PLEIAQ

Building & ductwork airtightness trends and regulations in Czech Republic, Latvia and Spain

AIVC & TIGHTVENT WEBINAR
MAY 9TH 2023

NOLWENN HUREL
PLEIAQ/INIVE

1

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 the Czech Republic: national trends and requirements
  Jiří Novák (CTU, Czech Republic)
- 10:20 | Questions and answers
- 10:30 | Building and ductwork airtightness in Latvia: national trends and requirements
  Nolwenn Hurel (INIVE, France)
- 10:45 | Questions and answers
- 10:55 | Building and ductwork airtightness in Spain: national trends and requirements
  Irene Poza-Casado (UVA, Spain) & Sergio Melgosa (eBuilding, Spain)
- 11:10 | Questions and answers
- 11:30 | End of webinar

2

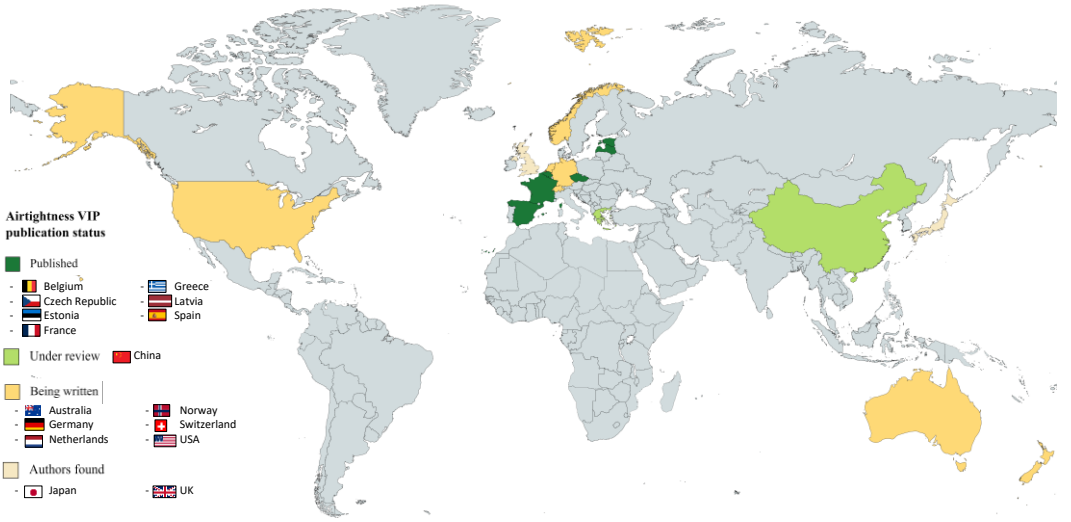
Webinar Introduction:
VIP series on Building & Ductwork Airtightness

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"*
- Authors found in various countries via the TightVent Airtightness Associations Committee (**TAAC**) and the **AIVC** board members
- Template prepared: **similar structure** for all papers
- 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



Building and ductwork airtightness in Czech Republic: national trends and requirements

Jiří Novák
Daniel Adamovský
Jan Vitouš

FACULTY OF CIVIL ENGINEERING CTU IN PRAGUE

ASOCIACE BLOWER DOOR_CZ

1

Building airtightness - Requirements

From 2002 up to now

- indicator: n_{50} [h^{-1}]
- limit values set in a technical standard (ČSN 730540-2)
- applicable for all of buildings, new construction, refurbishment
- proof of compliance not mandatory

Type of ventilation	$n_{50,N}$ [h^{-1}]	
	level 1	level 2
Natural	4,5	3,0
Mechanical	1,5	1,2
Mechanical with heat recovery	1,0	0,8
Mechanical with heat recovery, buildings with very low heat demand	0,6	0,4

2

Buildings tested

Reasons for testing

- avoiding structural damage (timber structure buildings)
- avoiding excessive heat loss (energy efficient buildings – PH)
- complying with a certification scheme (e.g. BREEAM, ADMD)
- obtaining financial support – NZÚ (since 2009)

Number of buildings tested

- exact number unknown
- 21 members of A.BD_CZ → approx. 1 800 tests/year
- no more than 15 % of new residential buildings are tested

Test protocol and guidelines

Test protocol

- fan pressurization method - ČSN EN ISO 9972
- no alternative methods used...

