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BUILDING AND DUCTWORK AIRTIGHTNESS IN FRANCE NATIONAL TRENDS AND REQUIREMENTS

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4th May 2023

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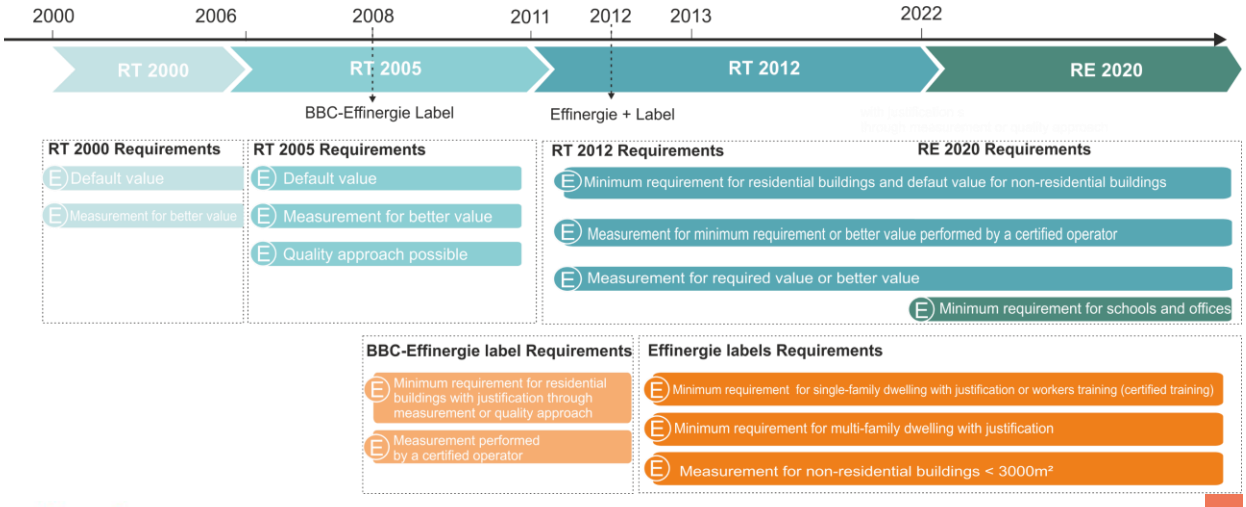
FRENCH CONTEXT OF BUILDING AIRTIGHTNESS



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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**)*

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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**

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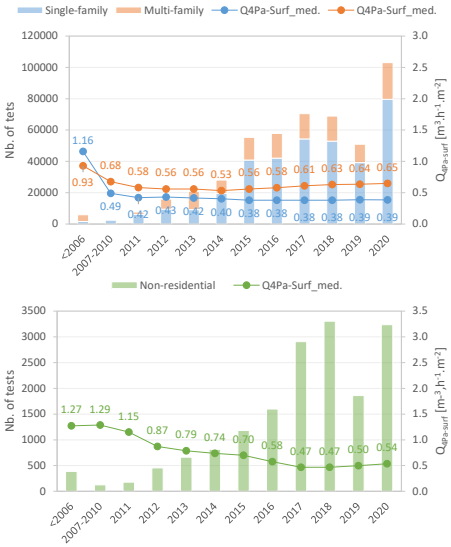
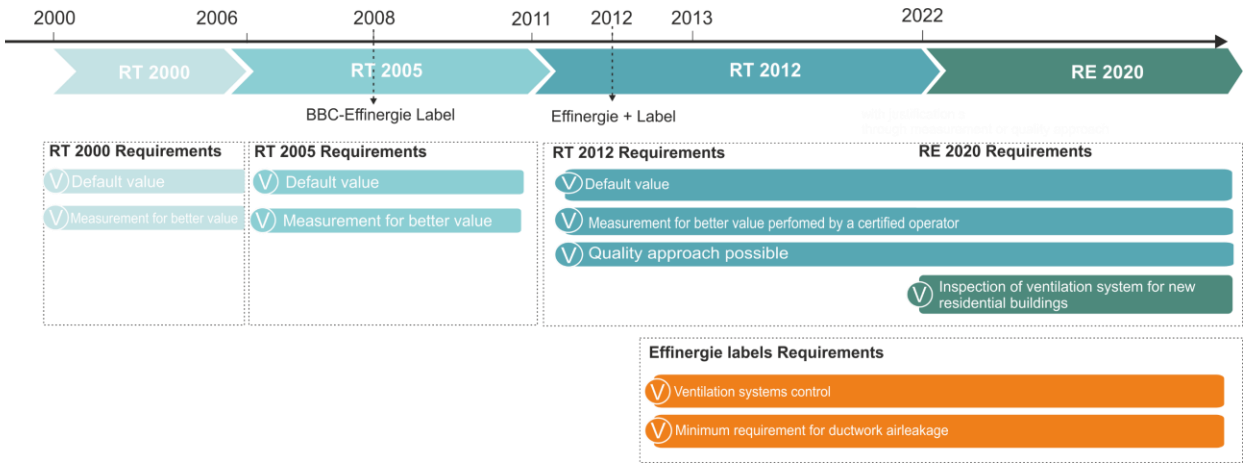
FRENCH CONTEXT OF BUILDING AIRTIGHTNESS

- **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

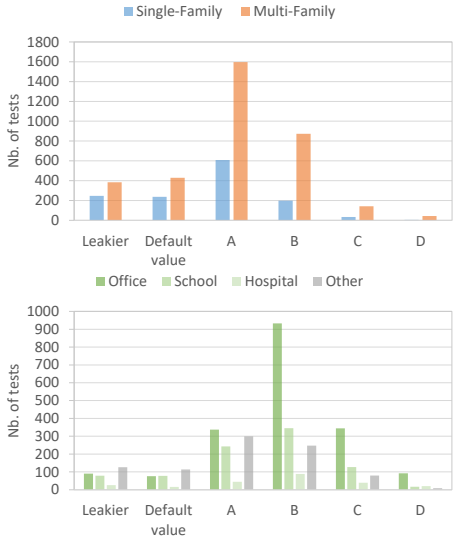
Regulatory context

- **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

* *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).