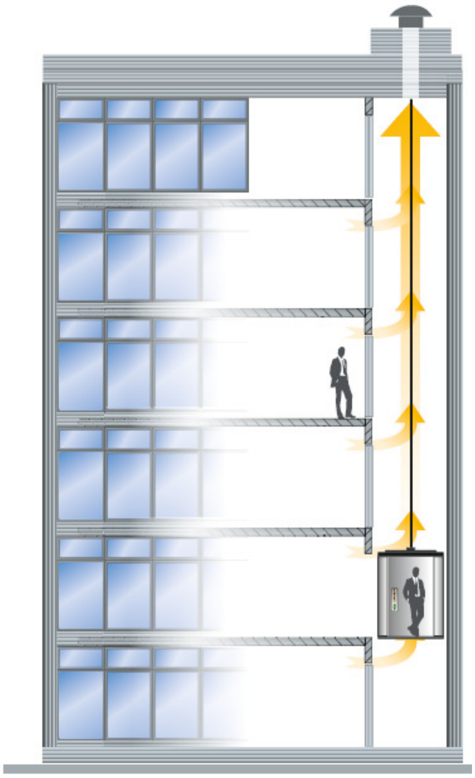
Secure Ventilation of Wells and Machine Rooms in Low Energy Buildings

Guy Stamet
Maison de l'énergie GIE
2A, rue de l'école
4394 Pont Pierre
Luxemburg

Abstract

Presence-controlled lift ventilation - for optimum air quality and protection from new dangers for lift users and maintenance personnel, in elevator shafts in low energy buildings.



A lift gets stuck. But as the building is old and the lift shaft has no insulation to speak of, the people in the car at least do not have to worry about lack of fresh air. In a building designed or refurbished according to what is thought of as state-of-the-art technology, however, this may be different: In some low and passive energy houses or buildings with improved energy efficiency, building shell and lift shafts are so tightly sealed that natural, uncontrolled air flows are almost excluded. It is true that the building laws require sufficient ventilation of the lift car – but what good does this do if the ventilation of the lift shaft is insufficient or even worse if the thermal movement of the air in the shaft is inexistent similar to the inside of an empty bottle?

It has become evident that the new risks that may occur in low-energy buildings for example by reason of an insufficiently ventilated lift shaft must not be underestimated. Thus, it is imperative that building owners as well as tenants, when looking at a lift shaft ventilation system, insist on a risk analysis by an independent technical expert under special consideration of the situation of passengers in a stuck lift car and the lift maintenance personnel in highly sealed low-energy buildings. In our days it has become clear that the EU regulations require the provision of much more than a confirmation that smoke extraction systems or point type detectors are other than non-lift components.

1. Danger: high temperatures, CO_2, VOC_2 and N_2 in the lift car

The temperature in a lift car that gets stuck in a fully sealed building may quickly rise to 30° Celsius and more. This is because in case of a lift breakdown, the thermal air movement between car and shaft wall is disrupted when the ventilation and smoke flap is closed. The breathing frequency of the stressed passengers quickens, the warm air expands, no natural ventilation happens over the ventilation joins and the significantly increased content of CO_2 and N_2 in the respiration air impairs the health of the transpiring stranded lift passengers in an inacceptable degree. Even more than CO_2, the Volatile Organic Compounds (VOCs) can affect the human health. VOCs are numerous, varied, and ubiquitous. VOCs include both man-made and naturally occurring chemical compounds. The United States Environmental Protection Agency has reported that, even though VOC emissions by humans are not that high in an indoor environment, the indoor total VOC concentrations can be up to five times higher than the VOC outdoor levels. Another risk exists in new or renovated buildings where the abundant new materials especially generate high volumes of VOC particles. For certain indoor activities like restaurants, hairdressing, dentists or washing rooms the levels of VOCs may reach more than hundred times that of the outside.

In low energy sealed buildings with insufficient lift shaft ventilation, the maintenance personnel is subject to similarly bad conditions, all the more so as more than 95 per cent of all new lift installations nowadays do without a machine room above the shaft, traditionally ventilated by means of windows or corrugated wire mesh. Lifts without machine rooms are maintained directly from the insufficiently ventilated shaft head. In this specific environment, the N_2 concentration (N_2 = lighter than air) also can be a danger to the health of the maintenance personnel working a day long in headroom’s of low traffic elevators. This danger does not come from the so called nitrogen narcosis effect known by scuba-divers produces for instance a state similar to alcohol intoxication or nitrous oxide inhalation, but even though the shaft headroom cannot cause this kind of nitrogen narcosis, every possible damaging effect on the concentration capabilities of the elevator maintenance technicians must be considered.

