What is Ventilation?

The intentional supply of outdoor air to, and extraction of indoor air from, a dwelling to dilute and remove pollutants (moisture, CO_2, VOCs, odours, combustion by-products) while supporting occupant health, limiting condensation risk, and maintaining energy efficiency in line with Building Regulations Part F requirements for means, rates and control of ventilation in domestic buildings in England.

Ventilation in UK housing combines three interacting pathways:

1. purpose-provided ventilation (mechanical systems and background ventilators),
2. purge ventilation (usually rapid opening of windows / doors), and
3. infiltration (adventitious air leakage through the fabric).

Approved Document F requires that design ventilation rates are achieved by combining these pathways in a controlled, predictable manner rather than relying on uncontrolled infiltration alone. Properly designed ventilation is also coordinated with thermal performance upgrades under Part L to avoid creating unintended moisture and indoor air quality issues when airtightness is improved. Avoidance of summertime overheating (Part O) interacts with purge ventilation strategies (e.g., window opening areas). In retrofit, enhanced airtightness (e.g., EnerPHit-style refurbishments) typically necessitates continuous mechanical systems (e.g., MVHR) to maintain indoor air quality and manage humidity while recovering heat.

Regulatory Context (England – latest published revision at time of writing):

- Approved Document F 2021 (in force from 15 June 2022 for most new work) sets out ventilation system types (System 1: background + intermittent extract; System 2: passive stack; System 3: continuous mechanical extract (MEV / dMEV); System 4: continuous mechanical supply and extract with heat recovery (MVHR)) and associated performance criteria.
- Part L (Conservation of fuel and power) emphasises airtightness and energy efficiency; increasing airtightness heightens the importance of correctly designed, commissioned and maintainable ventilation.
- Part O (Overheating) recognises purge ventilation as a mitigation measure; design must balance noise, security and indoor air quality considerations with overheating risk.
- Damp and mould risk is mitigated by adequate ventilation, as highlighted in government guidance addressing health risks in homes.

Selected Performance Examples (extract/purge design figures from Approved Document F):

- Intermittent extract fan minimum extract rates: kitchen 30 L/s (adjacent to hob) or 60 L/s (elsewhere), bathroom 15 L/s, utility room 15 L/s, WC 6 L/s (with or without window).
- Example whole dwelling continuous supply (MVHR) design rates scale with bedrooms (e.g., 1-bedroom 19 L/s up to 5-bedroom 43 L/s).
- Purge ventilation is typically achieved by openable window areas sized to achieve rapid air change (see Section on purge ventilation in Approved Document F).

Practical Application Examples (UK domestic context):

- Loft conversion: Added airtightness from new insulation layers can raise winter humidity; installing continuous dMEV in new shower room plus ensuring adequate background ventilators in existing rooms helps maintain balanced moisture removal.
- Deep retrofit (solid wall insulation + new windows): Replacement of leaky sash windows with modern airtight units often necessitates adding trickle ventilators or adopting MVHR to maintain ventilation rates and limit condensation on colder bridging points.
- New-build extension incorporating open-plan kitchen: Specifying an efficient, quiet, appropriately ducted intermittent or continuous extract close to the hob reduces moisture migration to cooler existing rooms, reducing mould risk.

Common Pitfalls of Ventilation:

- **Relying on infiltration**: Unpredictable; does not reliably meet minimum ventilation rates in low-leakage (airtight) retrofits.
- **Undersized or obstructed background ventilators**: Reduces effective equivalent area; verify cumulative equivalent areas per dwelling design stage.
- **Poor duct routing (crushing / excessive bends)**: Increases resistance, lowering delivered airflow versus design. Commissioning measurements (e.g., using calibrated airflow hood) are essential.
- **Omission of commissioning records**: Part F requires provision of testing and commissioning information to occupants and Building Control; absence compromises verification and occupant operation.
- **Noise leading occupants to disable systems**: Select low specific fan power, low-noise fans; site MVHR units away from bedrooms and use attenuators where necessary.

Best Practice Recommendations:

- Integrate ventilation strategy early with fabric and services design to ensure routes for ducts, minimise length and thermal bridging, and coordinate with structural openings.
- Target balanced mechanical ventilation with heat recovery (MVHR) for high airtightness retrofits (e.g., air permeability ≤3 $m^3/(h \cdot m^2)$ at 50 Pa) to sustain indoor air quality while reducing heating demand (heat recovery unit selection per SAP Appendix Q assumptions).
- Adopt demand-controlled boost (humidity / CO_2 sensors) only where reliably commissioned and understood by occupants; maintain baseline rates at or above regulatory minima.
- Provide clear user guidance (filter changes, boost operation, window use for purge) in the handover pack as required under Approved Document F (Commissioning and Handover).
- Coordinate purge ventilation calculations with Part O overheating assessments to ensure sufficient free area while addressing security and noise constraints (e.g., window restrictors, acoustic vents).

Health and Indoor Air Quality (IAQ) Link:

Adequate ventilation assists in controlling relative humidity levels that, if persistently elevated, can contribute to mould growth, with associated health risks particularly for vulnerable occupants (children, those with respiratory conditions) as highlighted in government health risk guidance on damp and mould.

Retrofit Considerations:

When upgrading insulation and airtightness (e.g., external wall insulation, new membranes,

replacement windows), a ventilation assessment should verify whether existing intermittent extract plus background ventilation remains sufficient or whether a shift to continuous mechanical systems is warranted. Failure to adapt ventilation when significantly reducing infiltration may elevate internal moisture levels, surface RH at cold bridges, and interstitial condensation risk (risk assessment aligned with BS 5250 principles—note: standard text not cited here as domain restriction applies; regulatory cross-reference remains Part F).

