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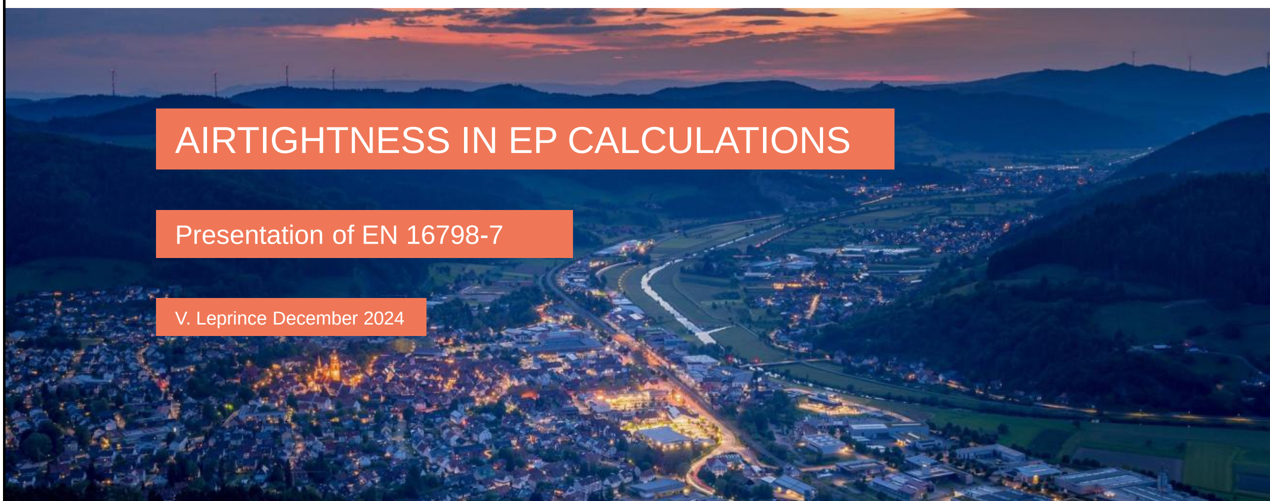
CLIMAT & TERRITOIRES DE DEMAIN



AIRTIGHTNESS IN EP CALCULATIONS

Presentation of EN 16798-7

V. Leprince December 2024

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SCOPE

1 Scope

This European Standard describes the methods to calculate the ventilation air flow rates for buildings to be used for energy calculations evaluation, heating and cooling loads.

This European Standard applies to buildings with:

- Mechanical ventilation systems (mechanical exhaust, mechanical supply or balanced system);
- Passive duct ventilation systems for residential and low-rise non-residential buildings;
- Combustion appliances;
- Windows opening by manual operation;
- Kitchens where cooking is for immediate use (including restaurants)

This European Standard is applicable to hybrid systems combining mechanical and passive duct ventilation systems in residential and low-rise non-residential buildings.

This European Standard applies to buildings smaller than 100 m and rooms where vertical air temperature difference is smaller than 15 K.

The results provided by the standard are:

- the air flow rates entering or leaving a ventilation zone;
- the air flow rates required to be distributed by the mechanical ventilation system, if present.

This European Standard is not applicable to:

- Buildings with kitchens where cooking is not for immediate use
- Buildings with automatic windows (or openings)
- Buildings with industry process ventilation.

The definition of ventilation and airtightness requirements (as indoor air quality, heating and cooling, safety, fire protection…) is not covered by this standard.

The following information can be found in other standards and technical reports:

- guidance to estimate pressure drops in ducts (CR 14378:2002)

Table 1 shows the relative position of this standard within the EN EPB package of standards.

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Part of the European Energy Performance of Buildings Standards - Ventilation (EN 16798 family) (former EN 15242)

Energy performance of buildings - Ventilation for buildings - Part 7 : calculation methods for the determination of air flow rates in buildings including infiltration (Modules M5-5)

Objective of the standard:

- To calculate the air exchange rates in a building
  - To include them in the energy performance calculation.

