Window Restrictors; What’s the Deal?

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Ventilation is more effective with bigger holes. The larger the opening, the greater the volume of air that can flow through it. Sometimes, other parameters directly conflict with the ability of a designer to provide large openings for ventilation, for example noise issues, or safety concerns. Windows – the most common form of natural ventilation opening – have various safety concerns associated with them, for example collision by people either inside or outside the building, or by people or objects falling through open windows. For these reasons, windows are in many cases restricted as to how far they may open, often to only 100 mm. But from where has this requirement been derived?

Let us begin with the Building Regulations. Approved Document Part K of the regulations (Protection from Falling) does contain a “100 mm” requirement to protect building users from colliding with windows. It is stated that where windows, skylights or ventilators project by more than about 100 mm internally or externally and where the projection is within 2 m of the ground or floor into spaces used by people, then measures must be taken. This could take the form of positioning barrier rails where the window projects externally, or the use of “surfaces with strong tactile differences or by suitable landscaping features, so that people are guided away from them. The important point to consider is that this does not preclude windows from opening by more than 100 mm. For externally opening windows, this only has relevance to ground floor openings, and even in those cases other design options are available other than window restrictors. A cautionary note however, whilst inward opening windows are far less common, the Passivhaus standard generally adopts inward opening windows as they are far easier to be certified as Passivhaus components, and so core would need to be taken where windows project inwards into a space.

Approved Document N of the regulations (Glazing Safety) does not explicitly state anywhere that the opening distance of windows should be restricted. Section 4 within that Approved Document pertains to Safe access for cleaning windows etc., and there it is stated that where windows cannot be cleaned safely from a person standing on the ground, that an approved provision could be to use windows that reverse for cleaning, and in those cases there should be a mechanism to hold the window in the reverse position.

BS 8213 adopts a risk assessment approach to window design, with a greater emphasis on the use of safety restrictor devices to limit the initial opening of a window to minimise the risks of people falling out. It is stated that attention has been drawn to these needs following a number of incidents where fatalities have occurred. It is also stated that the standard is mainly aimed at residential accommodation, although the recommendations are applicable to other building types. For non-domestic buildings,
attention is drawn to the Workplace (Health, Safety and Welfare) Regulations 1992, and specifically regulations 14 – 16. Regulation 14 concerns the safety of the glazing in the case of breakage, and Regulation 16 states that windows should be able to be cleaned safely. The most pertinent of those regulations to window restrictors is Regulation 15 which states that windows or ventilators should not expose people to risks to their health and safety either due to operation or location. However, there is no explicit requirement or recommendation within the Workplace Regulations to fit window restrictors.

Within BS 8213 it is stated that a risk assessment should be carried out taking account of relative priority needs and including the type of occupancy and age range of occupants. It is stated that the risk assessment should be signed by the client and designer and kept with the Health and Safety File. It would seem quite likely that at present where windows are being limited to open to 100 mm only, that this is not standard practice. Given that the risks for many building types, for example schools, are likely to be similar nationally, this might suggest that a centrally dictated approach to the risks could be adopted. This would fit well with the recommendations of the James Review.

Table 1 within BS 8213 lists the range of window and ventilator types together with associated risks in use and in cleaning (which are mainly collision, falling out, or slamming), together with comments. These comments often state that safety restrictors should be fitted depending on the risk assessment. Annex B to the document provides further details regarding safety restrictors. The restrictors should limit initial movement of an opening light so that a clear opening of not more than 100 mm is achieved at any point. An important distinction must be made here. If a window is restricted to open to 100 mm, due to the thickness of the window reveal the actual clear opening

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**The CIBSE Natural Ventilation Group**

The CIBSE Natural Ventilation Group is a large, international group, that was founded in 1994. The committee comprise some 40 members serving a wider membership of 5400.

**Group Aims**

The aims of the group are:

- to ensure natural ventilation is properly considered at the design stage equally with mechanical ventilation or air conditioning;
- to disseminate knowledge via seminars and publications;
- to recommend research projects;
- to be at the forefront of knowledge about the low energy, environmental and economic performance of natural ventilation;
- to work with consultants, contractors, manufacturers and researchers in pursuing these aims.

