



TRADITION AND INNOVATION

in

Smoke and Heat Control Systems



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www.smay.eu



Who are we? Few words about our way to success...

SMAY is one of the leading Polish companies for ventilation technology in the active fire protection systems. Our products can be found in office, residential, commercial and industrial building with special focus on high and super high-rise buildings. SMAY has started to set standards in ventilation technology since 1989.

Being not only manufacturer we react quickly to the actual needs of the market providing full support at each and every stage of the project. SMAY as one of the most plants in Poland has its own construction site, design office, R&D department and technical offices located in Warszawa and Poznań. Customer demands can be also supported anywhere in the world. Today our aspiration is to become a global trendsetter and provide innovative technical solutions in the field of smoke and heat control system.

Together we can do more...

Cooperation is one of our foundations. Lately we have proven once again that exchange of ideas and thoughts can bring brilliant results. This is an indisputable fact. Therefore SMAY has always been and still is looking for potential partners.

At the moment it employs four PhD's and funds research projects at the Warsaw University of Technology. Looking towards the future SMAY cooperates with European Committee for Standardization (CEN), supports Federation of European Heating, Ventilation and Air-conditioning Associations (REHVA) and Polish Chapter of the Society of Fire Protection Engineers (SFPE). We would be glad to become a part of the global family of forward-thinking companies together with you to guarantee progress.

Our mission and technical offer

Bringing innovative tailor-made solutions to the market that meet even the most demanding requirements and most of all provide the highest possible safety level in case of fire. SMAY products are offered in three basic groups:

- stand-alone ones e.g. grilles, diffusers, fire dampers and VAV boxes,
- pressure differential kits iSWAY-FC® type,
- complete systems e.g. forced airflow pressure differential system SAFETY WAY®, jet fan system SAFETY CarPark® and SmayLab®.

Our specialized teams and in-company production control are the best guarantee that SMAY is the brand you can depend on. We have never stopped looking for new challenges to make our offer more complete and up-to-date.

Within next few months we may expect introduction of new optimized products by SMAY that should perfectly meet the market needs.

Smoke and Heat Control Systems supplied by SMAY

SMAY is probably the only Polish company that manufactures and supplies complete smoke and heat control systems. Our speciality are pressure differential systems based on application compact pressurization units iSWAY-FC® type. Our flexibility and good understanding of the market lets us successfully compete with big international brands together with becoming well recognized European company.

Idea of operation of Pressure Differential Systems (PDS)

Modern building constructions shall comply with strict requirements regarding safety level in case of fire. Key issue is to ensure safe evacuation of all people from the building on the basis of evacuation scenario. Since the most significant threat during evacuation is the risk of toxic fumes inhalation and sustaining burns key issue is to control temperature and keep all escape routes free of smoke. It is possible assuming that fire ventilation installations are properly designed and balanced. The most common installations applied in multi-story high-rise buildings are pressure differential systems. Major aims of this solutions regardless of the technical details are to depending on the actual criterion:

- produce and control fixed value of pressure difference between selected spaces in order to control smoke movement inside the building e.g. staircase in reference to the fire floor,
- generate directed and controlled airflow through open evacuation door between protected space and the corridor or open-space.

Overpressure in protected spaces is produced by supplying airflow rate corresponding to the total air leakage rate of given space. Depending on the protected space type and cubature air can be supplied in different manner:

- multiple injection – air is supplied to the staircase through the ductwork and multiple inlets located along the staircase. According EN 12101-6 air inlets shall be located at least every third floor,
- concentrated air supply – usually with single air inlet located at the bottom or at the top of the staircase.

NOTE: Location and number of air inlet points doesn't influence significantly static pressure distribution inside the staircase.

Design standards if the Pressure Differential Systems (PDS)

Depending on the country and its national regulations there are many local requirements regarding design of the PDS. Special attention is paid to the nominal (safe) pressure differential and air velocity ensuring that escape routes are smoke free. Precise control of an overpressure in the protected space is particularly important since it results in the door opening force value. If the overpressure is too high evacuation may be significantly hindered or even impossible. Nevertheless some common rules and requirements are presented in the globally recognized standards listed below.

EN 12101-6 Smoke and heat control systems. Specification for pressure differential systems - Kits,

Nominal pressure differential	50 Pa+/- 10%
Nominal air velocity	0.75 – 2.00 m/s
Maximal door opening force	100 N.

Design standards if the Pressure Differential Systems (PDS)

NFPA 92A Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences,

Minimal pressure differential **12.5 – 45 Pa**

Maximal door opening force **133 N.**

French national regulations and Building Research Institute (ITB) Instructions no. 378/2002

Nominal pressure differential **20 – 80 Pa,**

Nominal air velocity **1.00 m/s,**

Maximal door opening force **n/a.**

Pressure differentials shall be measured in the reference to the selected space in the building. The fundamental goal is to produce and control pressure differential in the reference to the corridor on the fire floor. Minimal acceptable pressure differential depends on the ceiling height and whether sprinklers were applied. Pressure differential across the door strongly influences door opening force which also corresponds to the size of the door and door closing device characteristics. Regardless of the selected evacuation scenario it shall be obligatory that the maximal door opening force, measured in the direction of evacuation does not exceed normative value. Air velocity depends on the selected design objective of the PDS. Air velocity equal to 1.00 m/s is recognized to be sufficient to prevent smoke backflow in the early stage of the fire development (evacuation purpose) whereas 2.00 m/s is recognized to be appropriate for the fire-brigades operation when the fire may be fully developed. Moreover critical air velocity to prevent smoke backflow can be easily calculated and depends on energy release rate to the corridor, corridor width and correctional factor value.

Building as a complex system of an airflow paths.

What shall be taken into consideration at the design stage?

In practice even simple designs may turn-out to be quite a challenge. Proper design of the PDS in the high-rise building requires both experience and knowledge since there are many processes and phenomena that shall be taken into consideration. First of all the conceptual design including basic design criteria and building characteristics must be developed. Furthermore it is vital to identify the hazard as to the efficiency of the PDS that are caused by physical phenomena responsible for airflows and smoky gases movement in a building. It has to be noted that ambient conditions such as air temperature or wind speed and direction may seriously influence operation of the PDS.

The phenomena responsible for the airflows and smoke movement in a building include: stack effect, natural convection, thermal expansion, wind forces, airflow resistance in the staircase, piston effect, day-to-day ventilation installation operation. It is recommended to analyze listed factors together as they all shall be taken into account when designing the PDS. Those are the most visible in the high-rise and super high-rise buildings due to their height and architecture.