The scope specifies the limits of the standard

CALCULATION OF AIRFLOWS IN EN 16798-7

Two Methods Described:

- **Method 1:** Uses detailed building data for precise airflow rates (Equilibrium Pressure Model, EPM)
- **Method 2:** Simplified calculations by relying on national averages.

Countries can choose the approach based on local conditions.

METHOD 1: MAIN INPUT AND OUTPUT

Inputs: detailed characteristics of…

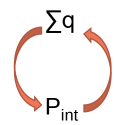
- Leakages
- Air inlets
- Windows
- Passive ducts
- Combustion system
- Ventilation system

→

Output: airflow through

- Leaks
- Air inlets
- Windows
- Passive ducts
- Combustion system
- Ventilation system

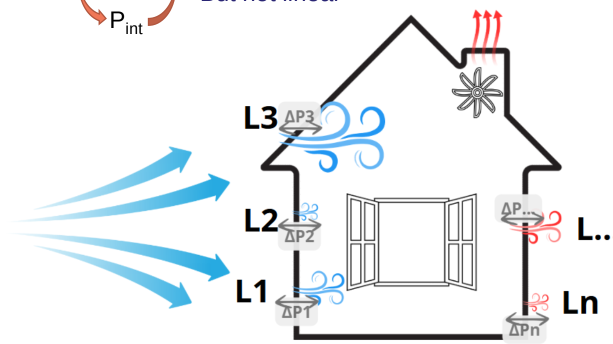
METHOD 1: THE EQUILIBRIUM PRESSURE MODEL



1 equation with 1 unknown variable…
But not linear

A dynamic method for calculating air infiltration in buildings.

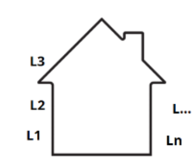
- Based on a **mass balance equation** to determine pressure distribution.
- Requires inputs on:
  - Pressure distribution across the building envelope.
  - Leakage characteristics and airflow paths.



DETERMININING THE LEAKAGE DISTRIBUTION

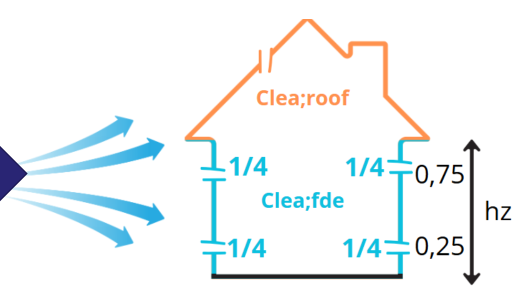
6.4.3.6.3 Envelope leakage distribution

The envelope leakage shall be distributed assuming pre-defined locations of the leakage paths: B.3.3.16 gives default values for the flow characteristics of the airflow paths for default airflow path heights and wind orientation.



$$C_{\text{lea}} = q_{V;\Delta p_{\text{lea;ref}}} \frac{A_{\text{lea}}}{\Delta p_{\text{lea;ref}}^{n_{\text{lea}}}}$$

Default leakage distribution



$$C_{\text{lea;fde}} = C_{\text{lea}} \cdot \frac{A_{\text{fde}}}{A_{\text{fde}} + A_{\text{roof}}}$$

n_{50} or Q_{50} => Clea
General for the tested zone => no information on how much leakage there is and the characteristics of each

Default value for n_{lea} : 0,667

DETERMINING FLOWRATE THROUGH LEAKAGE

$$q_{V;lea;path,i} = C_{lea;path,i} \cdot sign\left(\Delta p_{lea;path,i}\right) \cdot \left|\Delta p_{lea;path,i}\right|^{n_{lea}}$$

What is the pressure difference at each leakage?