**Links**

To access the Natural Ventilation Group cut and paste the following link into your browser or click [here](http://www.cibse.org/index.cfm?go=groups.details&item=11)

**Committee Officers**

Professor Derek Clements-Croome
Reading University (Chairperson)

Dr. Benjamin Jones
University College London (Secretary)
Barriers for Natural Ventilation in the UK

Guido Mendez, Management Science and Innovation, UCL

Advanced design techniques today allow large buildings from different sectors to be naturally ventilated without the use of mechanical HVAC systems. Where natural ventilation has been applied, a considerable saving opportunity has been demonstrated, so why it is not widely adopted and why are mechanical systems still preferred? This article summarises a study carried out by a postgraduate student from University College London and sponsored by Arup. It shows that barriers to natural ventilation are still high and that there will be a long road ahead if natural ventilation is to become a standard in the UK. The results are based on interviews and surveys with professionals and the analysis of case studies.

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Barrier 1: Natural Ventilation is perceived as too complex

Many stakeholders in the industry share the opinion that simplicity is key to project success. Natural ventilation is often described as a complex interaction between thermal comfort, ventilation and acoustics. Every natural ventilation system is different and simulation models still require further R&D effort to achieve better predictions. A specialised industry for natural ventilation has been created to cope with this high complexity. However, among non-specialised designers, architects and consultants there is a reluctance to apply the new methods as they are often perceived as too complex and therefore risky and time-consuming.

Barrier 2: Natural Ventilation is perceived as too unconventional

The amount of available and independent design rules, tools and best practice guides is not sufficient for some professionals. HVAC engineers still rely on mechanical solutions to their problems. The main difficulty arises when experienced engineers, who have an established way of doing things, are not willing to change. Furthermore, there is widespread scepticism among professionals concerning the abandonment of HVAC systems. Despite the conservative mindset in the industry, natural ventilation professionals are optimistic that this is going to change.

Barrier 3: Natural Ventilation is limited to specific conditions

One reason why natural ventilation solutions could often not be considered is because there are requirements that cannot be fulfilled, particularly external conditions such as air speed, noise level and outside temperature. Requirements for internal conditions were also limiting, especially in existing buildings, with factors such as the building’s orientation, space requirement, internal air resistance and thermal behaviour needing to be taken into account.

Barrier 4: Decision makers have no financial incentive

This barrier applies to most of the energy-saving measures in the building sector and is known as the tenant-landlord conflict. Usually running costs and energy consumption are not part of the negotiation when renting a space. The consequence is that the building owner has no incentive to invest in an energy efficiency technology that will benefit the building user. In addition, there is also a lack of incentive among designers and consultants if their payment scheme assumes that they retain a fixed percentage of the system cost they have designed. For natural ventilation these are in general lower than for HVAC.

Barrier 5: Switching costs can be too high

For established building-owners changing to natural ventilation is a higher risk due to the lack of experience and expertise in the market. It is also more inconvenient because it means changing suppliers and re-educating people. For decision-makers there is a higher transaction cost because they too have become familiar with the technology prior to making decisions. For some commercial sectors building energy costs are a very small fraction of the total operational costs, and therefore, the energy savings provided by natural ventilation do not compensate for the switching costs.

Barrier 6: Collaboration across the value chain can be poor

Natural ventilation systems require intensive collaboration between building design and construction due to complex design requirements. The design procedure, therefore, has to be different. The building owner, architects, engineers, indoor climate and energy consultants have to work simultaneously, rather than sequentially, as is often common practice. Many experts on natural ventilation complained that they were involved too late in the design stage.

Barrier 7: Lack of knowledge across the value chain

Even in cases where natural ventilation is successfully implemented in the design stage, there is the risk that different parties without knowledge of natural ventilation become involved during the construction phase, potentially harming the project. One of the most noted problems with natural ventilation was the apparently small changes made during the construction phase, which significantly affected the final performance of the natural ventilation system.

Barrier 8: Procurement, specification and liability structure are tailored for HVAC

The normal procurement cycle does not always tie in with natural ventilation. For example, the procurement of windows and façades is organised separately and prior to the procurement of the building management system (BMS). In a naturally ventilated building they have to be integrated. Specifications and liability contracts which are intended for
HVAC systems were also mentioned by interviewees as challenges for natural ventilation.

**Barrier 9: Users fear the unreliability of natural ventilation**

A number of naturally ventilated buildings have been unable to provide satisfactory ambient conditions. These examples discourage decision makers from considering natural ventilation. In fact, the reliability of a natural ventilation system cannot be guaranteed solely through simulation models. The problem with unreliability is that occupants perceive negative experiences many times higher than positive ones.

**Barrier 10: Users requirements on ambient conditions cannot be satisfied**

Many users are willing to pay more to have a higher comfort level in their buildings rather than accepting less ambient control. Building control has been mentioned as one of the main challenges for naturally ventilated buildings. In many cases it requires the education of building occupants, what has not always been successful. Interviewees mentioned several cases in which customers’ ambient requirements were too high to warrant the choice of natural ventilation and they were not willing to accept thermal comfort concessions.