**Building as a complex system of an airflow paths.
What shall be taken into consideration at the design stage?**

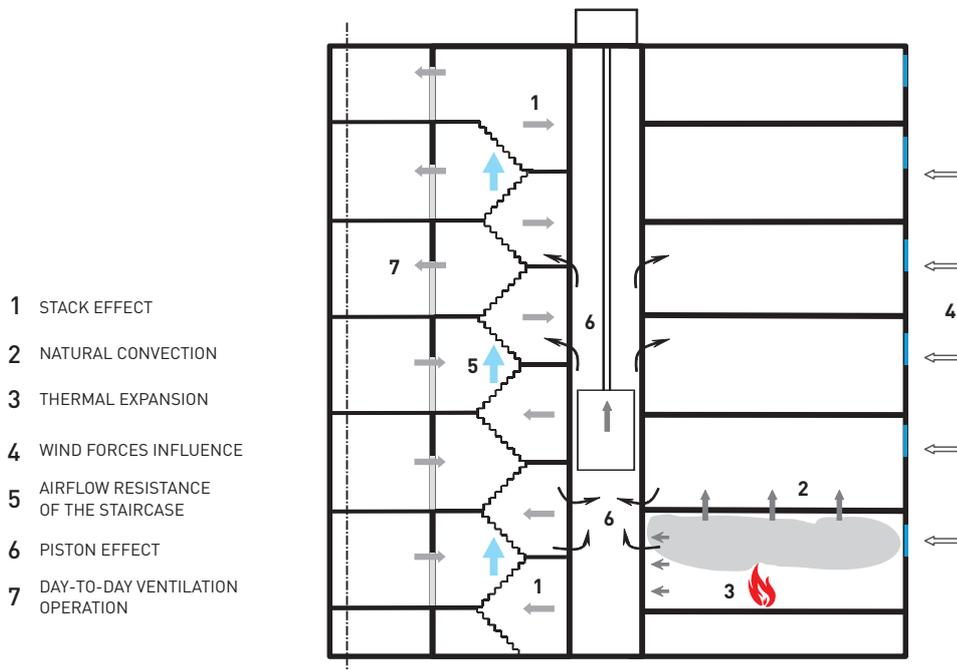


Fig. 1. List of effects influencing operation of the PDS

Stack effect

A factor of particular importance that influences pressure distribution in high-rise buildings and selecting methods of effective protection of escape routes is stack effect. Stack effect is a pressure difference resulting from a difference in density between two interconnected columns of air at different temperatures (internal air and the ambient). It results in vertical air movement in staircases, lift or installation shafts and natural static pressure gradient between top and bottom floors. Static pressure difference is proportional to the actual value of temperature difference and building height. The problem can significantly influence pressure distribution in buildings over 30 m high and may often result in faulty pressure differential system operation. If the airflow is from down up it is normal (normal stack effect).

Normal stack effect is best visible in the winter, with low ambient temperatures. Supplying cold outside air to warm staircases causes substantial increase of pressure gradient inside the staircase or elevator shaft. It results in low pressure zone at the bottom floors level and high pressure zone at the top floors level. If the air flow directed from up down it is reverse stack effect. Reverse stack effect is best visible in the summer, with high ambient temperatures. Supplying warm outside air to cooler staircases causes substantial increase of pressure gradient inside the staircase or elevator shaft. It results in low pressure zone at the top floors level and low pressure zone at the top floors level. Due to a large heat capacity of staircase or elevator shaft envelope it is not possible to stabilize pressure distribution with intensive ventilation its cubature within reasonable time.

The stack effect is not only associated with seasons of the year, faults in the work of the PDS but they are also visible within the time of 24 hours. Set in particular periods (e.g. one day) environment conditions do not always guarantee that at a particular hour there will be a given pressure distribution inside the building. Even small ambient temperature changes e.g. caused by weather breakdown may cause that in a very short time there will appear or worsen substantial pressure distribution in the staircase, on particular floors.

Stack effect

In case of fire the stack effect poses two fundamental risks resulting from uncontrolled pressure distribution in protected space:

- maximum force required to open evacuation door may significantly exceed normative 100 N value due to the increased pressure differential across evacuation door in high pressure zone;
- smoke infiltration to the pressurized space due to the pressure differential drop in low pressure zone. This problem is especially important since even relatively small amounts of smoke may contaminate air in the protected space and seriously hinder evacuation. The common mistake is to assume that stack effect is present only in the pressurized spaces. Airflows resulting from this effect can be registered on the floors as well, especially in where building facades are air tight.

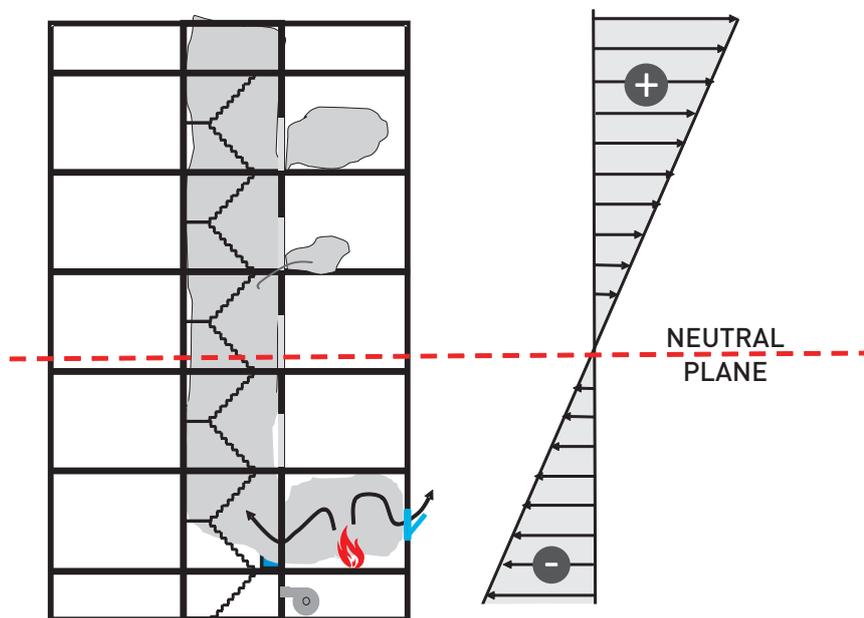


Fig. 2. Smoke movement inside the building resulting from the stack effect

Natural convection

The phenomenon is connected with temperature difference resulting from fire. It is responsible for 'leaking' of toxic combustion products through the leakage paths of the buildings structure to the floors above the fire affected space. To prevent smoke infiltration at the floors above the fire floor it is possible to supply fixed air volume via day-to-day ventilation ductwork. In practice it is likely that smoke will migrate from the fire compartment through the cracks and small openings to another rooms at the fire floor and what is even more dangerous to the floors above.

