός κτιρίου κατά την ενεργειακή επιθεώρηση δεν είναι εύκολα εφικτή. Ακόμα όμως και στις περιπτώσεις πιστοποιημένων ως προς την αεροστεγανότητα τους κουφωμάτων, η διείσδυση του αέρα δεν μπορεί να προσδιοριστεί, αφού εξαρτάται και από την τελική θέση των κουφωμάτων στο κτιριακό κέλυφος, τη δυνατότητα διαμπερούς αερισμού, κ.α.

Στην παράγραφο 3.4.2 της Τ.Ο.Τ.Ε.Ε. 20701-1/2010 δίνεται αναλυτικά ο τρόπος προσδιορισμού του αερισμού λόγω χαραμάδων από τα κουφώματα ενός κτιρίου, ανάλογα με τον τύπο του κουφώματος, την ανεμόπτωση και το υλικό του πλαισίου, καθώς επίσης και λόγω της διείσδυσης του αέρα από τις θυρίδες αερισμού. Σε περίπτωση που δεν υπάρχει μελέτη ενεργειακής απόδοσης με αναλυτικούς υπολογισμούς του αερισμού λόγω χαραμάδων, ο επιθεωρητής για τους υπολογισμούς λαμβάνει τις τιμές των πινάκων που δίνονται στην παράγραφο 3.4.2 της Τ.Ο.Τ.Ε.Ε. 20701-1/2010.

*The **unintentional ventilation** that results from the penetration of air in the above ways depends on many components and therefore **cannot be easily estimated**. In practice, various **empirical** parameterized **practices** are used to calculate air penetration. Measuring the airtightness of the openings of a building during **the energy inspection** **is not easy to carry out**. However, **even in the cases of windows certified for their airtightness, the air penetration cannot be determined, since it also depends on the final position of the frames in the building envelope, the possibility of ventilation, etc. "***

2. Building airtightness

2.1 Introduction

In the **official technical directive of the Technical Chamber of Greece**

paragraph 4.4.2: "Ventilation due to airtightness (air penetration)"

airtightness is divided into three descriptive categories, low, medium or high airtightness and depends only on the certificates that accompany the frames.

Specifically for **the building envelope** it is stated:

"For the calculations of ventilation due to **airtightness the air penetration through the structural transparent external surfaces of the building envelope** is considered negligible and is taken **equal to zero".**

2. Building airtightness

2.1 Introduction

For the calculation of the general losses, Table 3.23 of the Regulation on the Energy Performance of Buildings (KENAK) is taken into account
"Typical air penetration values due to cracks per unit area and kind of window".

Type	Air penetration (m^3/h)
Fireplace chimney, wood or oil heater chimney or other combustion stove	20
Ventilation boxes, e.g., for use with gas appliances	10
Doors with a margin at the bottom> 1.0 cm and in contact with the external environment	10

2. Building airtightness

2.1 Introduction

That is to say, a value is theoretically calculated depending on the surface of the window, **no real airtightness measurement is taken into account** and everything is calculated in a conventional way through the above-mentioned tables.

The reference made to **the main entrance doors**: "… the air penetration from the doors with a gap <1cm at the bottom in contact with the outside environment **is taken to be zero**, if the gap is>1cm it is **taken to be 10m³/h**."

Type	Air penetration (m^3/h)
Fireplace chimney, wood or oil heater chimney or other combustion stove	20
Ventilation boxes, e.g., for use with gas appliances	10
Doors with a margin at the bottom> 1.0 cm and in contact with the external environment	10

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2.2 Requirements and drivers

As of 2017, no upgrade has been made to the existing regulation. This means that buildings are still being built **with outdated guidelines**

There **is no regulation or national directive regarding the measurement of th airtightness.**
Only for windows and not any incentives in Greece to promote a good building airtightness.

There is **no official testing method** accepted and **the only limits in the market** used **by the freelancer testers** are described in the following table:

There are no sanctions regarding the airtightness.

For buildings < 7.500m³				
Data	Very good Airtightness	Good Airtightness	Average Airtightness	Bad Airtightness
n50: 1/h (Air Change Rate)	≤ 0,7	0,71 ≤ n50 ≤ 1,5	1,51 ≤ n50 ≤ 3,0	≥ 3,1

2.3 Building airtightness in the energy performance calculation

The building airtightness is an input to the energy calculation, but the values are just theoretical.

The following table (3.24) is taken from **the Regulation on Energy Performance of Buildings** document (KENAK) and shows the default values used for airtightness calculations.