⇒Different from one leakage to another

$$\Delta p_{path,i} = p_{e;path,i} - p_{z;path,i}$$

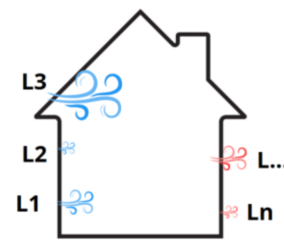
Wind impact

$$p_{e;path,i} = \rho_{a,ref} \cdot \frac{T_{e;ref}}{T_e} \cdot \left(0,5 \times C_{p;path,i} \cdot u_{site}^2 - h_{path,i} \cdot g\right)$$

$$p_{z;path,i} = p_{z;ref} - \rho_{a,ref} \cdot h_{path,i} \cdot g \cdot \frac{T_{e;ref}}{T_z}$$

Thermal draft

?? Internal equilibrium pressure => result of the full calculation



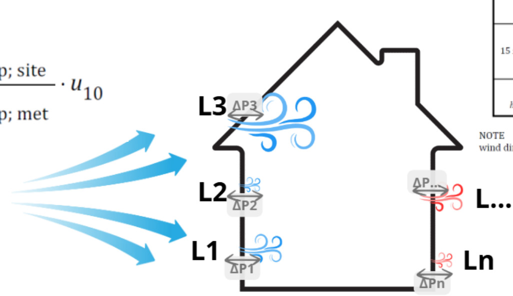
WIND IMPACT ON THE PRESSURE AT EACH LEAK

Pressure coefficient depends on:

- Its height on the facade
- The facade exposure to wind

Wind speed

$$u_{site} = \frac{C_{rgh;\,site} \cdot C_{top;\,site}}{C_{rgh;\,met} \cdot C_{top;\,met}} \cdot u_{10}$$



B.3.3.3 Pressure coefficients associated to an air flow path

Table B.7 gives C_p values for ventilation zone that can be cross-ventilated (f_{cros} = 1) depending on the height of the air flow path on the façade and its shielding class.

Table B.7 — Dimensionless wind pressures coefficients

Height of air flow path on façade	Shielding class	Dimensionless wind pressures C_p				
		Windward Cp1	Leeward Cp2	Roof (depending on slope) Cp3		
				< 10°	10°-30°	> 30°
Low h_{path} < 15 m	Open	+ 0,50	- 0,70	- 0,70	- 0,60	- 0,20
	Normal	+ 0,25	- 0,50	- 0,60	- 0,50	- 0,20
	Shielded	+ 0,05	- 0,30	- 0,50	- 0,40	- 0,20
Medium 15 ≤ h_{path} < 50 m	Open	+ 0,65	- 0,70	- 0,70	- 0,60	- 0,20
	Normal	+ 0,45	- 0,50	- 0,60	- 0,50	- 0,20
	Shielded	+ 0,25	- 0,30	- 0,50	- 0,40	- 0,20
High h_{path} ≥ 50 m	Open	+ 0,80	- 0,70	- 0,70	- 0,60	- 0,20

NOTE The wind pressure coefficients given are valid for a wind sector of approx. ± 60° to the facade axis. The wind direction is not considered more specifically.

CALCULATION OF THE EQUILIBRIUM PRESSURE

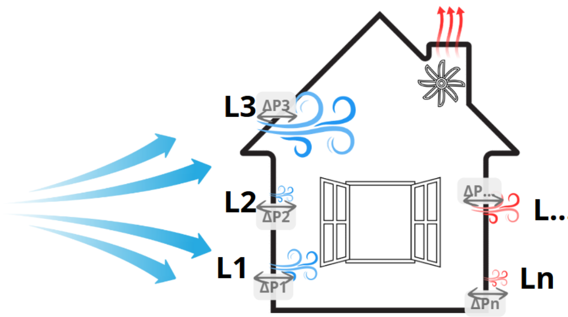
6.4.3.9 Implicit mass balance formula for determining internal reference pressure

The internal reference pressure used to calculate the air mass flow rates shall be calculated by solving the following mass balance formula:

$$q_{m;V;SUP;dis} + q_{m;V;ETA;dis} + q_{m;V;comb;in} + q_{m;V;comb;out} + q_{m;V;pdu;in} + q_{m;V;pdu;out} + q_{m;V;arg;in} + q_{m;V;arg;out} + q_{m;V;vent;in} + q_{m;V;vent;out} + q_{m;V;lea;in} + q_{m;V;lea;out} = 0 \qquad (67)$$

with the internal reference pressure $p_{z;ref}$ as unknown.