Thermal expansion

It's a phenomenon that is caused by volumetric expansion (thermal) of hot gases during fire. Small pressure change corresponds to significant temperature growth. Unless window brakes what may happen in non-sprinkled building the smoke may migrate from the fire compartment to the adjacent rooms.

Wind forces

The wind outside the building generates a characteristic pressure layout around the building facade. On the windward wall the pressure rises (positive pressure). On the opposite leeward wall the pressure drops (negative pressure). The wind influence on the PDS performance poses a serious problem in case of planned (e.g. window opening) or accidental (e.g. window cracking) increased air leakage throughout the building envelope. The resulting pressure distribution inside the building may significantly influence how the whole smoke and heat control system works.

Depending on the wind direction and speed, building shape as well as location of the natural vents, attention must be paid to the possibility of occurring the phenomena of blowing in or sucking out mixture of air and smoke. In buildings with complex roof shape and for high-rise buildings it is required to determine pressure distribution in vicinity of air release or air intakes and smoke exhaust openings with a use of CFD simulations. Nevertheless it is recommended to locate air intakes at the lower part of the building whereas natural or mechanical smoke vents shall be located at the roof level. Since in many cases this is not possible some additional precautions are recommended.

Air intake shall be provided for drawing air in from outside the building in such a way that it is not contaminated by smoke from a fire within the building. Air shall be supplied via fans and where necessary ductwork to the pressurized space.

Consideration shall be given to the siting and construction of the ductwork and fans to ensure that they are not compromised by a fire from within the unprotected space. To prevent supplying smoke to the protected space twin air intakes to alternative facades of the building complete with smoke detector and motorized smoke damper. Moreover it is vital to analyze whether natural air release from the fire floor will be effective for given location of the building.

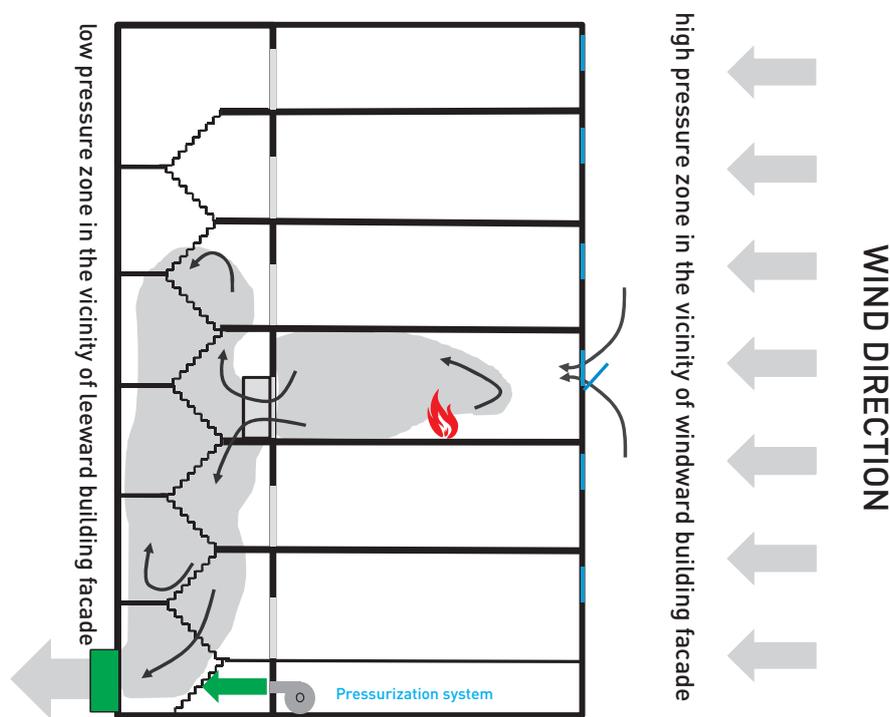


Fig. 3. Wind influence on natural air release through the window in the building façade

Airflow resistance of the staircase

PDS operation in the staircase always results in airflow and pressure drop in its cubature. Staircase may be compared to the large size vertical duct transporting air with additional elements such as stairs and landings. Pressure gradient mostly depends on air supply rate, staircase geometry and its

total height. According to measurement data typical staircase airflow resistance per single floor is in the range 2 – 6 Pa for typical stairwells in the modern buildings. In result stabilization of pressure distribution inside the staircase may be difficult by means of passive pressurization systems based on mechanical overpressure dampers application. This problem is best visible in high-rise buildings moreover this problem will occur regardless of the current ambient condition. On the other hand it shall be mentioned that stack effect and airflow resistance often come together and shall not be evaluated separately. Airflow resistance differs depending on how air is supplied to the staircase. Concentrated air supply results in the linear distribution of the pressure drop.

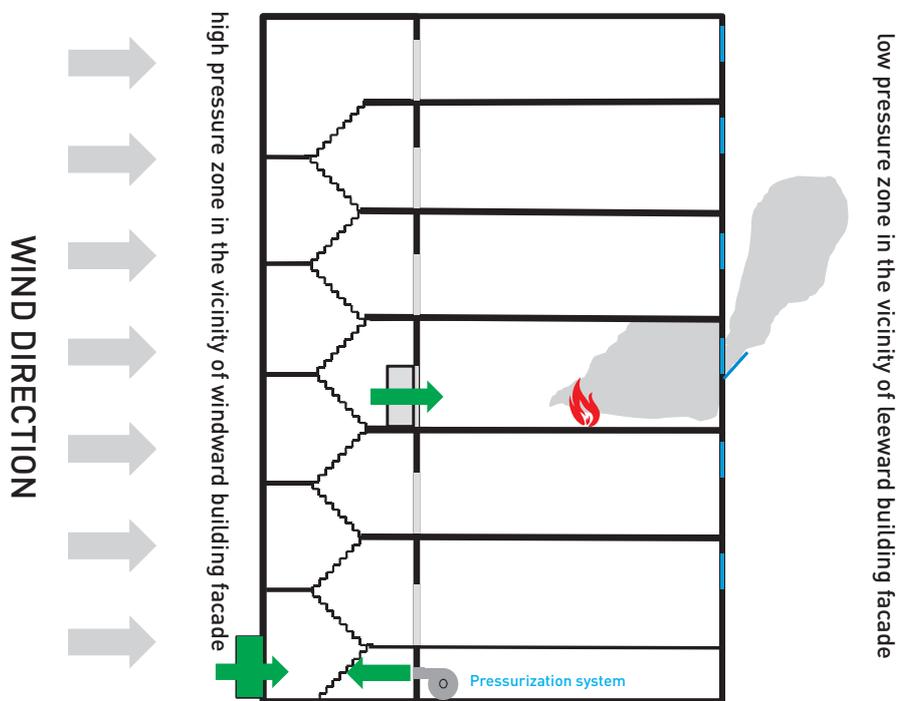


Fig. 4. Wind influence on natural air release through the window in the building façade