Guidelines

Guideline for NZÚ	TNI 73 0330
• requirements on equipment • time of measurement • building preparation (method 3) • position of measuring device • Δp sequence • control of regression line • calculation of reference values • test report (filled in special form)	• sampling method for residential buildings • sampling rules • assessment of tests results • guard zone technique allowed

Incentives

EP programme New Green Savings (NZÚ)

nová zelená úsporám

- launched in 2009
- administered by the State Environmental Fund
- funded by revenues from EUA and EUAA units
- goal – reducing greenhouse gases emissions by means of energy savings in family houses and residential buildings

- financial support for:
  - construction of new energy-efficient houses (PH standard)
  - renovation with substantial energy savings
  - installation of ventilation system with heat recovery
  - installation of renewable energy heat sources
  - other measures contributing to sustainable goals..

Incentives

New Green Savings - Airtightness requirements

- proof of compliance is mandatory
- testing acc. to ČSN EN ISO 9972 + special guidelines
- special form for the test report

nová zelená úsporám	Required value of n_{50} [h^{-1}]	
	Single-family house	Residential building
new building with low energy demand (low-energy house)	1.0	---
new passive house	0.6	0.6
installation of ventilation system with heat recovery	2.5	---

Incentives

New Green Savings - lessons learnt

- mandatory testing has stimulated progress in knowledge and skills
- implementing mandatory testing is a feasible approach
- it requires a regulative framework:
  - requirements
  - test protocol (incl. guidelines)
  - procedures for the compliance check
  - qualified testers
  - supervision of the testers activity

⬇

- efforts to prepare the framework for general purpose

Requirements

2020 revision of ČSN 73 0540-2 (not voted yet)

- indicator: n_{50} [h^{-1}]
- limit value depends on the building size (ratio A_E/V)
- calculated individually for each building

$$n_{50} \leq n_{50,RQ} \qquad n_{50,RQ} = \frac{A_E}{V} \cdot q_{E50,RQ}$$

Type of ventilation	q_{E50} [$m^3/(h \cdot m^2)$]	
	required	recommended
Natural	3,0	3,0
Mechanical	1,5	1,2
Mechanical with heat recovery	1,0	0,8
Mechanical with heat recovery, buildings with very low heat demand	0,6	0,4

Test protocol and guidelines

2022 Proposal of a new standard ČSN 73 0515

- supplementary guideline to ČSN EN ISO 9972
- goal: detailed testing protocol for check of compliance

- combines NZÚ Guidelines and TNI 73 0330
- updates the information
- sets requirement on equipment and technicians
- gives more detailed instructions (+ illustrations)
- gives guidelines for testing in special situations
- makes use of :
  - recent research results
  - international knowledge exchange (TAAC, Buildair)

Qualification of testers

Options

- member of accredited laboratory (ČSN EN ISO/IEC 17025)
  (3 laboratories hold the accreditation)
- member of Association Blower Door CZ
- combination of both...

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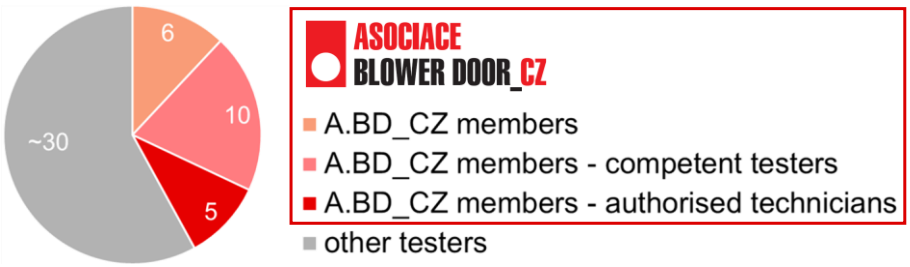
Qualification of testers

Association Blower Door CZ

- supervises competence of the members
- supervises good function of equipment
- organises the reproducibility experiments (round-robin tests) (needed for accreditation acc. to ČSN EN ISO/IEC 17025)
- since 2021 - provides a complex competent testers scheme „Authorised technician for airtightness testing of buildings“



Building airtightness - conclusions

Conclusions

- testing is still not mandatory (except for the EP programme)
- mandatory testing:
  - a strong driver (EP programme..)
  - feasible approach
  - contributes to the energy efficiency goals
- necessary framework for mandatory testing – almost ready...

