

Ultimate Guide to Mechanical Ventilation with Heat Recovery Systems to Meet Approved Document F

Introduction: The Imperative of Ventilation and the Role of MVHR in UK Dwellings

The standards governing ventilation in the United Kingdom have undergone a significant evolution, reflecting a growing understanding of the critical role that indoor air quality plays in public health and building performance.

Historically, ventilation in dwellings relied heavily on natural means, such as opening windows, coupled with intermittent extract fans in areas prone to moisture, like kitchens and bathrooms. However, contemporary construction practices increasingly prioritize energy efficiency, leading to the development of more airtight building envelopes. This enhanced airtightness, while beneficial for thermal performance, inherently limits the effectiveness of traditional natural ventilation strategies, necessitating the adoption of more controlled and sophisticated ventilation methods to ensure healthy indoor environments.

This shift is clearly reflected in the updated Building Regulations Approved Document F (Ventilation), which came into effect on 15th June 2022 for use in England. A primary objective of this updated document is to improve air quality within buildings and mitigate the risk of mould growth, which is recognized as a significant hazard to health. The increased emphasis on ventilation within Approved Document F underscores a growing societal recognition of the profound impact that the air we breathe indoors has on our well-being.

In response to the need for effective and energy-efficient ventilation in modern, airtight homes, Mechanical Ventilation with Heat Recovery (MVHR) systems have emerged as a holistic solution.

An MVHR system is a comprehensive, whole-house ventilation approach that employs mechanical means to continuously extract stale, damp air from the building and simultaneously draw in fresh air from the outside. Crucially, these systems incorporate a heat recovery mechanism that transfers heat from the outgoing stale air to the incoming fresh air, thereby minimizing energy losses. This balanced supply and extract methodology ensures a consistent exchange of air throughout the dwelling.

The integration of heat recovery offers a multitude of benefits, including significantly improved indoor air quality, enhanced energy efficiency by reducing heating demands, and a marked reduction in condensation and associated dampness. The dual functionality of MVHR, addressing both air quality and energy conservation, positions it as a pivotal technology in the pursuit of sustainable building practices. By providing controlled ventilation while simultaneously recovering energy, MVHR systems offer a comprehensive approach that aligns with the increasingly stringent demands of building regulations and the growing awareness of the importance of healthy and energy-efficient homes.

This guide aims to provide a thorough understanding of Mechanical Ventilation with Heat Recovery (MVHR) systems specifically within the context of meeting the requirements stipulated in the UK's

Approved Document F for dwellings in England. It is important to note that Approved Document F is divided into two volumes, with Volume 1 specifically addressing ventilation in dwellings. By focusing on Approved Document F, this guide ensures its direct relevance and practical applicability for individuals and organizations involved in residential building projects in England who need to comply with the prevailing building regulations.

Decoding Approved Document F: Key Ventilation Requirements for MVHR Systems in England

To effectively implement an MVHR system that meets regulatory standards, a fundamental understanding of the legal framework provided by Approved Document F is essential.

Approved Documents are issued by the Secretary of State and offer practical guidance on how to comply with the requirements set out in the Building Regulations 2010. While these documents provide detailed guidance, it is crucial to recognize that the legal obligation lies in meeting the requirements of the Building Regulations themselves, and the Approved Documents offer a common pathway to achieving this compliance.

The primary requirement concerning ventilation is F1(1), which states unequivocally that “There shall be adequate means of ventilation provided for people in the building”. A secondary, but equally important, requirement, F1(2), pertains to the commissioning of ventilation systems and the provision of adequate information to the building owner regarding the system’s operation and maintenance.

Within Approved Document F, Mechanical Ventilation with Heat Recovery (MVHR) is specifically identified as “System 4”. To comply with the regulations when using an MVHR system, several specific performance criteria must be met. These include adherence to minimum whole dwelling ventilation rates, which are directly linked to the number of bedrooms in the dwelling (as detailed in Table 1.3 of ADF1).

The following table summarizes these minimum ventilation rates:

Number of bedrooms	Minimum ventilation rate (Litres per second)
One	19
Two	25
Three	31
Four	37
Five	43

Furthermore, Approved Document F specifies minimum extract ventilation rates for the wet rooms within a dwelling, as outlined in Table 1.2 of ADF1. These rates are essential for effectively removing moisture and pollutants at their source:

Room	High rate (Litres per second)
Kitchen	13
Utility room	8
Bathroom	8
Toilet	6

A fundamental requirement for MVHR systems is the provision of balanced supply and extract

airflow, ensuring that the volume of air entering the dwelling is approximately equal to the volume of air being extracted.