Other negative effects of lack of ventilation in the lift shaft may include fungus, insufficient air hygiene, and bad smells in the lift car and the adjacent circulation areas very often of the most expensive surfaces in a building like penthouses or skyline offices.

Mechanical ventilation systems seem to be a simple and thus widely accepted solution to these problems that became more and more apparent over the last few years. To really alleviate the situation, however, they must have an intelligent control system that is adapted to this specific application.

2. The perfidy of mechanical ventilation systems

All over Europe, experts increasingly often refuse technical approval for manually, only CO2- or time-controlled ventilation systems in lift shafts because these systems do not guarantee optimum ventilation of the lift shaft, primarily in low-energy houses. Additional CO_2 sensors or humidity meters in the lift shaft are no help either. If humidity meters detect a to high humidity value in the shaft headroom, the damage most probably is already done to electronic components of the elevator regulation or the physical components of the building. Controlling CO2 in the shaft does not help at all as life tests have proven, that even in the pit CO2 concentrations generally stay below 1000ppm. The CO2 health risk is not located in the shaft, but in the elevator car.

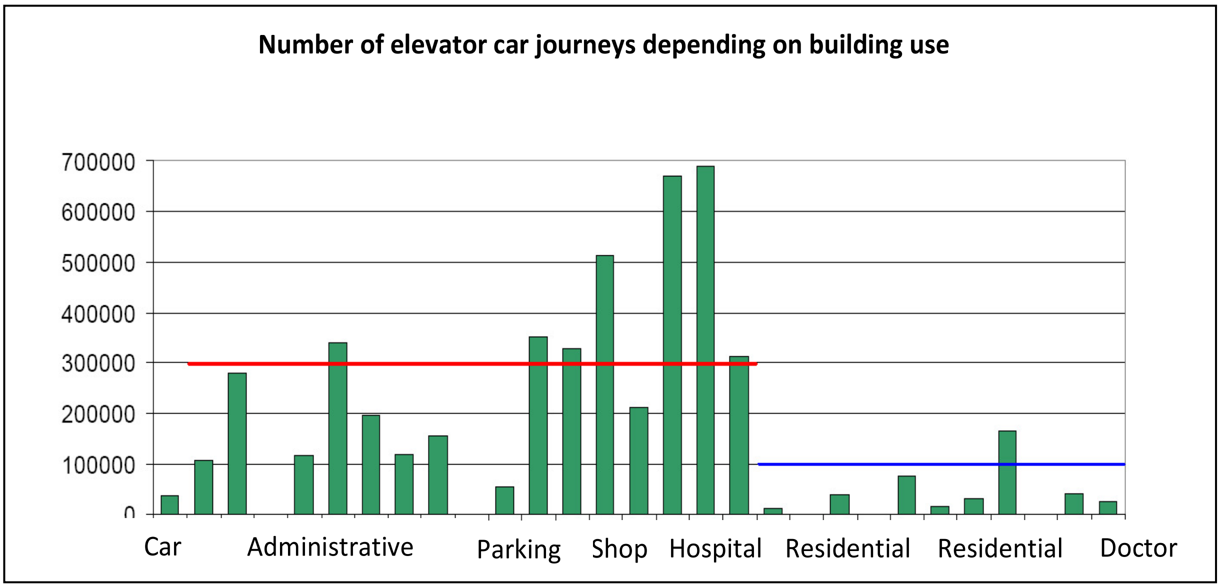
Furthermore, a conventional ventilation system controlled by several different sensors or one that even works in combination with manual intervention by the user is prone to failure and generally not advisable from the technical or economical point of view. Besides, the stale heated air from the lift shaft should not be discharged to an upper floor – instead of to the outside – as this would result in bad smells and low ventilation quality on that floor. Feeding the air warmed up by the waste heat of the lift machinery to a heat recovery system is likewise not an efficient option as the heat recovery system cannot make an important use of the high temperatures. Furthermore, a number of undesirable consequences may occur, e.g. premature soiling of the filter of the heat recovery system, negative pressure in the shaft, and increased suction of dirt particles into the lift shaft. As lift shafts are cleaned very rarely if at all, hygienic problems are inevitable, for example fungus in the headroom, the filter of the heat recovery system, or the mechanical ventilation. Also, it must be clarified how the vital lift car ventilation function can be guaranteed in case of ventilation system failure or summer shut-down.