⬇

- effort needed to convince the state authorities

Ductwork airtightness

Regulations

Vent. system components	Ductwork installation
• airtightness testing required • part of product certification before its release to market • products tested in laboratory	• no regulation • testing only recommended • if required, limit values and penalties are set in the contract

Ductwork airtightness - installations

Incentives

- no special programmes promoting the testing
- poor motivation – ductwork airtightness not taken into account in the EP calculations

Testing practice

- number of tests performed - no data available
- only a low portion of the installations is tested
- reasons for testing:
  - certification schemes (e.g. BREEAM, LEED)
  - special installations (laboratories, clean rooms, industry...)

Ductwork airtightness - installations

Airtightness indicator, classification

- air leakage factor:

$$f = \frac{q_v}{A} \left[\frac{\mathrm{m}^3}{\mathrm{s} \cdot \mathrm{m}^2} \right]$$

- classification of ductwork airtightness:
  - ČSN EN 12237
  - ČSN EN 1507

Test protocol

- ČSN EN 12599
- no national guidelines

Ductwork airtightness - conclusions

Future trends

- no requirements neither mandatory testing of ductwork installations
- no regulation is foreseen in the next future
- in general:
  - check of compliance perceived as a matter of contract
  - mandatory testing perceived as an administrative obstacle

Thank you for your attention

Jiří Novák
Daniel Adamovský
Jan Vitouš

FACULTY OF CIVIL ENGINEERING CTU IN PRAGUE

ASOCIACE BLOWER DOOR_CZ

Trends in building and ductwork airtightness in Latvia

AIVC & TIGHTVENT WEBINAR
BUILDING & DUCTWORK AIRTIGHTNESS TRENDS AND REGULATIONS IN CZECH REPUBLIC, LATVIA AND SPAIN

MAY 9TH 2023

NOLWENN HUREL
PLEIAQ/INIVE

ANDREJS NITIJEVSKIS
VLADISLAVS KEVISS
IRBEST LTD

Introduction – Building market in Latvia

- **Population**: 1,9 million
- **Residential buildings**: about 3000 building permits delivered / year
  (2/3 for single dwellings; 1/3 for multifamily)
- **Non-residential buildings**: about 45% of the construction activity
- **Total investment** : 1.2 billion €

Per cent variation of investment in real terms

investment Mln. € fixed prices

Sectors	2019a	2016	2017	2018	2019a
Building	1,232	-2.5	12.1	19.9	9.7
1.1. Housebuilding	287	2.1	-10.1	32.2	6.0
1.1.1. New	174	10.6	13.7	3.6	7.1
1.1.2. R&M	113	-8.6	-46.6	126.0	4.3
1.2. Non residential (c)	945	-4.1	20.5	16.4	10.8
1.2.1. Private	NA	NA	NA	NA	NA
1.2.2. Public	NA	NA	NA	NA	NA

a: estimate - b: forecast - c: incl. R&M

Building airtightness

Introduction on building airtightness

- **2010:** requirement of blower door tests for buildings renovated with EU funds
  → interest in building airtightness starting
- **2015:** Latvian Construction Standard (LBN 002-01) on thermal insulation and airtightness became stricter
- **2021:** government recommendation to provide airtightness tests for the commissioning of all public buildings > 5000 m^3

Source: green-check.be

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Source: green-check.be

Airtightness indicator: q_{50} ($m^3/(h.m^2)$)

→ Leakage flowrate at 50 Pa divided by the total envelope area (incl. floors)

n_{50} (h^{-1}) also used for some project

Requirements in the regulation

From 2001 to 2015:

- $q_{50} \leq 3{,}0$ $m^3/(h.m^2)$ for **dwellings, hospitals, kindergartens, homes for the elderly**
- $q_{50} \leq 4{,}0$ $m^3/(h.m^2)$ for other **public** buildings
- $q_{50} \leq 6{,}0$ $m^3/(h.m^2)$ for **industrial** buildings
- Mechanical ventilation for buildings with $q_{50} < 3$ $m^3/(h.m^2)$