The 2021 update to Approved Document F also increased the minimum heat recovery efficiency required for MVHR systems to 73%, up from 70%. Additionally, the regulations mandate the inclusion of a summer bypass mechanism and a variable speed controller within the MVHR unit. Notably, dwellings employing MVHR systems as the primary means of ventilation are not required to have background ventilators, such as trickle vents, installed in windows.

Finally, Approved Document F provides guidance on the provision of purge ventilation, which is the rapid removal of high concentrations of pollutants from the building when necessary. The updated regulations, particularly the increased minimum ventilation rates, necessitate careful consideration during the design and specification of MVHR systems to guarantee compliance.

The air permeability of the building fabric is another crucial factor that influences ventilation requirements.

Approved Document F assumes a design air permeability of $\leq 5 \text{ m}^3/\text{h}\cdot\text{m}^2$ at 50Pa for new homes. Dwellings with air permeability exceeding this threshold may require adjustments to the ventilation strategy to ensure adequate air exchange. In essence, the tighter the building envelope, the more critical the role of a controlled mechanical ventilation system like MVHR becomes, and the system design must be tailored to the specific air permeability characteristics of the dwelling.

The Science Behind MVHR: Principles of Operation and Heat Recovery

Mechanical Ventilation with Heat Recovery systems operate on the fundamental principle of continuously exchanging indoor air with outdoor air using mechanical means, primarily fans.

These systems are designed to supply fresh, filtered air into habitable rooms, such as bedrooms and living areas, while simultaneously extracting stale, humid air from wet rooms, including kitchens, bathrooms, and utility rooms. This continuous and simultaneous supply and extract process creates a balanced ventilation system, meaning that the air pressure inside the dwelling is neither significantly positive nor negative relative to the outside. This balanced approach is crucial for maintaining consistent air quality throughout the entire home.

At the core of an MVHR system lies the heat exchanger, which is the key component responsible for the heat recovery aspect of the system.

The heat exchanger facilitates the transfer of heat from the outgoing stale air to the incoming fresh air without allowing the two air streams to mix directly. In colder months, the warmer exhaust air passes through the heat exchanger, transferring a significant portion of its heat energy to the colder fresh air being drawn into the building. This pre-warming of the incoming air drastically reduces the energy required to heat the home.

Modern MVHR systems can achieve impressive heat recovery efficiencies, often up to 90% or even higher in well-designed and efficient units. This high level of heat recovery is a defining characteristic of MVHR systems, enabling substantial energy savings by minimizing heat loss through ventilation.

In addition to air exchange and heat recovery, MVHR systems typically incorporate air filtration mechanisms to enhance indoor air quality. These filters are designed to capture airborne particles

such as pollen, dust, and other pollutants from the incoming fresh air before it is circulated throughout the dwelling. This filtration process contributes significantly to a healthier indoor environment, particularly beneficial for individuals with allergies or respiratory sensitivities.

Some MVHR systems offer the option of installing more advanced filters, such as those designed to remove nitrogen oxides (NOx) or fine particulate matter (PM2.5), which can be particularly advantageous in areas with high levels of outdoor air pollution.

Many MVHR systems are also equipped with a summer bypass function.

During warmer months, when heating is not required, this feature allows the incoming fresh air to bypass the heat exchanger, so it is not pre-heated by the outgoing air. This ensures that the system provides fresh, filtered air without inadvertently increasing the indoor temperature, thereby maintaining comfort during the summer. The summer bypass mechanism is often activated automatically based on temperature sensors or can be manually controlled by the user.

Unlocking the Benefits: How MVHR Enhances Energy Efficiency and Indoor Air Quality

The incorporation of Mechanical Ventilation with Heat Recovery systems into dwellings offers a wide array of significant benefits, primarily centred around enhanced energy efficiency and a substantial improvement in indoor air quality.

The most notable energy efficiency gain stems from the system's ability to recover heat from the outgoing stale air and transfer it to the incoming fresh air. This process significantly reduces the demand on the home's heating system, with estimates suggesting a potential reduction in heating energy consumption of around 25% or even more. Consequently, homeowners can experience lower energy bills and a reduced carbon footprint associated with heating their homes.

While MVHR systems do consume a small amount of electricity to power the fans, the energy savings achieved through heat recovery typically far outweigh this operational cost. In fact, some studies suggest that the initial investment in an MVHR system can be recouped within a few years due to the substantial reductions in energy expenditure. By effectively retaining heat within the dwelling, MVHR systems allow the central heating system to operate more efficiently, further contributing to overall energy savings.