**Outlook**

Despite all the barriers to adoption for natural ventilation, there are favourable trends such as new regulatory requirements, new funding opportunities and an increasingly environmentally friendly mind-set among customers. Many experts believe that mixed mode systems will become a big trend rather than pure natural ventilation. There are also occupants who state that they do or would feel better in a naturally ventilated building. There is an agreement that barriers could be overcome if old habits deriving from the use of mechanically ventilated systems would change. However, this may not happen in the short-term. With the joint effort of industry, government and academia, solutions to lower the barriers to the adoption of natural ventilation could be designed and implemented.

For a full copy of the report please contact the editor.

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**Fresh air, like water, is vital for human survival. Way back in the Middle Ages it was recognised that crowded spaces can encourage the spread of infections and also make smoke removal difficult. Since then many famous names like Lavoisier in 1777 and Pettenkofer in 1862 studied the effects of CO\textsubscript{2} which they believed gave rise to stuffiness and bad air. Tredgold in 1836 published the first estimation of the minimum amount of air to satisfy metabolic needs but that was too low to overcome people’s feelings of stale or stuffy air. Physicians such as Billings considered the ill effects of air impurities arising from the body and he published in 1893 some figures suggesting fresh air rates of 14 l/s per person for comfort and 28 l/s per person to limit the spread of infection.

Today we are still pondering these questions but the work of Fanger advanced our knowledge and understanding of the subject much more profoundly and he introduced the olf which denotes the pollution level and decipol which is a unit used to measure people’s perception of air quality. One decipol (dp) is the perceived air quality (PAQ) in a space with a sensory load of one olf (one standard person) ventilated by 10 l/s. Fanger’s work also established that air quality is just as important as temperature when defining thermal conditions for a space. In general we aim to set the basic CO\textsubscript{2} level in most buildings at 1000ppm. Recent research in UK primary schools shows that excessive CO\textsubscript{2} levels of 2500—5000ppm can occur in classrooms and this can affect learning by impairing concentration and reaction times. Other work in hospital wards has shown some Victorian buildings had lower infection rates than some modern ones and this was thought to be due to the bigger height spaces and large openable window areas.

So what systems should be employed to meet these aims? Natural ventilation has many benefits such as low energy consumption; smaller plant rooms; little noise; cheaper to
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maintain but it is more difficult to control than mechanical systems. And yet in history we see many effective natural ventilation solutions in vernacular architecture such as wind towers exemplified in modern times with their modified use in the Queens Building at De Montfort University. Then there is the Malay House which copes with hot and humid conditions in Malaysia. The Natural History Museum in London built in 1873 is an example where the architect Alfred Waterhouse considered the natural airflow throughout the building when he planned it and it is very successful. We can learn from other cultures and locations.

Today we have more pollution and a growing number of people living in cities which intensifies noise and other pollutants. Sustainability is now a driving force and is making us rethink our approaches to building design. The emphasis is on the need for passive environmental control with hybrid systems installed to cope with extreme temperature conditions. Some situations still demand air conditioning but natural ventilation has a special place even more today than ever before and our knowledge and experience of such systems needs to be pursued. The CIBSE Natural Ventilation Group has a role in this and now has a worldwide membership of over 7000 people. It was mainly responsible for the CIBSE AM10 publication in 1997.

In the intense efforts being made to design low carbon buildings, which includes recommending air tightness as desirable, we have to remember that a lack of fresh air is a health risk. The need for proper means of introducing fresh air throughout the year is paramount. Likewise building users need to be able to see the CO₂ levels just as much as temperature so window or system controls can be activated hence spaces need CO₂ monitors.

The distribution of the air is important even if the quantity of air is sufficient. This means the built form and layout are key considerations. Higher spaces are easier to ventilate than low height ones for example. To make natural ventilation work requires a team effort and architects need to work closely with engineers at all stages of design, installation and operation in use. Consultants, contractors, manufacturers and facilities managers are all involved from the design inception.

In general the public, and even legislators, remain unaware of the effects of fresh air on their state of being since CO₂ is a harmless gas, but they seem much more concerned about draughts that are easy to avoid. Buildings and transport systems need to take ventilation seriously and ensure the tiring effects of bad air that were recognised centuries ago do not diminish our well-being. Another questionable development is the Building Regulations that restrict window openings in public buildings and are
deemed necessary to avoid extreme events such as people jumping out; but what about everyday health? Many hospital wards and residential homes are too hot and stuffy and this restriction does not help.

The big issue is that environmental design affects us more then we realise. It affects our concentration and our moods, not just our physiology.