Credit: Brittany Richard

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- Mechanical ventilation for buildings with $q_{50} < 3\ m^3/(h.m^2)$

Credit: Brittany Richard

Since 2015:

- $q_{50} \leq 3{,}0\ m^3/(h.m^2)$ for buildings with **natural** ventilation (airing);
- $q_{50} \leq 2{,}0\ m^3/(h.m^2)$ for buildings with **mechanical** ventilation;
- $q_{50} \leq 1{,}5\ m^3/(h.m^2)$ for buildings with mechanical ventilation equipped with a **heat recovery system**;
- $q_{50} \leq 4{,}0\ m^3/(h.m^2)$ for **industrial buildings**
- ~~Mechanical ventilation for buildings with $q_{50} < 3\ m^3/(h.m^2)$~~

Update in 2019: same requirements regarding airtightness

Credit: IAQ.works

Building airtightness justifications

So there are **mandatory airtightness requirements** for all new buildings…

… but **no mandatory justification** !

- **No sanctions** in case a building does not comply with the requirements
- Only the owner/developer or construction regulator can initiate and write requirements to **perform airtightness tests for new projects** (Requirements usually described initially in the **project documentation)**

Incentives for building airtightness

- **2021:** government recommendation to provide airtightness tests for the commissioning of all public buildings > 5000 m^3

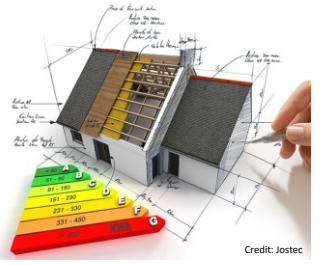
- **Since January 2022**: the city of Riga (capital) gives a **90% discount on property taxes** for:
  - **newly built detached houses classified as NZEB** (for a period of 5 years from the commissioning of the building)
  - **apartment in multi-family buildings for which the insulation of all facades has been performed after its commissioning** (as energy retrofit reaching better than class C)
    Discount applied throughout the period of validity of the energy certificate, with a maximum of 10 years.

Building airtightness in the EP calculation

- Airtightness is an **input of the Energy Performance (EP) calculations**

- **Default values**: requirements provided in the Latvian construction standard

  - $q_{50} \leq 3{,}0$ $m^3/(h.m^2)$ for buildings with **natural** ventilation (airing);
  - $q_{50} \leq 2{,}0$ $m^3/(h.m^2)$ for buildings with **mechanical** ventilation;
  - $q_{50} \leq 1{,}5$ $m^3/(h.m^2)$ for buildings with mechanical ventilation equipped with a **heat recovery system**;
  - $q_{50} \leq 4{,}0$ $m^3/(h.m^2)$ for **industrial buildings**



- Possible to use **lower air permeability values** if a test is performed

→ the rather favourable default values are **not encouraging airtightness testing**

Building airtightness test protocol

- **No national qualification scheme** for airtightness testers
  Currently there are approximately:
  - **8 persons** qualified by the manufacturer program **Retrotec**;
  - **1 person** qualified by **FLiB** (German Association for Airtightness)
  - **2 persons** qualified by the Air Tightness Testing & Measurement Association (**ATTMA**)

  Only some of them are testing building airtightness as their main activity

- **No national guidelines** to perform the airtightness test
  Tests should be performed in accordance with **EN 9972:2016**
  Method 2: "by closing all the windows, doors, hatches in the building"


Source: green-check.be

Building airtightness tests performed

Estimation of the percentage of buildings tested (no official data available):

- **70-80%** of **public** buildings (new or renovated)
- **5-10%** of **industrial** buildings;
- **5-15%** of **dwellings** (single-family houses and multi-apartment buildings)

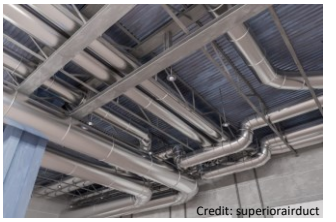
Conclusion

- **Awareness** on building airtightness in Latvia is **slowly growing**
- Mandatory **airtightness requirements** but **no mandatory tests** → still very few buildings tested
- Currently: airtightness **stimulated by the taxes reduction** for NZEB in Riga
- Changes can be expected in the future, but probably has to be **initiated by the EU regulations**