Beyond energy efficiency, MVHR systems deliver a marked improvement in indoor air quality.

By continuously supplying fresh, filtered air and extracting stale air, these systems effectively remove a wide range of indoor pollutants, allergens, odours, and excess moisture. Poor indoor air quality has been linked to an increased risk of various health issues, including respiratory and cardiovascular illnesses, cognitive impairment, and even certain cancers. The filtration component of MVHR systems is particularly beneficial for individuals suffering from asthma and allergies, as it removes airborne allergens like pollen and dust, creating a healthier living environment. In modern, tightly sealed homes, where the natural exchange of air is limited, MVHR systems play a crucial role in preventing the build-up of these harmful indoor pollutants.

Furthermore, MVHR systems are highly effective in preventing condensation and the growth of mould by continuously extracting humidity from wet rooms such as kitchens and bathrooms.

Excessive humidity can lead to condensation on surfaces, which in turn can create ideal conditions for mould growth. Mould not only damages the building structure but can also have significant

negative impacts on the health of occupants. By maintaining controlled humidity levels, MVHR systems help protect the building fabric and ensure a healthier indoor environment.

Beyond the tangible benefits of energy efficiency and air quality, MVHR systems also contribute to enhanced comfort and security within the home.

The continuous exchange of air helps maintain a comfortable and stable indoor climate without the draughts often associated with traditional ventilation methods like opening windows. Additionally, because ventilation is provided mechanically and continuously, homeowners can keep their windows closed, which helps to reduce the infiltration of external noise, particularly in noisy urban environments. This also enhances security, as ventilation is achieved without the need to leave windows open.

Navigating the Options: Centralized vs. Decentralized MVHR Systems for English Homes

When considering the implementation of an MVHR system, one of the initial decisions involves choosing between a centralized or a decentralized approach.

Centralized MVHR systems typically consist of a single, centrally located air handling unit that is connected to a network of ductwork distributing fresh air to and extracting stale air from various rooms throughout the entire building. This single unit manages the ventilation for the whole dwelling. Centralized systems require dedicated space for the main unit and the extensive network of ducting, which is often concealed within ceiling voids or located in a utility room.

Due to the complexity of installing ductwork throughout the building, centralized MVHR systems are generally more suitable for new construction projects or major renovation works where the building's structure is being significantly altered. A key advantage of centralized systems is their ability to provide uniform air quality control across all areas of the dwelling.

In contrast, decentralized MVHR systems involve the installation of individual, self-contained ventilation units within specific rooms.

These units are typically mounted on external walls and do not require an extensive network of ductwork, making them a more straightforward solution for retrofitting into existing properties where installing ducts might be challenging or disruptive. Decentralized systems offer greater flexibility in design and installation, allowing homeowners to tailor ventilation to the specific needs of individual rooms. They can be used effectively for ventilating single rooms, extensions, or smaller buildings.

Decentralized MVHR provides more direct and localized control over ventilation in different areas of the building. Some decentralized systems utilize "push-pull" units that operate on a reversing cycle with a regenerative heat exchanger.

The decision between a centralized and a decentralized MVHR system hinges on several key considerations.

The size and layout of the building are significant factors, as larger or more complex layouts might benefit from the comprehensive coverage of a centralized system. The extent of any planned renovation work is also crucial, as significant renovations make the installation of centralized ductwork more feasible. Budget constraints and installation costs can also play a role, as decentralized systems often have lower upfront installation costs due to the absence of extensive

ductwork.

The desired level of control and the need for zoning ventilation in different areas of the home might also influence the choice. Aesthetic preferences and the potential impact of visible units or ductwork on the interior design can also be a consideration.

Finally, the anticipated need for future modifications or expansions to the ventilation system might favour the flexibility offered by decentralized units. Ultimately, selecting the most appropriate MVHR system requires a careful evaluation of these factors in relation to the specific characteristics of the property and the homeowner's individual requirements.

Anatomy of an MVHR System: Essential Components Explained

A Mechanical Ventilation with Heat Recovery system comprises several key components, each playing a vital role in its overall functionality and performance.

The central hub of a centralized MVHR system is the Air Handling Unit (AHU). The AHU typically houses the heat exchanger, the supply and extract fans, air filters, and the system's control mechanisms. Within the AHU, there are two separate fans: one dedicated to supplying fresh air into the building and another responsible for extracting stale air. The quality and efficiency of the AHU directly impact the overall performance of the MVHR system, as it is where the core processes of air exchange and heat recovery take place.