Πίνακας 3.24. *Τυπικές τιμές διείσδυσης αέρα λόγω ύπαρξης χαραμάδων ανά μονάδα επιφανείας και είδος κουφώματος.* **Table 3.24** **Typical air penetration values due to the presence of cracks per surface unit and type of window.**

Type of opening (glazing, doors, etc.) Είδος ανοίγματος (υαλοστάσια, πόρτες κ.ά.)	Air penetration (m^3/h) Διείσδυση του αέρα	
	Door Πόρτα	Window Παράθυρο
	[$m^3/h/m^2$]	[$m^3/h/m^2$]
Windows with wooden frame without certification Κουφώματα με ξύλινο πλαίσιο χωρίς πιστοποίηση		
Single glazed window, non-airtight, recessed, superimposed, opening. Κούφωμα με μονό υαλοπίνακα, μη αεροστεγές, χωνευτό, επάλληλο, ανοιγόμενο. Frame without glass (door) and without airtightness. Κούφωμα χωρίς υαλοπίνακα (πόρτα) και χωρίς αεροστεγανότητα.	11,8	15,1
Double glazed window, superimposed sliding, with brushes, recessed Κούφωμα με διπλό υαλοπίνακα, επάλληλα συρόμενο, με ψήκτρες, χωνευτό.	9,8	12,5
Opening window, with double glazing, without certification. Ανοιγόμενο κούφωμα, με διπλό υαλοπίνακα, χωρίς πιστοποίηση. Frame without glass (door), with airtightness not certified. Κούφωμα χωρίς υαλοπίνακα (πόρτα), με αεροστεγανότητα μη πιστοποιημένη.		
Frames with metal or PVC frame without certification Κουφώματα με μεταλλικό ή συνθετικό πλαίσιο χωρίς πιστοποίηση		
Single glazed window, non-airtight, recessed, superimposed, opening. Κούφωμα με μονό υαλοπίνακα, μη αεροστεγές, χωνευτό, επάλληλο, ανοιγόμενο. Frame without glass (door) and without airtightness. Κούφωμα χωρίς υαλοπίνακα (πόρτα) και χωρίς αεροστεγανότητα.	7,4	8,7
Double glazed window, superimposed sliding, with brushes, recessed. Κούφωμα με διπλό υαλοπίνακα, επάλληλα συρόμενο, με ψήκτρες, χωνευτό. Opening window, with double glazing, without certification. Ανοιγόμενο κούφωμα, με διπλό υαλοπίνακα, χωρίς πιστοποίηση. Frame without glass (door), with airtightness not certified. Κούφωμα χωρίς υαλοπίνακα (πόρτα), με αεροστεγανότητα μη πιστοποιημένη.	5,3	6,8
Frames with metal, PVC or wooden frame certified according to EN 12207 (*) **Κουφώματα με μεταλλικό, συνθετικό ή ξύλινο πλαίσιο με πιστοποίηση κατά EN 12207(*)**		
Air permeability class based on the total surface of the window: Κλάση αεροπερατότητας με βάση τη συνολική επιφάνεια του κουφώματος:	1	7,7
	2	4,1
	3	1,4
	4	0,5

2.3 Building airtightness in the energy performance calculation

2.4 Building airtightness test protocol

There are not any national guidelines to perform airtightness tests, and not any specifications regarding the equipment.

There **is not any official qualification scheme for airtightness testers**, only the seminars made by the **Passive House Institute** and our company **Aerosteganotita**.

Until now there are about **50 qualified testers,** freelancers, architects or engineers.

Architectural Aluminium Academy engineers were recently trained in airtightness tests in order to confirm the good quality of their frames during the installation

2.5 Building airtightness tests performed
2.5.1 Tested buildings

Newly **constructed Lidl buildings** are mainly inspected as required by their specifications.

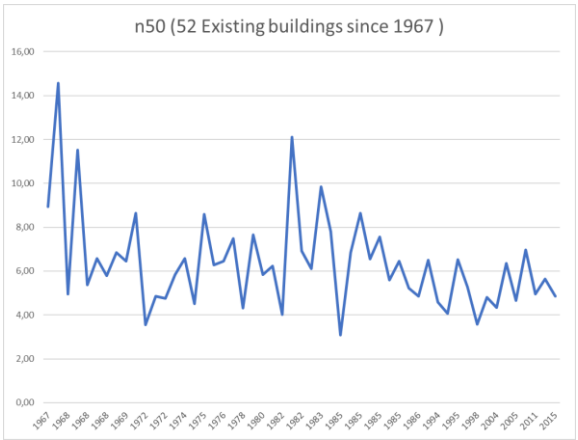
New **buildings or under renovation are not inspected** except in cases of failure where the owner will request the test to be conducted.