Ductwork airtightness

Ventilation ductwork airtightness

- **Not really taken into account** so far
  - No national regulations/guidelines
  - No requirements on airtightness levels
- **Reference document**: European standard LVS EN 12237
- Only **rare cases** in which **customers initiate a ductwork airtightness test**
- **No progress foreseen** in the next years


Credit: superiorairduct


Credit: Wikipedia

BUILDING AND DUCTWORK AIRTIGHTNESS IN SPAIN: NATIONAL TRENDS AND REQUIREMENTS

Sergio Melgosa Revillas, eBuilding

Irene Poza Casado, Universidad de Valladolid

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VIP 45.2: Trends in building and ductwork airtightness in Spain

https://www.aivc.org/resource/vip-452-trends-building-and-ductwork-airtightness-spain

Ventilation Information Paper n° 45.2

September 2022

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International Energy Agency's Energy in Buildings and Communities Programme

AIVC

Air Infiltration and Ventilation Centre

Trends in building and ductwork airtightness in Spain

Timo Hoek, airtest, Spain
Irene Poza-Casado, UVA, Spain
Sergio Melgosa, eBuilding, Spain

1 General Introduction

The Spanish residential stock is, on average, 45 years old and is in the lower part of the energy efficiency ranking, with an average valuation of 'E'. The market is recovering so vigorously from the Covid-19 hit that some voices in the sector warn that we are already facing the beginning of a new real estate "boom" that will continue until 2023. According to several projections, the number of dwellings in Spain could increase by 1,103,761 (5.9%) between 2020 and 2035, reaching 19,796,040.

As is the case at the European level, the non-residential market is the one with the most uncertain outlook: it has suffered a particularly negative year 2020 (-14.2%). The forecast for the following years includes growth (around 2.5% per annum) but it seems insufficient to recover the lost market volume. In a strict sense, it cannot be concluded that the global market is in a fragile situation, but niches with real momentum (logistics and offices) are coexisting with others where the demand raises questions. Although the Recovery Plan includes specific items for education, health and tourism, it is not expected that they will end up having a significant impact on construction [1].

2 Building airtightness

2.1 *Introduction*

Building airtightness has not traditionally been a major priority in the Spanish construction industry. Because most dwellings did not have any controlled ventilation systems, air infiltration has been a supplemental source of air renewal together with window airing, that contributed to indoor space air renewal [2]. From the point of view of research, knowledge on building airtightness is still scarce, owing to a lack of awareness about the subject. Whereas the topic has been widely addressed in the literature at an international level since the 1970s, little attention was paid on airtightness in Spain until a decade ago.

However, Spain is now on the change. Spanish building airtightness has only been present for windows and doors as an air permeability classification since 1975 [3], and, since 2006, according to UNE EN 12207 [4], when the Basic Document for the Energy Saving in Buildings (DB HE1) of the Spanish Technical Building Code (CTE) came into force [5]. The relative recent publication of the Royal Decree 732/2019, on 20th December 2019, modified the Technical Building Code. These modifications affected DB HE1 [6] and made the first statement limiting the whole air permeability of the building envelope.

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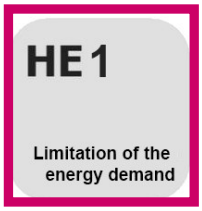
BUILDING AIRTIGHTNESS

Context

- No traditional awareness of airtightness
- Window permeability regulation since 1975 (RD 1490/1975)
- December 2019: whole building airtightness limitation (mandatory mechanical/hybrid ventilation system)



Windows airtightness

Maximum airtightness values of windows per climate zone in winter ($m^3/h \cdot m^2$) at a pressure difference of 100 Pa

Zone α	Zone A	Zone B	Zone C	Zone D	Zone E
≤ 27	**≤ 27**	**≤ 27**	**≤ 9**	**≤ 9**	**≤ 9**

where: q_{100} is the reference air permeability at a pressure difference of 100 Pa $[m^3/h\ m^2]$. *Note*: according to UNE-EN 12207, the permeability limit values correspond to Class 2 (≤ 27 $m^3/h\ m^2$) and Class 3 (≤ 9 $m^3/h\ m^2$). If a window has a rolling shutter, its permeability value should also include it. Climate zones A, B, C, D and E refer to Continental Spain. Zone α refers to the Canary Islands.