The option of airing and ventilating the lift shaft via a light dome in the shaft head normally provided for smoke extraction is not without problems either: The light dome would open not only in case of smoke or fire, but also when ventilation is required for other reasons of safety technology; accordingly, rain or other precipitation would recurrently get into the shaft and the lift machinery. Furthermore, to pass the approval test pursuant to EN 12101-2, light domes and their motors must complete a mere 10,000 open-and-close cycles. However, a light dome that is used as a general aperture for ventilation to the outside will easily perform 5,000 and more cycles per year – the guaranteed operational safety limit would soon be exceeded. It could be desirable that one aperture is used for ventilation, heat and smoke extraction, in this case the aperture should be located in the interior of the building, and an intelligent control should be provided to differentiate between the different requirements situations. To avoid unnecessary heat and energy loss, the flap would open only partially for regular ventilation, but totally for heat and smoke extraction or for ventilation in case of break down or during maintenance works.

3. The benefits of an intelligently controlled lift shaft ventilation

How can the ventilation of a lift shaft automatically and optimally be adjusted to the actual requirements without letting heated air escape to the outside and thus wasting energy?

Practice and research has demonstrated that the presence of people in the lift car and the number of lift movements are excellent variables for controlled, optimized ventilation of all kinds of traffic areas like corridors, stair rooms or lift shafts in sealed buildings (see also DIN 1946-6).



Speaking about elevator shafts, if the ventilation flaps are activated just when the lift is being used, a sufficient supply of fresh air at all times can be ensured with nothing more complicated than a small number of commercially available sensors. A ventilation adapted to the actual utilization of the lift furthermore prevents unnecessary withdrawal of heat from the ambient air in the adjacent circulation areas at times when the lift is not used, for example over the week-end for an office block. A survey by Dresden Technische Universität showed that there is a correlation between the utilization and type of a building and the number of lift movements. If the regulation of a ventilation system can be adapted to the utilization of the building, it could also be flexibly adjusted should the building be repurposed at a later date. For many fixed ventilation systems dedicated to a certain type of building, on the other hand, this would involve great technical efforts.

Presence-controlled ventilation systems are superior to all other solutions also in case of a “stuck” lift car because the ventilation flaps remain open as long as there are passengers in the car; thus, an optimum supply of fresh air is guaranteed. If a ventilation system is controlled by CO_2 sensors installed in the shaft, a false CO_2 reading in the shaft where CO_2 is mostly not at all a problem may significantly delay the start of ventilation after the car has gotten stuck, causing real danger for the people in the car.

State-of-the-art control technology furthermore differentiates between the cold and the warm season, reducing the loss of heat by the ventilation system during the winter to a minimum. In summer, the intelligent technology constantly compares the temperature in the shaft head with the outside temperature and the desired temperature in the building. In a 17° Celsius warm summer night, for example, the ventilation in the shaft head can be activated so that stale air of more than 22° Celsius is extracted and replaced by fresh outside air to naturally cool the entire building over the elevator shaft.

4. Intake of fresh air into the pit of the elevator hoist way

Theoretically, due to the lack of circulation of air through the airtight shell of the building we can start from the principle, in an extreme case, that for a passive or low-energy building, the airtightness of the building shell is such that smoke or air can only escape to a very limited extent by the opening of a ventilation valve mounted at the head of the hoist way and opening directly to the exterior.

To deal with this scenario as best as possible, when planning new buildings with elevator hoist ways it is necessary to provide a fresh air intake in the pit of the hoist way. This fresh air intake may, in the event of breakdown or maintenance of the elevator, be opened in synchronisation with the valve located at the head of the hoist way and thus also guarantee the ventilation absolutely essential for buildings with high energy performance. In the event of a fire alarm, the simultaneous opening of the smoke extraction valve and the fresh air intake may also be very useful in this type of building, in accordance with the fire prevention policy. This ventilation over fresh air access can happen naturally or be supported by mechanical ventilation (fresh air injection in the pit).

5. Minimum ventilation, secure application and maximum energy savings

The survey by Dresden Technische Universität scientifically demonstrated that there is a correlation between the utilization and type of a building and the number of lift movements. Thus as a conclusion on these results as well as on the present state of the art in the ventilation domain, it can be stated that presence-controlled ventilation systems are superior to all other solutions and do automatically adjusted to special events or changes in the building utilization. Furthermore life-tests on several pilot installations have proven that CO_2 in the elevator shaft generally is below 1000 ppm in the pit and below 500 ppm in the headroom. If nevertheless the installation of a

CO_2 sensor is considered it should be done in the pit, while the installation of a VOC detector would make sense in the shaft headroom.