Piston effect

It is a phenomenon assisting lift car movement in the shaft. During car movement transient pressures are produced. A downward-moving elevator car forces air out of the section below the car and into the section of shaft above the car. In case of upward-moving car airflow patterns are opposite to the described. Lift shaft usually connects all floors in the building so elevator operation can significantly influence pressure distribution in the building. The phenomenon is particularly visible in case of fast moving lift cars. The resulting danger is about pumping smoke by moving lifts. To eliminate this danger, at the moment of fire detection all the cars should automatically go down and be blocked (with doors open). Fire-fighting lift shaft shall be pressurized in order to prevent smoke movement through the hoistway. Latest research performed by SMAY have confirmed that it is possible to control overpressure in the lift shaft by means of concentrated air supply and pressure controller at the top of the shaft. In sum multiple air supply to the shaft is not indispensable.

What market needs? What SMAY can offer? What are our advantages when we talk about PDS?

SMAY company offer covers the whole range of the PDS starting from compact pressurization units iSWAY-FC® type through the control and monitoring electronics enabling integration and visualization of the PDS operating parameters up to the complete PDS counteracting stack effect SAFETY WAY®. All listed technical solutions are follow-up active controlled ones. All key components and electrical circuits are constantly monitored. Remote access and monitoring by means of the Internet are also provided.

Is it possible to define complete pressure differential kit? iSWAY-FC® type compact pressurization units

The iSWAY-FC® Adaptive series compact pressurization units (pressure differential kits in accordance with EN 12101-6) are comprehensive technical solutions designated to overpressure protection of both vertical and horizontal escape routes in the various buildings in case of fire. All iSWAY-FC® series units are equipped with predictive algorithm regulators which provide automatic adjustment of the operating parameters to the dynamic changes of the ambient e.g. wind speed and direction, air temperature and internal parameters e.g. different evacuation scenarios. Capacity of the air supply axial flow fan is continuously adjusted by means of the Danfoss frequency inverter with the FIRE MODE function which shall be applied in smoke and heat control systems. Correspondent iSWAY-FC® units can be equipped with dedicated automatics enabling to protect of certain spaces depending on the local requirements in the building.

Application

Due to the applied control system and wide range of accessories iSWAY-FC® series units can be used to protect number of spaces with different cubature e.g. staircases, lift-shafts etc. Moreover due to the compact design and structure iSWAY-FC® series compact pressurization units can be assembled almost anywhere inside the building e.g. technical floors, roof level or ground level.

The simpler the better

Everyone who had tried to integrate number of randomly selected components into a fully functional system knows that this may not be possible in reality. Therefore our strategy is to supply fully functional technical solutions. The best example and proof of our philosophy is iSWAY-FC® unit.

- units are characterized by compact structure and small dimensions,
- all components are placed in the self-carrying housing of three sizes 0, 1 and 2,
- units are equipped with frequency inverter driven axial air supply fans with wide range of nominal capacities from 3 000 m³/h up to 50 000 m³/h,
- only Danfoss frequency inverters with "Fire Mode" designated for smoke and heat control systems are applied,
- precise control and stable operation guaranteed by dedicated regulator MAC-FC (Adaptive Control Model) with powerful digital signal processor 64-bit 456 MHz,
- modular structure and easy integration,
- application of properly integrated iSWAY-FC® type units enables building fully functional SAFETY WAY® PDS (described in the next chapters).

Predictive self-adjustable control

iSWAY-FC[®] Adaptive units are equipped with innovative in the field of fire protection adaptive control system based on neural networks application. In comparison with typical PID controller this approach has one significant advantage that is capability of continuous learning. This feature enables automatic adjustment to the changing characteristics of the control object e.g. air leakage rate changes, different evacuation scenario. Regardless of the realized criterion main objective is to produce and control set pressure differential e.g. 50 Pa.

One unit, two units, three units... set of units... integration, monitoring, visualization

It's obvious that to realize design objectives it is indispensable to connect individual units into effective set of cooperating modules. This is provided by means of Local and Global FireBUS communication protocols. Both Local and Global FireBUS have a loop topology. Thanks to this, a single damage (e.g., burnout, wire breakage, regulator or sensor failure) does not cause interruption in communication between PDS components. To mention just the key advantages:

- single communication cable connecting all units and additional components e.g. remote pressure controllers,
- safe data transmission thanks to the closed loop topology (ring topology),
- radical improvement of reliability and reduction of cabling costs.

When using electronic components it shall be obligatory to monitor its condition while operating and in the stand-by mode. Therefore when PDS consists of more than three iSWAY-FC[®] Adaptive units SMAY recommends Operating Conditions Monitoring Device (MSPU) which enables continuous monitoring of key components with immediate failure detection. Advantages of the device are:

- display of the actual readings from the pressure differential sensors and conditions of key components,
- position of the escape doors,
- visualization of the PDS local architecture,
- 24-hours automatic tests of the shut-off damper and air supply fan,
- shortening of the acceptance and commissioning tests,
- remote control of the PDS settings via Internet.

Variety of the accessories... Anty Frost[®] system twin air intake module, assembly

To enable easy assembly and fulfill safety and reliability requirements SMAY offers complementary accessories for the whole type of series of the iSWAY-FC[®] Adaptive type units. First of all units designated for external assembly are equipped with Anty Frost[®] system preventing movable elements of the shut-off damper from freezing in extremely low temperatures. Since the typical heating cables were not efficient they were replaced with IR directional heater controlled by the thermostat. All elements of the damper were painted black to provide the maximum absorption of radiation in order to raise its temperature above the freezing point. Other interior elements of the units are made so that they reflect radiation.

Variety of the accessories... Anty Frost® system twin air intake module, assembly

When iSWAY-FC® Adaptive type units are located at the roof according to EN 12101-6 “Where air intakes are positioned at roof level there shall be two air intakes, spaced apart and facing different directions in such a manner that they could not be directly downwind of the same source of smoke. Each inlet shall be independently capable of providing the full air requirements of the system. Each inlet shall be protected by an independently operated smoke control damper system in such a way that if one damper closes due to smoke contamination, the other inlet will supply the air requirements of the system without interruption.” Twin Air-Intake Module shall be provided.

To simplify on-site assembly SMAY offers different options of supporting structures from suspensions through frames and Big Foot roof support system.