In addition, the **use of mechanical ventilation systems with heat recovery** is not widespread in Greek construction and the **necessary airtightness measurement is not required by the building regulations**.

2.5.2 Database

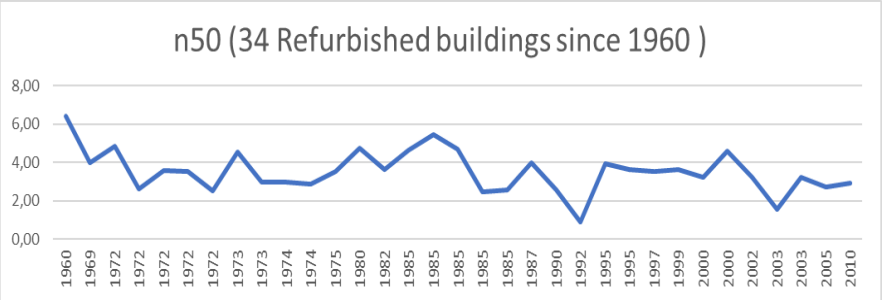
The available field database on building airtightness levels achieved, made by www.aerosteganotita.gr since 2011 provides the following results:

*The average of the 52 premises remained at their initial state of construction between 1967 and 2015 was n50=**6.49ACH**.*



2.5.2 Database

The average of the 34 refurbished premises between 1960 and 2010 was ***n50=3.43ACH***

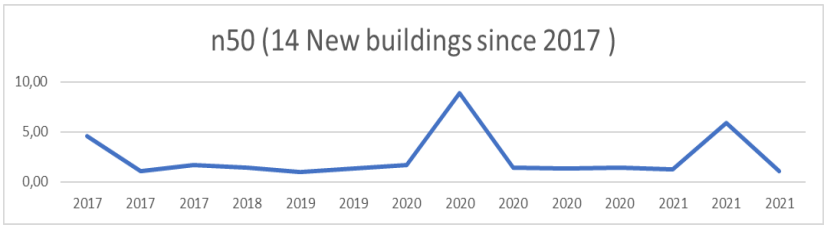


For buildings < 7.500m³				
Data	**Very good Airtightness**	**Good Airtightness**	**Average Airtightness**	**Bad Airtightness**
n50: 1/h (Air Change Rate)	≤ 0,7	0,71 ≤ n50 ≤ 1,5	1,51 ≤ n50 ≤ 3,0	≥ 3,1

2.5.2 Database

*Figure 3: The average of the 14 new build premises between 2017 and 2021 was n50=****2.44ACH****.*

The values represent the average quality of constructions in Greece even though a very small number of measurement is made.



For buildings < 7.500m³				
Data	**Very good Airtightness**	**Good Airtightness**	**Average Airtightness**	**Bad Airtightness**
n50: 1/h (Air Change Rate)	≤ 0,7	0,71 ≤ n50 ≤ 1,5	1,51 ≤ n50 ≤ 3,0	≥ 3,1

2.6 Guidelines to build airtight

At the time of this writing there are no plans to develop guideline/standards in Greece to introduce airtightness targets for the building industry.

In addition, **the Association of Certified Energy Inspectors of Greece**, in its official proposal to the **Ministry of Energy and Climate Crisis** for the improvement of the legal framework regarding the energy behavior of buildings, talking about the airtightness control, states the following (press type PSYPENEP **19/3/2020**):

2.6 Guidelines to build airtight

ΣΥΠΕΝΕΡ

Αρχική Σύλλογος Χάρτης Μελών Εκδηλώσεις Νέα

- Προτάσεις για υιοθέτηση γερμανικών προτύπων (DIN 4108-7) όχι ευρωπαϊκών (EN) και μετρήσεων με εξειδικευμένο και ακριβό εξοπλισμό (blower-door) που χωρίς να προσφέρουν κάτι παραπάνω στον ΚΕΝΑΚ και τις ΤΟΤΕΕ, αφού η αεροστεγανότητα ενός κτιρίου προκύπτει ήδη από πιστοποιημένες τιμές αεροστεγανότητας των κουφωμάτων, θα εγκλωβίσουν όλους τους μελετητές και τους επιθεωρητές αφού μπορούν να πραγματοποιηθούν μόνο από όσους διαθέτουν τον ανωτέρω εξοπλισμό και «πιστοποιημένα» (από ποιον άραγε;) ξέρουν να τον χρησιμοποιούν .