Anyone who wishes to join the CIBSE please contact d.j.clements-croome@reading.ac.uk or b.jones@ucl.ac.uk.

PUBLICATIONS


Richard Cowell FIOA, CIBSE School Design Group, CIBSE Natural Ventilation Group

Integral to the remit of the CIBSE Natural Ventilation Group is the dissemination of information in the public form. With this in mind a joint seminar was held with the CIBSE School Design Group on October 4th 2011 at University College London and had over 100 delegates.

For those involved in the design and construction of school buildings this is a time of great change. The river of money allocated for building schools has run dry and the price of energy is increasing. Yet, there are social and moral obligations to provide school buildings that are both safe and healthy for those who are amongst the most vulnerable in our society, and that enable children to achieve their full academic potential.

The noted Egyptian architect, Hassan Fathy, said “Before investing or proposing new mechanical solutions, traditional solutions in vernacular architecture should be evaluated and then adopted or modified and developed to make them compatible with modern requirements.” It is only in recent times that we have sought to resolve the inadequacies of design by using mechanical systems where previously passive systems had sufficed. Natural ventilation is still the most common ventilation strategy used by UK buildings yet to some involved in the design and construction of buildings it remains a black art.

This seminar aimed to answer three key questions:

(i) Is there still a case for naturally ventilating schools?

(ii) What are the objective lessons that can be learned from functioning naturally ventilated schools built during the last decade?

(iii) Can a compliant natural ventilation strategy ever be assured?

Headlines
Dr Mike Entwistle (Buro Happold) painted the current scene, noted the tightening of budgets for school building (£1100-£1500 per m²) and the £40m maintenance backlog, warned against designs becoming too complicated. There are good lessons from history. As an example of simplicity, he suggested that a little extra performance can be achieved with simple recirculating ceiling fans for some instances. Stronger engagement of users is needed.

Prof.Derek Clements-Croome (Reading University) ran through the real value to education of the quality of natural ventilation and referred to physiological evidence to support better learning with better controlled air changes, and more particularly CO₂ reduction.

Prof Martin Liddament reviewed the development of relevant and partially overlapping standards, some in conflict,
but full of good design advice and made the case for natural ventilation as common sense choice cf. mechanical ventilation.

Roderick Bunn (BSRIA) provided a damning critique of the performance of those delivering natural ventilation in classrooms, calling for a look at the real world, and the appalling track record. Briefs for design were not engaging users. Procurement contracts are entirely inappropriate with disconnected and second guessed designers. Systems are unduly complicated. Often the job is not finished, users have no idea how to use unlabelled controls, or even when to open windows! He asked how such an appalling situation was allowed to develop.

John Palmer (AECOM) reviewed a range of natural ventilation strategies for classrooms in practice, the relative benefits of different window configurations, air flow patterns and put these in context.

Dr Benjamin Jones (UCL, recently Monodraught, who were co-sponsors) provided measured data on performance of windcatchers, demonstrating impact on the ventilation rate and CO₂ for different seasons, with varying wind direction and speed, demonstrating substantial improvements in natural ventilation. Some acoustic performance data (attenuation through the windcatchers) was also presented.

Dr Malcolm Cook (Loughborough University) described calibration and use of modelling techniques for natural ventilation and suggested a satisfactory development of confidence that designs will meet regulation using models as one of the design tools. The relative merits of CFD and Dynamic Thermal Simulation were discussed. Corrections to allow for the effects of thermal mass are also included.

Nick Huddleston (SE Controls, co-sponsors) described a range of detailed issues arising in the mechanisms for opening and closing windows, in particular weight from large windows often preferred by architects, including the frequent mismatch between architectural intent and dimensions of drive units available.

Carl Sutterby (Windowmaster, co-sponsor) focused on the difficulties that arise when controls for natural ventilation are not considered properly at the outset. He was clear about the importance of clear labeling of controls, and thorough briefing of users.

As an overall headline for the day, I felt the shared disappointment there is in the outcomes from most of the new schools, and the huge scope for improvement. A lot of the scope for improvement is not dependent on technical knowledge, much of which is well trodden ground, but on patterns of procurement, better inter-disciplinary working (one of the reasons we were there), guiding users and keeping it simple!

Call for Articles

Do you have something to say on the subject of natural ventilation? Do you want to respond to any of the articles you’ve read here? Do you have a project in a field that relates to natural ventilation whose findings you’d like to share?
Please contact the editor.

Call for Photographs

Are you a keen photographer? Do you have photographs of naturally ventilated buildings or indoor environments that Nat Vent News could publish?
Please contact the editor.