Recommendation from Nordic Ventilation Group*

Principles of ventilation design to achieve high IAQ

Guidelines for design, operation, and maintenance of systems used to supply and extract the air for ventilation

PAWEL WARGOCKI
Nordic Ventilation Group &
Technical University of Denmark
paw@byg.dtu.dk

OLLI SEPPÄNEN
Nordic Ventilation
Group & FINVAC
Helsinki, Finland

* Members of the Nordic Ventilation Group

Alireza Afshari, Professor, Aalborg University
Amar Aganovic, Associate Professor, UiT The Arctic University of Norway
Gyangyu Cao, Professor, NTNU - Norwegian University of Science and Technology
Lars Ekberg, Associate Professor, Chalmers University of Technology
Per Kvols Heiselberg, Professor, Aalborg University
Dennis Johansson, Associate Professor HVAC, Lund University
Risto Kosonen, Professor, Aalto University
Jarek Kurnitski, Professor, TalTech - Tallinn University of Technology
Ivo Martinac, Professor, KTH- Royal Institute of Technology
Hans Martin Mathisen, Professor, NTNU - Norwegian University of Science and Technology
Arsen Melikov, Professor, DTU - Technical University of Denmark
Peter V. Nielsen, Professor emeritus, Aalborg University
Bjarne W. Olesen, Professor, DTU - Technical University of Denmark
Thomas Olofsson, Professor, Umeå University
Pertti Pasanen, Director, University of Eastern Finland
Svein Ruud, Tekn. Lic., Senior expert, RISE Research Institutes of Sweden
Peter Schildt, Professor, OsloMet - Oslo Metropolitan University
Olli Seppänen, Professor emeritus, Aalto University
Martin Thalfeldt, Professor, TalTech - Tallinn University of Technology
Pawel Wargocki, Associate Professor, director, DTU - Technical University of Denmark
Siru Lönnqvist, Secretary general, VVS Föreningen i Finland and SCANVAC

These principles of ventilation design are based on the results of an EU project "HealthVent". Tentative guidelines were published in the REHVA Journal 2/2021, page 10 in an article by Pawel Wargocki. It was further developed by experts of the Nordic Ventilation Group and edited by Pawel Wargocki and Olli Seppänen.

These guidelines are for securing high quality of air delivered to spaces by ventilation systems to maintain good and healthy indoor air quality in non-industrial environments (public buildings, dwellings) with human occupancy. Energy efficiency, structural strength, industrial processes, fire/smoke control, equipment, and other important properties of the ventilation system are not dealt with in these guidelines. Portable air cleaners and filters are not dealt with either. The guidelines are based on the documents produced during the EU-funded HealthVent project, which the Nordic Ventilation Group further developed.

The guidance is given in the following two areas:

I. Ventilation system functions and properties
   - I-I Supply and/or extract of the required airflow rate
   - I-II Air distribution
   - I-III System design

II. Commissioning and operation
   - II-I Commissioning and inspection
   - II-II Operation and maintenance

I. Ventilation system functions and properties

I-I Supply of the Required Airflow Rate

The systems should meet ventilation requirements to reduce risk for occupants through the entire lifetime of the building or the entire lifetime of the ventilation system (i.e., from the initiation to demolition). They have to be flexible and adaptable to the changes in the use of spaces or requirements regarding ventilation (demand-controlled).

The ventilation rates should reflect the actual needs and potential demands (based on the risk scenarios) which may change during operation; hence the design parameters should be selected so that reasonable flexibility and resilience would be achieved especially with regard to airflows.

The system should be balanced to prevent unnecessary pressure differences and transmission of air between different zones (spaces).

If a mechanical system is used for ventilation, there should be a contingency plan for ensuring ventilation (e.g., by opening the windows or other measures) in case of system failures. It should also allow blocking and shutting down the systems by the users and operators in the case of sudden severe deterioration of outdoor air.

I-II Air Distribution

Ventilation air should be properly distributed within the space that it is serving.

The systems should be designed to limit spreading of polluted air from less clean areas to areas with expected higher cleanliness. The systems to the extent possible should enhance the removal of pollutants from the source or its proximity.

The systems should minimize the risk of cross-contamination between occupants. The systems should decrease the risk of cross-contamination by ensuring proper ventilation efficiency.

I-III System Design

Low-emitting, certified and durable materials should be used in any system product/component used for ventilation. Emission from fibres and other pollutants from fibrous materials should be reduced to a minimum.

Systems must be properly drained and kept dry. Outdoor air intakes should prevent rain and snow entrainment. Condensation in the systems used for ventilation should be minimized to avoid microbial growth.

Air cleaning, and any products and technologies generating ozone in the systems used for ventilation should be avoided.

All outdoor air intakes, including openings for natural ventilation, should be located to minimize the direct entrainment of pollutants from nearby sources and exhaust openings.

The systems used for ventilation shall not become a source of nuisance and annoyance due to noise, vibration or draft at any time from the commissioning instant through all its service life.

The system used to supply and/or extract the air for ventilation must not create unfavourable or potentially harmful pressure differences over the building envelope or between rooms regarding the moisture and pollutant transfer from and through the structures.

The systems (ductwork) must be sufficiently airtight and controlled so that polluted air does not escape/flow from the system to the room air or the clean supply air. Supply air ducts must be sufficiently airtight so that the intended air quantity reaches the air terminal devices.

The systems must not circulate polluted exhaust air to the rooms or supply air so that air quality requirements in the room air are not met.

II. Commissioning and Operation

II-1 Commissioning and Inspection

The performance of mechanical ventilation systems should be verified at the commissioning phase and shall be granted by the deliverers/building owners throughout the service-life of the systems. This should include balancing in all control modes (e.g. unoccupied, normal and boost), and also the check of airflow balance between the zones to consider possible effects of toilet or kitchen or other separated exhausts.

The systems used for ventilation should be regularly inspected (retrospective commissioning) and maintained during regular operation. The inspections should include at minimum the same aspects as during commissioning and additionally examination of cleanliness, loading of filters, and the need for modifications and rebalancing in case of changing demands, layout, sensor location, zoning, etc. These obligations shall become the exclusive responsibility of the building owner.

Installation of the system and any changes in the existing systems should only be performed by the qualified/authorized personnel, best with the certification to perform such work.

II-2 Operation and Maintenance

Systems used for ventilation should be designed for easy and safe maintenance and operation. Operation instructions have to include advice on adjusting the ventilation rates based on the occupancy and strength of pollution sources. While demand controlled systems with regular and professional maintenance need are essential in non-residential buildings, more robust systems are favourable for residential buildings, typically maintained and operated by non-professional occupants.

Systems and the components used for ventilation should be kept clean for the whole building lifetime. They should be cleaned regularly using certified products for wet and dry cleaning that do not elevate exposures.

Well-documented operation and maintenance instructions must always be provided for the building owner and user.

The ventilation systems must be operated and maintained by qualified personnel. Qualifications of operation personnel have to correspond to the complexity of the system. Continuous education programs should be implemented for designers, consultants, and facility managers, which besides technical matters, should address the connection between ventilation and exposures. ■