"Proposals for the adoption of German standards (DIN 4108-7) non-European (EN) and **measurements** with **specialized and expensive equipment** (blower-door) **do not offer additional value to the Greek energy legislation** (KENAK) **since the airtightness is already given by the certification of the frames**.
If we apply in Greece **the standards for airtightness measurements**, there will be a problem for the Greek energy inspectors since the equipment is very **expensive** to acquire, the auditors will not know **how to use it** and nobody knows who will train them to do so."

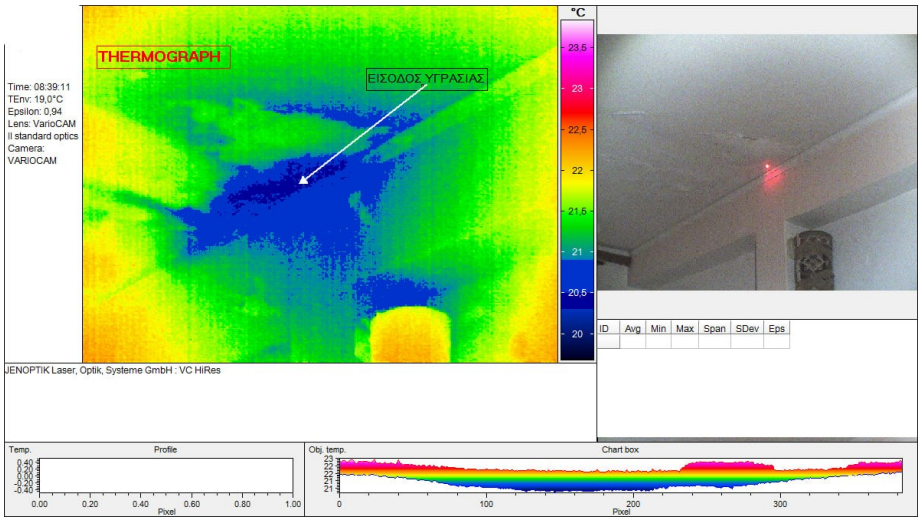
2.6 Guidelines to build airtight

In other words, the Greek energy inspectors consider **that the airtightness testing method is only a German model** for the northern climates and **is not necessary** in Greece.

Obviously, this is a **legitimate misconception** due to the **Ministry of Energy's erroneous official guidance** that do not face the envelope **as a possible leakage area and consider airtightness only as a matter of windows and door frames.**

This unfortunately reflects the average Greek perception of the word **airtightness** which expresses a negative, unhealthy and poor-quality environment.

2.6 Guidelines to build airtight



Diagnostic tool – not obligation

2.7 Conclusion

Nothing has changed **officially** in the last years **regarding airtightness in Greece** and there is not any regulation foreseen on airtightness.

Since **April 2023** the first **Greek Airtightness Testing Association** is formed, aiming to promote building airtightness in Greece, share and compare results to other European and Mediterranean countries.

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Bild Tight, Ventilate Right

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3. Ductwork airtightness

There are no specific test guidelines for ductwork airtightness.
It is stated that **the airtightness of the channels is required and their proper sealing is recommended** in the technical specifications for the contractors.

The official Hellenic Technical Specification in effect since 2009 provides the standards for airducts of metallic sheets in public projects.

The document is based on **several European ductwork standards** (EN 12237, EN1505, EN 1506) and defines the manufacturing methods.

Regarding the quality control requirements for receipt, it is stated that **a visual inspection must be performed.**

Regarding the **tightness of the ducts**, it is stated that there must be a **comparative measurement** of the supplied air amount between vents and fans.

3. Ductwork airtightness

In **2022 a new draft is published** for the updated version of the **2009 Technical Specification.**
The document describes the manufacturing methods with more details, but still, there are **not any specifications regarding the airtightness**.
The only difference from the latest version is that **the PITOT method** is described as **a testing method to confirm the correct airflow**.

However, the practice of checking the airtightness of the ducts **is not known in Greece**.
Therefore, these measurements are not in demand, consequently there are not any professionals to offer this technique.

2022-03-11 ICS: 93.160

ΣΧΕΔΙΟ ΕΛΟΤ ΤΠ 1501-04-07-01-01:2022

ΣΧΕΔΙΟ
DRAFT

ΕΛΛΗΝΙΚΗ ΤΕΧΝΙΚΗ ΠΡΟΔΙΑΓΡΑΦΗ
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Trends in building and ductwork airtightness in Greece

Thank you for your attention

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