Knowing that the new dangers for passengers do not just come from the air quality in the elevator shaft, but exist in the elevator car in case of a break down with blocked passengers, it must be stressed that the security of elevator users have to prime against maximum energy savings without going for unreasonable expenses for inappropriate technical equipments. The application of CO_2 or VOC sensors in the elevator car for instance could lead under normal operation to a ventilation request and wouldn't make sense. Under these circumstances, it makes sense to definitely consider that the ideal solution for an optimum ventilation of the shaft and the car should indeed be based on presence control.

The Presence-controlled ventilation (DIN EN 13779 Class IDA-C5) of the elevator shaft is superior to all other possible solutions as for the health of the building occupants as well as for the maintenance personal or the building itself. With presence control the supply of fresh air is guaranteed and supported by hygienic ventilation adapted 24h/24h to the real need. The common placement of CO_2 and VOC sensors (DIN EN 13779 Class IDA 6) doesn't make great sense for most applications.

Updated European and national standards like DIN 1946-6 and/or DIN EN 13779 dealing with the complex matter of ventilation in new low energy but also renovated buildings do support this conclusion.

6. Safety for lift passengers and maintenance personnel

The above-described dangers that lift passengers and maintenance personnel may have to face in insufficiently ventilated lift cars in low-energy or renovated houses are considerable; it is imperative that they are not disregarded. Building owners and tenants can protect themselves from these dangers (and the potentially ensuing claims for compensation) by having the technical control boards check the lift shaft ventilation system for any potential risks before the lift system is brought into service.

The investigation should specifically consider the situation of passengers trapped in a stuck lift car, as well as the security of the maintenance personal acting in the shaft headroom area in highly sealed low-energy buildings. This technical evaluation will result in a true assessment of the quality of the lift shaft ventilation system. To pass this test, building owners in the EU must submit much more than a confirmation that their smoke extraction systems or point type detectors are other than non-lift components.

7. Legal status of the ventilation of elevator hoist ways

The responsibility and active role of the elevator professional have been greatly neglected in recent years, or even omitted on the pretext that the requirement for minimum hoist way ventilation was not explicitly covered in the texts of the directive 95/16/CE on elevators. This statement is wrong!

Directive 95/16/CE on elevators, in force in Europe since 2000 for elevators serving buildings and other constructions on a permanent basis, clearly defines the general basic health and safety requirements for the ventilation of elevator cars, hoist ways and machine rooms.

In order to reduce the documentation for compliance with these basic requirements for elevator installers, harmonized European standards such as EN 81-1 or EN 81-2 can be applied. The latter give protection against the risks associated with the design and assembly of elevators. Furthermore, these standards help in later ensuring that these basic requirements are indeed observed. It is considered that elevator manufacturers fulfilling the criteria of the harmonized standards in force automatically comply with the criteria of directive 95/16/CE. The elevator manufacturer is however free to decide to comply with some or all of these same standards when designing or installing. Alternatively, he may provide proof, by carrying out a risk analysis, that the replacement solution chosen is at least as safe and meets all requirements of the directive on elevators with respect to health and safety.

To guarantee the requirements of the CE marking or the CE declaration of conformity, European and national control institutions thereby also very often consider for elevator manufacture, in addition to the directive 95/16/CE, compliance with the harmonized standards EN 81-1 and EN 81-2.

The designer or installer of the elevator has two options for obtaining authorization to activate its elevators in a location without permanent hoist way ventilation:

- CE type-examination,
- or modification after commissioning.

7.1. Authorization of a solution for intermittent ventilation of the elevator hoist way by EU type-examination - module B

The elevator designer or installer who wishes to obtain the “CE” marking for its elevators with an intermittent opening option must proceed as follows:

- To apply for the CE type-examination for its elevator or range of products, the installer compiles the technical documentation required to assess the conformity of the elevator.
- He generally adopts the harmonized standards EN 81-1/2 (95/16/CE Annex V, chapter B.3. paragraph 3) to guarantee the conformity of the elevator and the solution chosen as a response to the basic requirements.
- He must also provide a copy of the instructions for use, service instructions and maintenance plans for the elevator. (95/16/CE Annex V, chapter B.3. paragraph 6).
- The installer may indicate in the technical documentation all the variants of the standard elevator to be inspected (95/16/CE Annex V, chapter B.3. paragraph 1).
- The installer informs the notified body of any modification, even if minor, which is not in compliance with the harmonized standards applied. (95/16/CE Annex V, chapter B.6.).
- To prove that the modifications undertaken do not affect the health or safety of persons or goods the installer is required to carry out a risk analysis to assess all the dangers linked to its product. This risk analysis must then be taken into consideration in the design and construction of the elevator (95/16/CE Annex I, preliminary remarks point 3).
- The notified body examines the modifications and informs the applicant whether or not the CE type-examination remains valid or not. It may issue a supplement to the CE type-examination or require a new application to be submitted.
- If a positive response is given, the notified body may consider that it is necessary to supply certain relevant information to other member states of the European Union. (95/16/CE Annex V, chapter B.7.).
- As the CE type-examination has generally been granted in compliance with the harmonized standards arising from directive 95/16/CE on elevators, the installer is obliged to follow the provisions of these standards, in particular articles 5.2.3, 6.3.5 and 8.16 on ventilation of the car, the elevator hoist way and the machine room.

As national legislations differ from country to country, we can take as a starting principle that the installers have chosen in the CE type-examination, for certification of conformity at the European level, a minimum ventilation aperture corresponding to 1% of the horizontal cross-section of the elevator. As a result, the technical properties as well as the operating and maintenance procedures of elevators are designed, developed and documented on the basis of a minimum ventilation surface area. Within this framework, it goes without saying that the standard EN 81-1/2 recommends natural and permanent ventilation opening to the exterior of the building shell.

According to the directive 95/16/CE on elevators, within the framework of the CE type-examination, any exemption from this ventilation principle clearly must be submitted to a risk analysis even before commissioning and then approved by a notified body.

"Knowing about the new dangers in combination with low energy or energetically renovated buildings, any modification to a new installation with CE type-examination should undergo an additional inspection carried out by a notified body before commissioning."

7.2. Authorization of a solution for intermittent ventilation in elevator hoist ways in the case of elevator modification after commissioning

Until now, to our knowledge no one has yet carried out a CE type-examination for elevators with the option of integrated intermittent ventilation. Furthermore, on the European market most elevators have realized the CE type-examination with respect to the harmonized standards EN 81-1/2.

However, permanent ventilation of the elevator hoist way at 1% has recently been modified in different member states of the European Union by technical or structural measures in order to provide optimal management of the buildings with respect to energy efficiency. Whether these modifications to elevator hoist way ventilation result from modification of an existing installation or a CE type-examination with modification authorization before commissioning of the elevator, this only has an influence on the qualification required from the inspection body authorized to give its endorsement.

The inspection and accreditation of modification of existing elevators, affecting the health and safety of users and maintenance staff, must be carried out by an accredited inspection body. Logically, this can only be carried out by a new risk analysis linked to the modifications in ventilation. The replacement measures recommended must meet at least the same safety requirements as the application of harmonized standards EN 81-1/2, but in any case the respect of Chapter 4.7. (95/16/CE) about the ventilation of the elevator car must be guaranteed.

"The present state of the art in the domain of building ventilation obliges the elevator designer or installer to seriously reconsider the existing legal frame and status with respect to the security and health of elevator users and maintenance personnel!"

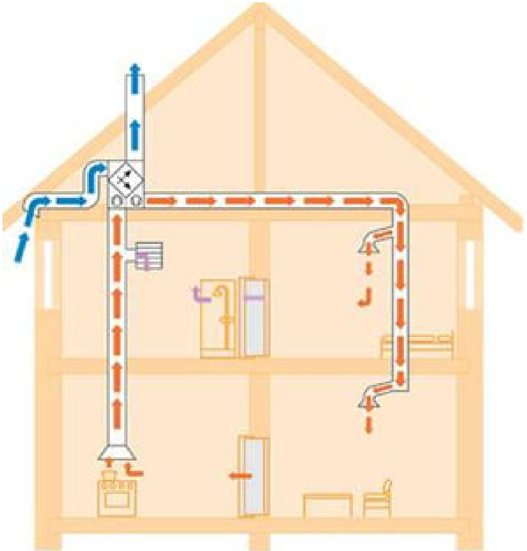
8. Corollary to legal status

In order to simplify the accreditation of technical solutions for intermittent ventilation at the European level, it is recommended, in accordance with the legal framework defined hereinabove, that all proposed solutions be submitted for approval by the notified inspection body.

After this unique examination, the installer may without difficulty add to its technical documentation the documents relating to the technical modification of the ventilation drawn up once and for all, including the expert appraisal with the risk analysis drafted by the notified inspection body.