Commissioning & Verification:

Approved Document F requires measured flow rates and provision of a commissioning notice to Building Control and the occupant. Delivered flow should match or exceed design minima; if not, remedial action (duct adjustments, fan speed changes) should be undertaken before sign-off.

Operation & Maintenance:

Filters (in MVHR) should be replaced or cleaned per manufacturer instructions (commonly every 3–6 months for coarse filters; at least annually for finer filters—verify with manufacturer; if not stated in a regulation, occupant guidance must clarify). Blocked filters reduce airflow and efficiency; occupants should be trained to recognise maintenance indicators provided in handover documentation mandated by Part F.

Energy Interaction:

Part L airtightness improvements can reduce uncontrolled heat loss; without suitable ventilation strategy, this can inadvertently reduce background air change. MVHR reconciles energy and air quality by transferring heat between outgoing and incoming air streams; achieving intended efficiency depends on good insulation of ductwork outside thermal envelope and avoidance of leakage at joints.

Cross-Regulatory Coordination:

- Part F (ventilation performance, system types, commissioning).
- Part L (interaction of airtightness and energy performance).
- Part O (purge ventilation and summertime overheating strategy).
- Health-related government guidance (damp and mould risk mitigation via adequate ventilation).

Related Terms (Supplementary Glossary Entries)

Air Change Rate (Air Changes per Hour, ACH)

Definition: The number of times the entire volume of indoor air is theoretically replaced with outdoor air in one hour.
Explanation: Used in design and assessment to express ventilation adequacy; in UK dwellings, regulatory compliance is typically demonstrated via specific extract/supply flow rates rather than a single ACH value, but ACH is still referenced in performance analysis (e.g., comparing infiltration test results with design ventilation provision).
Example: A retrofit achieving 3 $m^3/(h \cdot m^2)$ at 50 Pa air permeability may exhibit significantly lower background ACH under typical pressure conditions, reinforcing need for purpose-provided ventilation.

Mechanical Ventilation with Heat Recovery (MVHR)

Definition: A balanced ventilation system (Part F System 4) providing continuous mechanical supply and extract with a heat exchanger transferring heat from exhaust to incoming fresh air.
Explanation: Promotes controlled airflows, heat retention, and filtered supply air—common in airtight new builds and deep retrofits. Reduces heating demand while maintaining IAQ, provided commissioning and maintenance (filter changes, balanced flows) are properly executed.
Example: A 3-bedroom new-build installing MVHR sized to deliver circa 31 L/s whole dwelling supply (example value from design table) with individual room supply/extract terminals balanced at commissioning.

C. Background Ventilators (Trickle Vents / Background Ventilation Openings)

Definition: Purpose-provided, normally small, controllable ventilation openings (often in window frames) supplying background fresh air (System 1 or supplement in other systems).
Explanation: Equivalent area requirements per room type aggregate to meet whole dwelling background ventilation; must remain user-adjustable and not be permanently closed for compliance.
Example: Replacement windows in a retrofit include suitably sized trickle vents to maintain background ventilation after reducing infiltration through improved window sealing.

D. Intermittent Extract Fan

Definition: A mechanically driven extract fan operating intermittently (manually switched or automatically via occupancy / humidity trigger) in moisture / pollutant generating rooms (kitchens, bathrooms, WCs) (System 1).
Explanation: Must meet minimum extract rates (e.g., 30 L/s adjacent to hob or 60 L/s elsewhere for kitchens; 15 L/s bathrooms) with effective overrun where specified to manage residual moisture.
Example: A through-the-wall axial fan with timer overrun in a bathroom reduces post-shower humidity peaks, lowering condensation risk on colder retrofit-improved surfaces.

E. Continuous Mechanical Extract Ventilation (MEV / dMEV)

Definition: A ventilation approach (System 3) using continuously operating centralised (MEV) or decentralised (dMEV) fans extracting from wet rooms; make-up air is admitted via background ventilators in habitable rooms.
Explanation: Provides consistent moisture and pollutant removal; sizing ensures both minimum extract per wet room and whole dwelling rates; background ventilators must not be omitted.
Example: A dMEV fan in a kitchen runs continuously at a low trickle (e.g., meeting design whole dwelling flow) with boost activated by occupant switch when cooking.

F. Infiltration (Adventitious Ventilation)

Definition: Uncontrolled flow of external air into a dwelling through unintended gaps, cracks, and porous materials, driven by wind and stack effects.
Explanation: Not reliable for meeting regulatory ventilation requirements in modern or retrofitted airtight dwellings; design should not depend solely on infiltration for baseline ventilation.
Example: Pre-retrofit solid wall terrace relied partly on leaky sash windows; post-window-replacement infiltration decreased, necessitating added purpose-provided ventilation to maintain indoor moisture control.

G. Indoor Air Quality (IAQ)

Definition: The condition of indoor air as it relates to occupant health and comfort, considering

pollutants such as CO_2, moisture, particulates, VOCs, and biological contaminants.
Explanation: Part F ventilation provision aims to dilute/remove indoor-generated pollutants; poor IAQ is associated with increased condensation, mould and health risks highlighted in government guidance on damp and mould.
Example: CO_2 readings exceeding typical comfort benchmarks (e.g., 1500 ppm during occupied evening periods) in a retrofitted dwelling indicate insufficient background ventilation or imbalance in MVHR commissioning (CO_2 benchmark figure widely used in practice; regulatory focus remains on prescribed airflow rates—CO_2 thresholds beyond regulatory text should be treated as practitioner guidance rather than a regulatory limit).