Quality and reliability

It is worth to mention that iSWAY-FC® Adaptive type compact pressurization units are first complete pressure differential kits marked with building industry B – Mark. Each unit before leaving SMAY construction site is thoroughly tested in accordance with quality control procedures, labeled and registered. Except Declaration of Conformity issued by SMAY each unit is covered by the Technical Approval and Certificate of Conformity issued by Building Research Institute in Warsaw, PL.

Much more than declarations... way to certification

Since in accordance with European law pressure differential kits shall be tested by independent bodies SMAY from the very beginning tried prove that our solutions are really the top ones. Therefore iSWAY-FC® Adaptive type units were tested in the labs and in the real scale. Obviously real scale tests have lots of advantages but, some parameters and features can be tested only in the lab. In sum both laboratory and real scale tests shall be treated as complementary. Our declarations were proven by Laboratory of Industrial Aerodynamics I.F.I. Aachen, DE and Fire Detection, Alarm, Fire Automatics and Electrical Installations Laboratory ITB, Warsaw, PL.

How to protect high-rise and super high-rise buildings from the real scale test rig to the SAFETY WAY® PDS

Our strategy was always to fill the gap in the market. In 2008 the new era begun while SMAY started the research and implementation project co-financed by UE in cooperation with Krakow and Warsaw Universities of Technology. For over two years we have carried out number of real scale tests on the test rig build up in the high rise building located in Krakow, PL. Project's main objective: design, development and optimization of an innovative active controlled Pressure Differential System (PDS) dedicated for high-rise buildings called SAFETY WAY®.



Fig. 5. PDS real scale test rig

How to protect high-rise and super high-rise buildings from the real scale test rig to the SAFETY WAY® PDS

At the test rig different pressurization methods of the staircase were tested and compared. Test rig was equipped with complete control and data acquisition system. Ambient conditions and their influence on pressure distribution were monitored with the weather station. The test rig was unique in the European scale and enabled to define and confirm basis of the PDS counteracting stack effect. This was the place where SAFETY WAY® PDS idea was born. Stack effect is recognized as one of the most dangerous phenomenon influencing operation of the PDS. The higher building is the bigger problems may be expected. Obviously there are many different ways to reduce its influence e.g. dividing staircases into sections not higher than 30.5 m. Our strategy was to solve problem instead preventing it. That was the turning point where forced airflow PDS idea was born.

Forced airflow SAFETY WAY® PDS was developed to protect vertical escape routes in buildings against smoke infiltration in case of fire. The basic idea of its operation is to generate fully controlled and directed airflow inside the staircase and in consequence airflow resistance. Pressure gradient resulting from the stack effect is eliminated with the airflow resistance pressure drop.

SAFETY WAY® PDS should be applied in high-rise and super high-rise buildings staircases and in industrial buildings with large heat gains where it can operate in the day-to-day ventilation mode e.g. power plants. In such application iSWAY-FC® type units are equipped with additional filter modules located at the air intake. Depending on the selected design standard it is intended for the buildings higher than:

- 30 m (98 ft.) (according to the EN 12101-6 European Standard);
- 55 m (180 ft.) (according to French National Regulations, quoted in the ITB Instruction 378/2002);
- 65 m (213 ft.) (according to NFPA 92A Standard).

In order to generate the airflow in the pressurized staircase the simplest SAFETY WAY® PDS consists of two reversible flow iSWAY-FCR® Adaptive type units supplying/extracting air at the bottom/top floors. Optionally both units may be located at the roof level. Capacity of the frequency inverter controlled fans depends on the measured pressure differential between pressurized staircase and the reference. Direction of an airflow is automatically set while SAFETY WAY® PDS is activated from the Fire Alarm Signal (FAS) basing on measured air temperature differential between inside and ambient. Air temperature differential is measured between the pressurized space and ambient around the top and ground floors.

Moreover application of SAFETY WAY® PDS doesn't require any additional pressure control devices such as mechanical barometric dampers. In case when such device locations are not possible it is necessary to provide air inlets/outlets in the top and bottom zones. Whole year can be divided into three conventional periods depending on standard internal and ambient temperature difference:

- winter period – when ambient temperature is lower than air temperature inside the building. During this period due to the stack effect high pressure zone at the top floors and low pressure zone at the bottom floors occur in reference to the barometric pressure. iSWAY-FCR® Adaptive type pressurization units supply air to the bottom floors zone and exhaust it from the top floors zone.
- summer period – when ambient temperature is higher than air temperature inside the building. During this period due to the stack effect high pressure zone at the bottom floors and low pressure zone at the top floors occur in reference to the barometric pressure. iSWAY-FCR® Adaptive type pressurization units supply air to the top floors zone and exhaust it from the bottom floors zone.

How to protect high-rise and super high-rise buildings from the real scale test rig to the SAFETY WAY® PDS

Natural pressure gradient value is proportional to actual value of temperature difference and total building height.

- Interim period – when internal and ambient air temperatures are approximately equal. During this period no pressure gradient should occur. Significant problem in terms of pressure differential design is pressure drop connected resulting from staircase airflow resistance.

Idea of operation of SAFETY WAY® PDS for winter and summer periods is presented below. For interim period system operates in similar way to the winter period with reduced airflow rate.

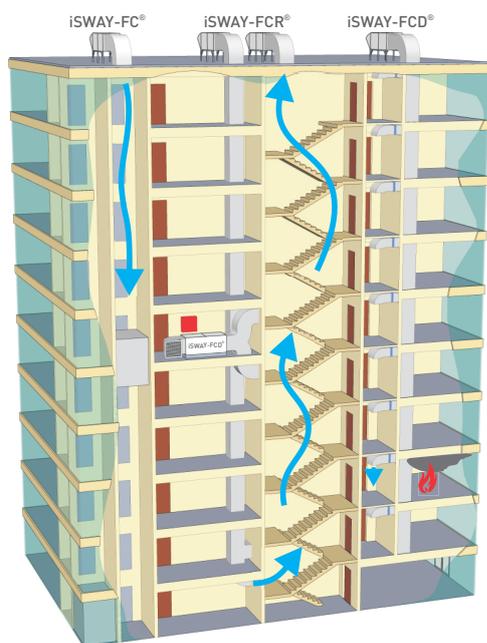


Fig. 6. Default SAFETY WAY® PDS operation in the heated building in the winter time