The heat exchanger, located within the AHU, is the critical component responsible for transferring heat between the two air streams.

Several types of heat exchangers are used in MVHR systems, including crossflow, counterflow, and rotary heat exchangers. Counterflow plate heat exchangers are a common choice due to their ability to achieve high heat recovery efficiencies. Another type is the enthalpy heat exchanger, often used in Energy Recovery Ventilation (ERV) systems, which can recover both heat and moisture from the exhaust air. The type of heat exchanger employed significantly influences the system's heat recovery efficiency and its capacity to manage indoor humidity levels.

Air filters are an integral part of MVHR systems, ensuring that the air supplied to the dwelling is clean and free from particulate matter. Various types of filters are available, ranging from basic dust filters to more sophisticated pollen filters and even specialized filters designed to remove finer pollutants. Regular cleaning or replacement of these filters is essential for maintaining both the quality of the indoor air and the efficiency of the MVHR system.

For centralized MVHR systems, a network of ductwork is required to distribute the conditioned air throughout the building and to extract stale air from designated rooms.

Different types of ducting are available, including rigid ducts made of metal or plastic, semi-rigid ducts, and flexible ducts. Rigid ducts are generally preferred due to their lower air resistance and ease of cleaning. Proper sizing and insulation of the ductwork are crucial for ensuring the correct airflow rates, minimizing energy losses due to friction, and preventing condensation within the ducts.

Finally, MVHR systems incorporate various control mechanisms to allow users to manage their operation.

These can range from simple on/off switches and boost buttons for increasing ventilation rates when needed, to more sophisticated app-controlled systems that incorporate sensors to monitor humidity, carbon dioxide (CO₂) levels, and volatile organic compounds (VOCs), automatically adjusting ventilation accordingly. Many systems also include controls for activating the summer bypass function.

Designing for Compliance: MVHR System Considerations Under Approved Document F

Designing an MVHR system that complies with Approved Document F requires careful consideration of several key factors, with airflow rates being paramount.

The regulations specify minimum whole dwelling ventilation rates and minimum extract ventilation rates for wet rooms, as previously detailed. Achieving these rates necessitates accurate calculations based on the size and occupancy of the dwelling. Furthermore, Approved Document F mandates a balanced ventilation system, meaning the supply airflow rate should closely match the extract airflow rate.

Imbalances in airflow can lead to issues such as pressure differentials within the building, reduced heat recovery efficiency, and potentially increased energy consumption by the fans as they try to compensate. Therefore, meticulous design and balancing of airflow are essential for both regulatory compliance and optimal system performance.

The design of the ductwork system is equally critical.

Proper duct sizing is necessary to minimize pressure losses within the system and ensure that the required airflow rates are achieved at each air terminal. Minimizing the length of duct runs and the number of bends in the ductwork helps to reduce air resistance and improve energy efficiency. The placement of supply and extract air terminals must be carefully considered to ensure uniform distribution of fresh air throughout habitable rooms and effective extraction of stale air from wet rooms, while also avoiding draughts.

The system should also be designed to prevent the recirculation of moist air from wet rooms into other areas of the dwelling. A well-designed ductwork system is fundamental to achieving the required airflow rates, minimizing fan energy consumption, and providing comfortable and effective ventilation.

The location of the MVHR unit itself is another important design consideration.

Approved Document F recommends placing the unit in a dry room that maintains a relatively consistent temperature throughout the year, such as a utility room or a well-insulated loft space. Easy access to the unit for routine maintenance, particularly filter changes, is essential. Adequate space should be provided around the unit to facilitate maintenance and potential repairs. Furthermore, the potential for noise transmission from the unit to habitable rooms needs to be considered when selecting its location.

Finally, Approved Document F provides guidelines on minimizing noise generated by ventilation systems.

It recommends maximum sound levels, such as 30 dB in noise-sensitive rooms like bedrooms. Strategies for mitigating noise include selecting appropriately sized and low-noise MVHR units, using acoustic silencers in the ductwork, and ensuring proper installation techniques. Addressing

noise levels during the design phase is crucial for ensuring occupant comfort and compliance with the regulations.

Best Practices for Installation: Ensuring Performance and Regulatory Adherence

Proper installation of an MVHR system is paramount for ensuring its efficient operation, longevity, and compliance with Approved Document F and manufacturer guidelines. Adhering strictly to the installation instructions provided by the manufacturer is a fundamental best practice. These guidelines are specific to the particular model of MVHR unit and provide crucial information for correct assembly, mounting, and connection of the system.