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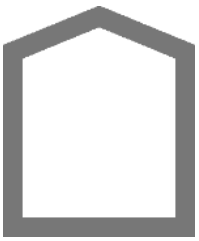
Envelope airtightness



- New dwellings >120m^2
- Based on compacity (Volume/Area)

Maximum n_{50} [h^{-1}] values at a pressure difference of 50 Pa

Compacity V/A [m^3/m^2]	n_{50}
V/A <= 2	**6**
V/A >= 4	**3**

where: n_{50} is the air change rate at 50 Pa $[h^{-1}]$; V is the internal volume of a building or part of a building $[m^3]$; A_{ET} is the sum of areas of the thermal building envelope with heat exchange with the outdoor air. Therefore, internal partitions and the envelope area in contact with other adjacent spaces or buildings are excluded $[m^2]$. Note: the limit permeability values for intermediate V/A values can be obtained by interpolation.

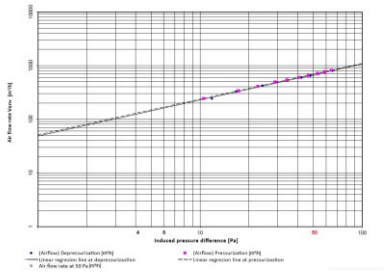
6

Building airtightness justification

OPTION A

BlowerDoor test

- ISO 9972, Method 2
- No other specification
- No qualification scheme for testers. The number of testers is unknown.



O P T I O N B

Analytically

$$n_{50} = 0.629 \cdot \frac{C_0 \cdot A_0 + C_h \cdot A_h}{V}$$

where:
n_{50} is the calculated air change rate at 50 Pa $[h^{-1}]$
V is the internal volume $[m^3]$
C_0 is the airflow coefficient of the opaque part of the thermal envelope at a reference pressure of 100 Pa $[m^3/h\,m^2]$. Reference values:
- New or existing buildings with improved airtightness, C_0 = 16 $m^3/h\,m^2$
- Existing buildings C_0 = 29 $m^3/h\,m^2$

A_0 is the sum of areas of the opaque thermal building envelope $[m^2]$
C_h is the permeability of doors and windows in the thermal building envelope at a reference pressure of 100 Pa $[m^3/h\,m^2]$
A_h is the sum of the area of the doors and windows of the thermal building envelope $[m^2]$. The thermal building envelope consists of the building parts with heat exchange with the outdoor air. Therefore, internal partitions in contact with adjacent indoor spaces or buildings are excluded.

7

Analytical model validation

- This is the widespread approach
- Input values of the energy performance calculation
- Airtightness test results were compared to calculated values
- Lack of linear association between the values of the CTE model and the test values

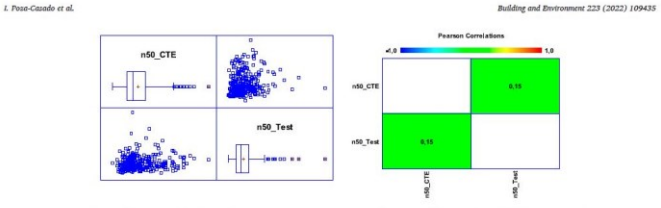


Fig. 1. Correlation analysis between the n_{50} values obtained from pressurization tests and those computed using the CTE model.

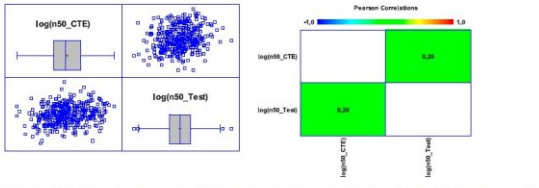


Fig. 2. Correlation analysis between the logarithms of the n_{50} values obtained in the pressurization tests and those computed using the CTE model.