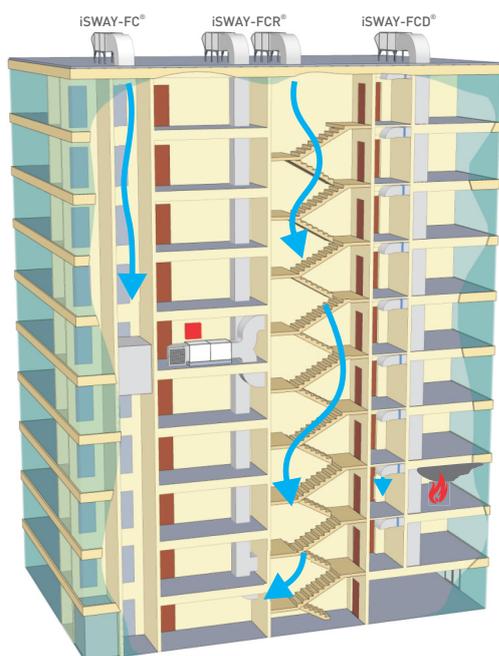


Fig. 7. Default SAFETY WAY® PDS operation in the air-conditioned summer time

How to protect high-rise and super high-rise buildings from the real scale test rig to the SAFETY WAY® PDS

During airflow criterion in high-rise building staircase depending on selected system class and total air leakage rate additional air supply units may be required to provide stable pressure distribution all along the staircase as well as nominal air velocities at open evacuation doors. By default it is assumed to provide one air supply inlet per each ten floors of the staircase. Additional air volume is supplied with iSWAY-FCD® Adaptive type unit with pressure controller calibrated in that manner to maintain 30-35 Pa of pressure difference between protected space and the reference. In super high-rise buildings with total height of 120 m or more SMAY recommends to apply remote pressure differential sensors every 5 floors. Fire Alarm Signal shall be capable of locating the fire floor and provide this information to the closest pressure sensor. Supporting air supply units iSWAY-FCD® Adaptive type are controlled basing on this given sensor measurement, while other sensors are neglected.

Cooling down the staircase or lift shaft. Is it really a solution?

There are some opinions that to eliminate stack effect it shall be recommended to cool down the staircase in the initial stage of pressurization...The problem is that since thermal capacity of the typical staircase or lift shaft envelopes are really big it is simply not possible within reasonable time. Our strategy is to enable evacuation after 60 s from the moment PDS had been started. Latest tests have proven that exchanging air inside protected space is definitely not sufficient. After initial temperature drop the heat balance between air supplied and the envelope resulting in the very slow internal air temperature decrease. In sum our opinion is that for the climate similar to Polish with low ambient temperatures in the winter time this is simply not effective.

SAFETY WAY® active controlled PDS main advantages

- ductless PDS, standard vertical air supply shaft can be eliminated,
- no partitioning of the staircase required,
- no mechanical barometric overpressure dampers required,
- stable pressure distribution all along the staircase regardless of the building height,
- fast acting and automatic adjustment to the changing characteristics of the building,
- an airflow through the pressurized space is provided all the time during pressurization,
- PDS also operational in the day-to-day ventilation mode.

How to pressurize fire-fighting lift shafts?

Special attention should be paid to the fire-fighters lift shafts servicing fire brigades. It is obvious that during the fire moving car can significantly influence pressure distribution in the building. SMAY recommends to provide at least two independent air supply points with individual pressure controllers to control pressure distribution in the shaft. If possible those points should be located at the top and bottom of the shaft. For super high-rise shafts additional electronically controlled air release at the top of the shaft may be required.

How to provide air release from the fire floor?

Air release can be provided by means of natural or mechanical installations e.g. openable windows, gravitational air release shaft or mechanical smoke extraction. It is very likely that regardless of the location corridors in the high-rise buildings will be equipped with mechanical smoke extraction system. The problem is that due to the national regulations in many countries using frequency inverters to control smoke extraction fans is forbidden. On the other hand heavy rotors of such fans are hard to control. In sum the biggest problem here is to provide compensative air supply to the corridor to prevent underpressures in the air tight corridors while evacuation doors to the lobby or staircase are closed.

Typical solution is to apply transfer dampers in the wall between the lobby and the corridor sized in the way to enable given airflow at the fixed pressure differential e.g. 7 000 m³/h at 45 Pa. This is acceptable for the PDS with relatively low air velocities at the door required e.g. 0.75 m/s. When 2.0 m/s is required transfer dampers simply cannot be assembled in the wall due to their size. Our strategy here is very simple that is SMAY assumes that there must be a link between the fire-fighting lobby and the corridor. In result amount of air supplied to the fire-fighting lobby should be sufficient to generate 100% of the design air velocity. In the plain words SMAY assumes that staircase, lift shafts, fire-fighting lobbies and corridors protect individually against smoke infiltration. No airflow from the staircase is taken into consideration at the design stage.

Fire-fighting lobbies

SMAY has developed technical solution enabling electronically controlled air transfer from the fire-fighting lobby to the corridor. Each fire-fighting lobby is equipped with independent set of two mechanically and electronically coupled pressure controllers with fast acting Belimo actuators NMQ24A-SRV-ST. Idea of operation is quite simple both air dampers operates backward in that manner that opening angle of each air damper is inversely proportional. Air damper located in the fire-fighting lobby operates as a pressure controller. While evacuation doors are closed excess air is transferred to the corridor via the by-pass damper and the pressure control damper is almost fully

closed. After opening the door by-pass damper closes and pressure control damper opens and required nominal air volume is supplied to the corridor through evacuation door.

Optionally SMAY offers standard solution based on mechanical air transfer dampers located in the wall between fire-fighting lobby and the corridor. Often due to the limited size of the lobbies it is not possible to apply mechanical air transfer dampers in the wall due to the large size required especially for class B PDS in accordance with EN 12101-6 European Standard.

Advantages of electronically controlled air transfer

- reduction of air transfer elements dimensions;
- precise control of pressure difference across evacuation door;
- constant monitoring of pressure differential system operating parameters i.e. pressure difference and possibility of failure detection.