For centralized systems, the installation of the ductwork requires meticulous attention to detail.

It is generally recommended to use rigid ducting wherever feasible, as it offers lower resistance to airflow compared to flexible ducting. The use of flexible ductwork should be minimized and typically reserved for final connections to air terminals. All duct connections must be mechanically secured and adequately sealed using appropriate methods to prevent air leakage, which can significantly reduce system efficiency.

Ductwork that runs through unheated spaces, such as lofts or basements, should be properly insulated to minimize heat loss or gain and prevent condensation from forming inside or outside the ducts. When routing ductwork, it is important to minimize the number of sharp bends, as these can increase air resistance and reduce airflow.

Ducts should also be adequately supported to prevent sagging, which can impede airflow. Air terminals, such as supply and extract valves, should have a free area of at least 90% of their associated duct to minimize airflow restriction.

The mounting and location of the MVHR unit itself should be carried out with care.

The unit should be securely mounted, ideally on a solid surface like a ply-lined wall or a gable wall, and positioned to avoid direct contact with other building services, which could lead to noise transmission. Ensuring that the unit is located within the thermal envelope of the building is important for its efficient operation. Sufficient space must be left around the unit to allow for easy access during routine maintenance tasks, such as filter changes, and for any potential future servicing.

Effective coordination with other building services, such as electrical and plumbing installations, from the initial planning stages is crucial.

The placement of external air intake and exhaust vents should be carefully considered to prevent the recirculation of stale air back into the building and to minimize the intake of external pollutants. These vents should also be positioned away from doors, windows, and other openings to ensure effective ventilation of the entire room before the air is extracted.

Commissioning and Verification: Meeting Approved Document F Testing Standards

Commissioning is a mandatory step for all mechanical ventilation systems, including MVHR, under Approved Document F. This process ensures that the installed system is operating according to the

design specifications and meets the performance standards outlined in the regulations. Commissioning is essential for verifying compliance with building regulations.

The commissioning process involves several required testing procedures.

A key aspect is the measurement of airflow rates at each supply and extract air terminal using a calibrated anemometer or a flow hood. The measured airflow rates must be compared against the designed flow rates for each room to ensure that the system is delivering the intended ventilation performance. It is important to verify that no individual room is significantly under-ventilated or over-ventilated.

The functionality of the MVHR unit's controls, including any boost settings and the summer bypass mechanism, should also be checked to ensure they are operating correctly. Additionally, a visual and auditory inspection should be conducted to identify any abnormal sounds or vibrations coming from the unit or the ductwork.

Following the testing procedures, proper documentation and certification are essential.

The measured airflow rates for each terminal should be recorded on a commissioning sheet, an example of which is provided in Appendix C of Approved Document F Volume 1. A comprehensive commissioning report should be prepared and submitted to the local building control body. In many cases, extraction readings also need to be submitted directly to the building control authority. A certificate confirming the recorded airflow rates and the successful commissioning of the system must be left with the property owner for their records.

Furthermore, the building owner should be provided with sufficient information regarding the operation and maintenance requirements of the ventilation system.

Approved Document F emphasizes that the installation and commissioning of mechanical ventilation systems should be carried out by a competent person.

Competent individuals or companies often have specific qualifications and may be registered with recognized schemes, providing assurance of their expertise. Engaging a qualified and experienced professional for the installation and commissioning of an MVHR system is crucial for ensuring compliance with building regulations and achieving the intended performance and benefits of the system.

Conclusion: Achieving Optimal Ventilation and Regulatory Compliance with MVHR

In conclusion, Mechanical Ventilation with Heat Recovery systems represent a highly effective solution for providing adequate ventilation in UK dwellings while simultaneously enhancing energy efficiency.

Meeting the requirements of Approved Document F necessitates a thorough understanding of the regulations, careful design considerations encompassing airflow rates, duct sizing, unit placement, and noise levels, adherence to best practices during installation, and rigorous commissioning and testing procedures. By implementing MVHR systems that comply with these standards, homeowners can benefit from improved indoor air quality, reduced energy consumption, and a healthier living environment.

The long-term advantages of compliant MVHR systems extend beyond individual dwellings,

contributing to a more sustainable and healthy building stock in the UK. Staying informed about the latest updates to building regulations and seeking expert advice from qualified professionals throughout the process are crucial steps in ensuring the successful implementation and long-term performance of MVHR systems in English homes.