Poza-Casado, I., Rodríguez-del-Tío, P., Fernández-Temprano, M., Padilla-Marcos, M.-Á., & Meiss, A. (2022). An envelope airtightness predictive model for residential buildings in Spain. Building and Environment, 223(July), 109435. https://doi.org/10.1016/j.buildenv.2022.109435

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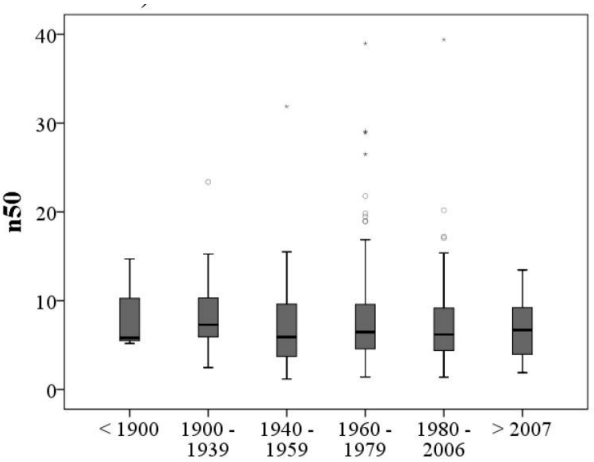
Building airtightness tests performed

- No official data regarding testing
  - 2015-2019: increase in testing mainly promoted by voluntary certifications
  - 2019 onwards: slight increase
- No official airtightness database
  - Available data from research projects since 2011. INFILES Project, first representative sample of the Spanish residential building stock.
  - Unavailable data from companies

INFILES Project. Location of the cases.

Evolution of the airtightness level

- Results from INFILES Project
- No statistically significant relation between airtightness and the period of construction
- Slight trend of improvement
- Reasons?
  - No concern
  - Traditional building systems
  - No requirements
- GAP: no recent data!!



Poza-Casado, I., Meiss, A., Padilla-Marcos, M. Á., & Feijó-Muñoz, J. (2018). Preliminary analysis results of Spanish residential air leakage database. 39th AIVC - 7th TightVent & 5th Venticool Conference "Smart Ventilation for Buildings." Retrieved from https://www.aivc.org/resources/collection-publications/aivc-conference-proceedings-presentations

Conclusions

- Raised awareness for the past few years
- Positive progress towards energy-efficient buildings
- Trends towards:
  - More demanding limits
  - Mandatory compliance for buildings of any kind and size, at least for the most extreme climate zones
- Gaps:
  - Mandatory testing: real performance values
  - Airtighness database
  - Qualification frame for testers
  - Specific guidelines: testing and designing

DUCT TESTING IN BUILDINGS

SERGIO MELGOSA REVILLAS

REQUIREMENTS AND DRIVERS

- RITE, IT 1.2.4.2.3
- UNE-EN 12237, UNE-EN 1507 and UNE-EN 13403

- NO SPECIFIC QUALIFICATION

13

What to test

- Single family houses 0%
- Multi-family houses 0%
- Public schools 0%
- Non public schools 10%
- Office Buildings 50%
- Hospitals 30%
- Other Buildings 10%

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EQUIPMENT FOR TESTING

Different equipment for different installation and preferences

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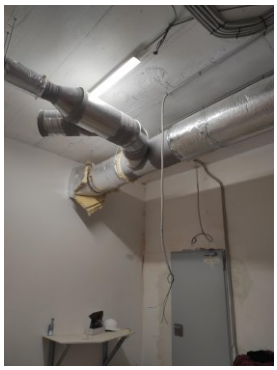
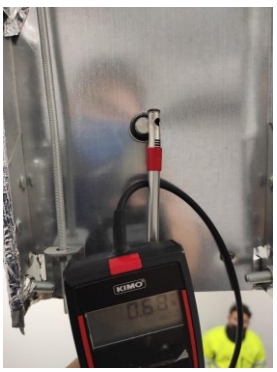
LEAKAGES REPARTITION

- Derivations and unions (joints)
- Dumps and grills





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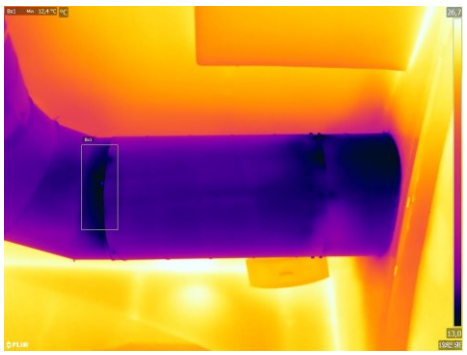
FINDING THE LEAKAGES

- Anemometer, fog machine, Infrared termal imaging, noise, dirty joints





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Thank you!

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