Advantages of electronically controlled air transfer

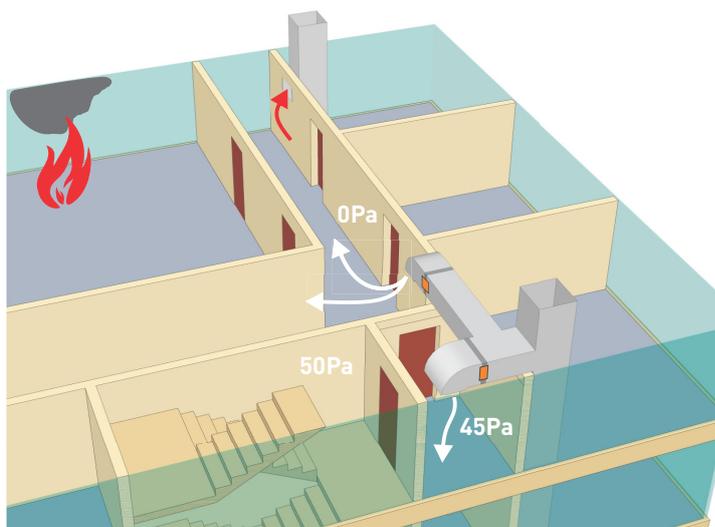


Fig. 8. Idea of operation of the electronically controlled air transfer during pressure criterion (no evacuation)

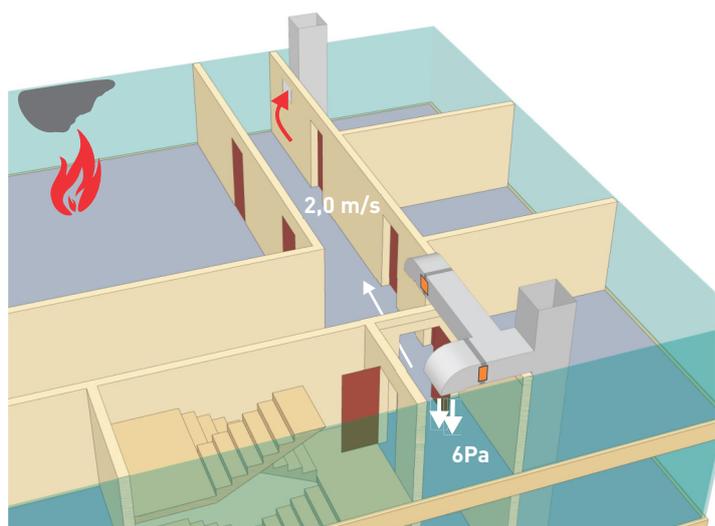


Fig. 9. Idea of operation of the electronically controlled air transfer during airflow criterion (evacuation)

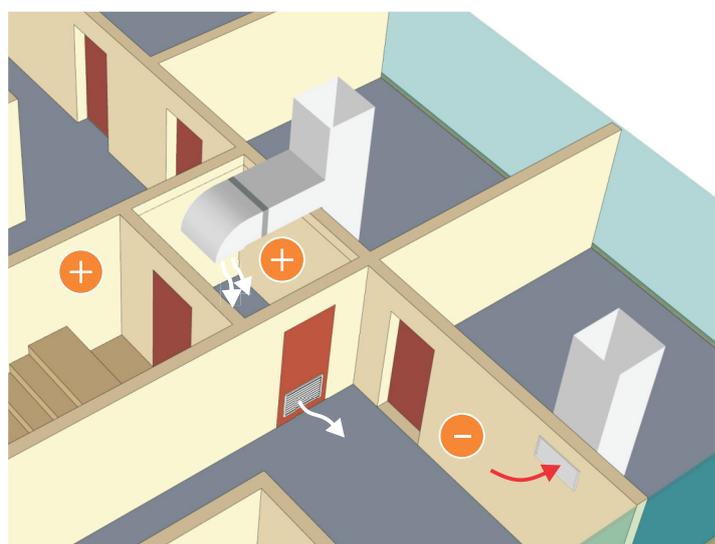


Fig. 10. Idea of operation of the mechanical air transfer in accordance with French national regulations (quoted in Instruction ITB no. 378/2002)

Supplying complete smoke and heat control system. Our main objective

Except PDS described above SMAY offers complementary installations required to supply functional smoke and heat control system. In our offer you can find smoke extraction installations servicing corridors and atria. Moreover we offer both ducted and jet fan ventilation systems for the underground car parks. There are so many controversies lately regarding jet fans that it seems to be necessary to explain our strategy here.

SAFETY CARPARK®

SMAY provides and supplies complete systems for car parks both ducted and based on jet fans application. Except fans our supply covers all supplementary components and installations e.g. smoke detection, CO/CO₂ detection, complete power supply and control. **Our strategy is based on one very important assumption, that is jet fans system should be designed for both fire and day-to-day ventilation modes.** Therefore it must be proven at the design stage and during the acceptance testing that both requirements are fulfilled. Our defined design assumptions are listed below:

- compensative air supply velocity should not exceed 5.0 m/s,
- gateways should be used to supply compensative air supply, air velocity should not exceed 3.0 m/s,
- smoke zones are defined in the same manner regardless if the car park is sprinklered or not,
- smoke curtains are recommended in order to control smoke distribution,
- capacity of the main smoke extraction fans should be in the range from 160 000 m³/h to 240 000 m³/h,
- jet fans should not be located directly over parking place where during the fire temperature may increase to 1200 °C,
- jet fans should be started after the evacuation is finished,
- CO is assumed to be the biggest threat in the car park,
- CFD simulations are great tools but only if validated against reliable measurement data.

Performance Based Design...how to confirm effectiveness of the PDS at the design stage?

Since building design is getting more and more complex and expectations are often huge it is necessary so smoke and heat control systems fulfill all requirements in terms of functionality, reliability, ergonomics and most of all economics. Therefore technical solutions offered by SMAY are characterized by modular structure enabling flexible adaptation to the given building. Our strategy is to provide tailor-made technical solutions that fit the project perfectly well. Our conceptual designs are always supported by thorough analysis involving state-of-the-art tools like Computational Fluid Dynamics (CFD) software. All numerical models are validated against real scale measurements results.

CFD simulations based on validated numerical models

CFD simulations are often used to evaluate effectiveness of both smoke extraction and pressure differential systems. Last years have brought significant changes in this field due to the improvement of calculation capabilities of available machines. This enabled more precise analysis of vast installations in terms of heat and mass transfer.

SMAY amongst other services offers professional CFD simulations of various issues connected with ventilation systems design and operation in the small and large scale:

- CFD modeling of pressure differential systems in staircases, fire-fighting lobbies and elevator shafts;
- CFD modeling of smoke extraction systems in horizontal escape routes, atria and car parks;
- CFD modeling and structure optimization of ventilating equipment e.g. fans, VAV controllers, diffusers etc.

Simulations listed above are carried out with a use of numerical model validated and verified against real scale measurements and provide accuracy of 10-15%. All CFD simulations are performed by SMAY engineers employed in Research and Development Department.

Depending on the analyzed problem and required accuracy Ansys® Fluent®, Fire Dynamic Simulator or Zone Modeling software is applied. In some cases additional numerical codes developed by SMAY R&D may be used.

On a special Client's request any technical problem may be analyzed after all the requirements and technical details are defined.