It should also be noted that structural measures which are a prelude to modifying ventilation in the interior of a building for instance while using mechanical ventilation systems are sometimes already undertaken when the building is constructed and therefore always before the commissioning of the elevator. In other words, in this case a risk analysis must always be carried out to identity and remedy all risks linked to the change of the building structure and it must be submitted for approval by the notified inspection body. In this specific case, the technical consultant body having requested the changes is responsible for providing the technical and scientific proof, through a risk analysis, that any new hazard is minimized by replacement measures meeting at least the same safety requirements as the harmonized standards in force EN 81-1/2. Only then can the installer be requested to install an elevator in a hoist way with ventilation to the interior of the building.

It will naturally be essential for the technical consultant body to have its risk analysis assessed by a duly appointed inspection body and to make all documentation available to the installer before the assembling of the elevator. The installer will adapt this situation in accordance with article 3.1.1, enclose the documentation from the technical consultant body with its technical application and thus be released from any liability concerning the mechanical ventilation.



“According the today’s state of the art, the elevator installer company must be aware of the new existing dangers in combination with the elevator shaft ventilation in low energy or energetically renovated buildings. Thus the possible outsourcing of the elevator shaft ventilation responsibility to a mechanical system supplier with heat recovery must respect the fact that a mechanical ventilation system break down or maintenance will request the elevator to be taken out of service as during this time the ventilation of the elevator shaft and thus the elevator car cannot be guaranteed!”

9. Conclusion

Knowing that smoke and heat extraction have always formed an integral part of building safety, it must be admitted that the ventilation of elevator hoist ways is today taking on an importance which was unthinkable just a few years ago, particularly in new constructions. When the European Committee for Standardisation (CEN TC 10) and the European Union years ago ratified and voted on the harmonized standards EN 81-1/2 and the directive 95/16/CE relating to elevators, no one could have imagined that the ventilation required for the hoist way, machine room and cabin of elevators would ever go beyond the extraction of heat, smoke and gas.

It has become evident that the new risks that can occur in low-energy buildings by reason of an insufficiently ventilated lift shaft must not be underestimated. Thus, it is imperative that building owners as well as tenants, when looking at a lift shaft ventilation system, insist on a risk analysis validated by an independent technical expert under special consideration of the situation of passengers in a stuck lift car and the lift maintenance personnel working in the shaft headroom's.

The Author

Guy Stamet, an engineer and graduate in management from HEC, was for thirteen years the director of the national organization of Schindler Luxembourg and a member of the management board of the Belgian subsidiary of Schindler. Within the EEA (European Elevator Association) Guy Stamet joined the marketing committee, was a permanent member of the Luxemburgish National Board relating to safety in elevators and represents today the state of Luxembourg within the CEN TC10 (European Committee for Standardization - Technical Committee for lifts, escalators and moving walks).

In his function as a general manager of "AIO Project Management G.I.E" and president of the competence centre "Haus vun der Energie G.I.E.", Guy Stamet today works to highlight a wide range of challenges relating to the design, construction, management and exploitation of buildings with high energy performance.

+352 4044441
guy.stamet@maisondelenergie.lu
www.maisondelenergie.lu

*All you should know about SVECH in passive or low-energy constructions (download from www.maisondelenergie.lu) by Jürgen Klaus & Guy Stamet
*The standard DIN EN 13799 on ventilation and air-conditioning systems stipulates for the category “superior amibient air quality” a value lower than 400 ppm with respect to the content of CO2 in the external air, whilst the lowest category “inferior quality of ambient air” tolerates a CO2 content of 1000 ppm higher than the reference value for the external air.
*The standard EN 15251 on the quality of ambient air, light and noise stipulates as a standard temperature value for office buildings 21°C in winter and 26°C in summer.
*Cf. brochure “Habitat et Santé” (Habitat and Health) by médecins en faveur de l’environnement (MfE – doctors for the environment), Switzerland, Basel, 2002, p.96 et seq., Internet: www.aefu.ch
*Cf. Prof. Wolfgang Richter et. al : summary report “Bedarfslüftung im Wohnungsbau” (Ventilation focused on needs in residential buildings), Technical University (TU) of Dresden, Faculty of Mechanics, domaine "Technical Fitting of Buildings", April 2001, p. ¾, p 6 point 19
*Cf. table “Fahrtenzahl der gemessenen Aufzüge nach Gebäudenutzung” (Number of journeys made by elevators based on the use of the building), standard SIA 380/4