The air volume or mass flow rate entering or leaving the ventilation zone through each air flow path described in 6.1 can be obtained by substituting the calculated $p_{z;ref}$ in the relevant formulae.



⇒ The impact of leakage

- ⇒ Depends on every other opening and on the ventilation system
- ⇒ Varies along the year
  - ⇒ The more wind, the more themperature difference… the more impact

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WHY EPM IS MORE ACCURATE THAN SIMPLIFIED METHODS?

Provides dynamic infiltration rates, often calculated **hourly**.

Considers real-time factors like:

- Wind speed and direction.
- Indoor and outdoor temperature differences.
- Aligns with methodologies from airflow simulation tools like CONTAM.

Method used at least in France and Czech Republic

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KEY BENEFITS AND CHALLENGES OF EPM

Benefits:

- Higher accuracy than simplified infiltration models.
- Matches well with measured data (e.g., tracer gas methods).

Challenges:

- Requires detailed data on building cracks and pressure distribution.
- Requires computational calculation

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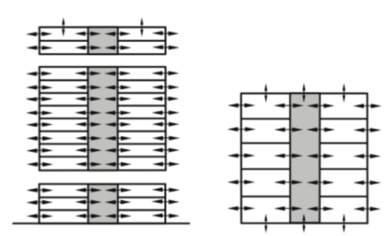
FUTUR CHALLENGE FOR EN 16798-7

Include multizone calculation

- Huge impact on actual airflow rate crossing the envelope

Include simplified calculation both for heating and cooling seasons

- All existing equations are meant to be safe-side for heating period



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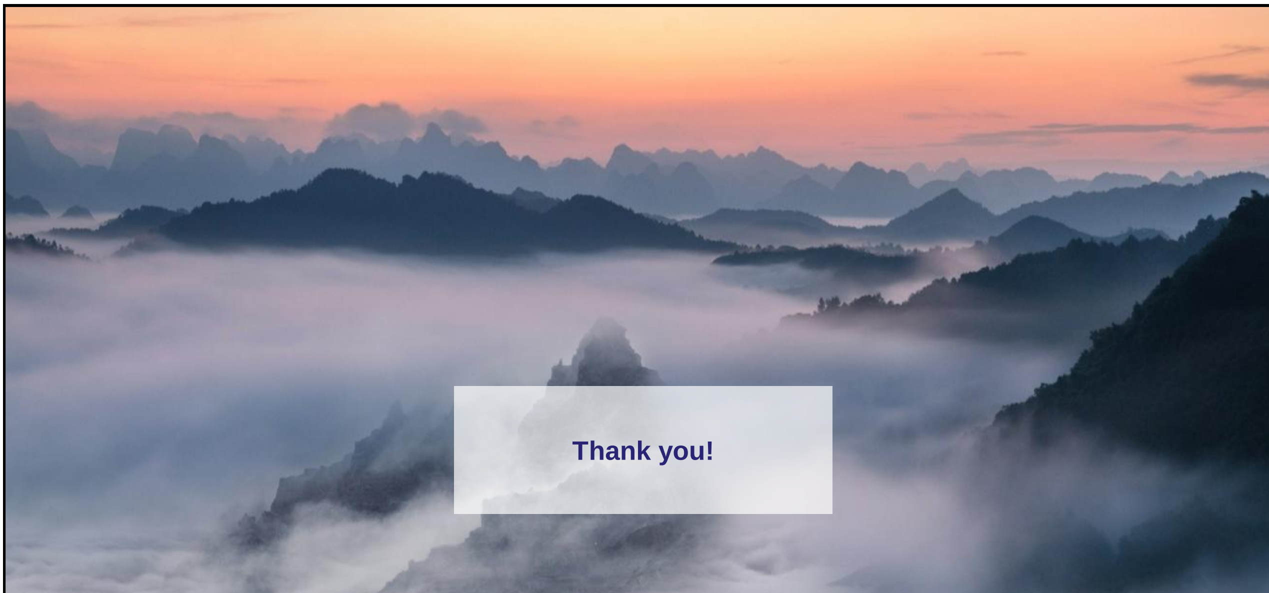

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