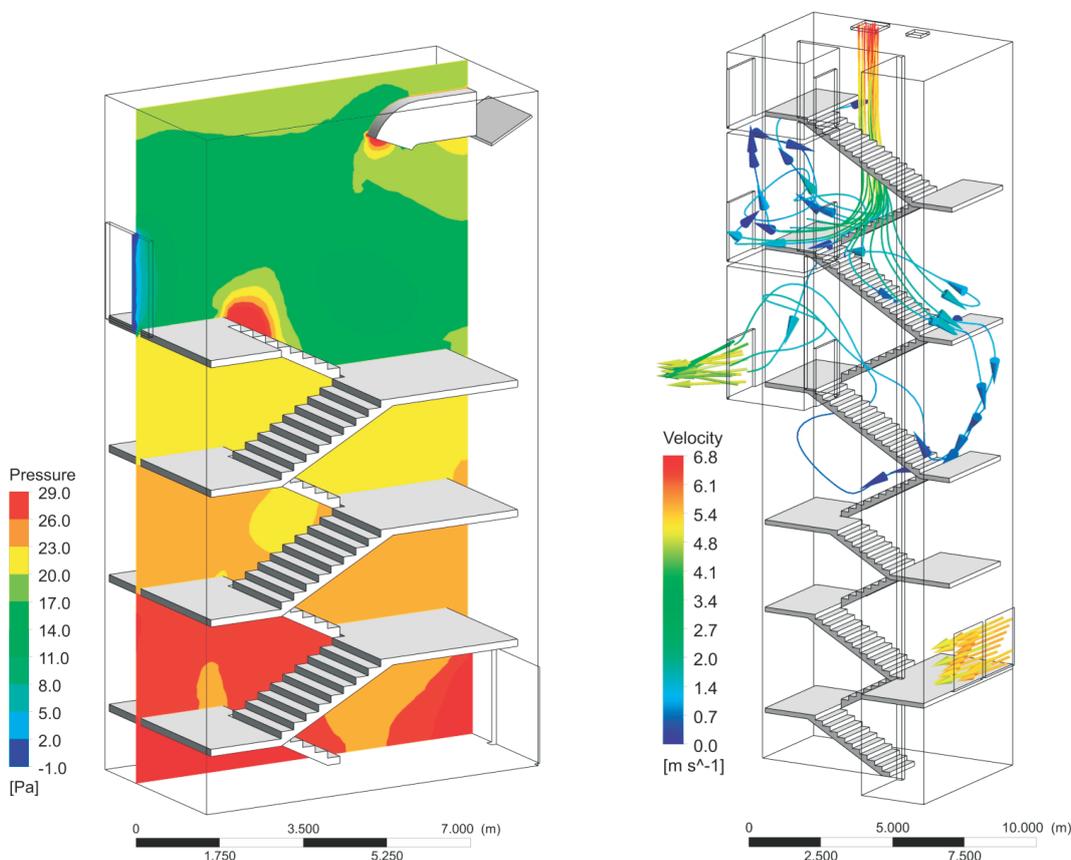


Fig. 11. CFD simulations results

Professional acceptance testing of the smoke and heat control systems. How to improve?

Moreover Research Laboratory of SMAY offers complete acceptance testing of the PDS in accordance with EN 12101-6 and hot smoke tests in accordance with AS 4391-1999 Smoke management systems - Hot smoke test. Since our goal is still to improve we have introduced some additional services which should result in the more reliable evaluation of the smoke and heat systems effectiveness. Just to mention the most significant one. As a part of standard acceptance testing carried out by SMAY innovative technology of 3D ultrasonic anemometer air velocity measurement were introduced. This enables to determine air velocity field in the car park and select the worse location of the fire. Moreover effectiveness of the day-to-day ventilation mode can be easily checked with exact location of the airflow stagnation zones.



Fig. 12. Ultrasonic 3D anemometer

Reference building as the best tangible evidence

You can find SMAY smoke and heat control systems in over 80 reference buildings all over Poland.

- Sky Tower, Wrocław
- BTA Office Center, Warszawa
- Park Biznesu Teofilów, Łódź
- Nova Park, Gorzów Wielkopolski
- Zespół Mieszkaniowy "Saska Kępa", Warszawa
- Budynek Mieszkalny "Na Gródku", Kraków
- Uniwersytet Rolniczy - Wydział Leśny, Kraków
- Politechnika Poznańska - Wydział Mechatroniki
- CNT Politechniki Śląskiej, Gliwice
- Akademia Rycerska, Legnica
- Dom Studencki "HELIOS", Lublin
- Hotel Globus, Gdańsk
- Marine Hotel, Kołobrzeg
- Hotel Reduta, Warszawa
- Jastrzębska Spółka Węglowa, Jastrzębie Zdrój
- Elektrociepłownia Konin
- Izba Celna, Katowice
- Międzyzakładowy Ośrodek Medycyny Pracy, Ostrowiec Świętokrzyski
- Hala Sportowa "Pogoń", Zabrze
- Stadion Wisły, Kraków
- Szpital Wojewódzki, Poznań
- Szpital Wojewódzki, Wrocław



Distinctions and awards of SMAY products



INNOVATOR OF MAŁOPOLSKA REGION

SMAY was among 5 most innovative companies of the Małopolska Province in 2010 and 2012



THE MOST INTERESTING PRODUCT OF THE YEAR

2010 - An award for iSWAY device
2012 - An award for iSWAY-FC Adaptive device
2013 - An award for SmayLAB system



**FORUM
WENTYLACJA**

INDUSTRY LIKES US - winner of the prestigious awards in the ventilation industry. For the fifth time the company has been recognized as the most friendly



A GOLDEN FITTER - An award for da Vinci fire damper in 2008
An award for iSWAY-FC compact pressurization unit in 2011



TOP BUILDER

An award in the category of "A Producer of Innovative Technology" for fire damper with a controller KTM-ME-VAV (da Vinci)



BUSINESS GAZELLE - in 2005, 2006, 2007, 2008



MEDIUM LEADER OF INSTALLATIONS

An award in the category of Ventilation and Air Conditioning for fire damper da Vinci.



SMAY more than the manufacturer... more still to come

Our philosophy is based on constant pursuing perfection and try to provide the highest quality level of our products. We cannot do it alone. Therefor we would like to ask You for support and cooperation. Regardless what are you involved and in and responsible for Your thoughts and ideas may become important and valuable for us. Regardless if you agree with our strategies and assumptions feel free to contact us. We are waiting for your feedback.

Our motto is to provide support at each and every stage of the project from the very early conceptual stage through the calculations, design, optimization and CFD simulations, up to on-site assembly, start-up, calibration and acceptance testing. We would like to be present to help and explain. We would like to support.

Last years have proven that this may be the right way to become recognizable in the global scale. We still believe that enthusiasm moves the world...

Best Regards

SMAY Company Team