

Tunnel Ventilation

Business Area Tunnel Fans



Trust Systemair

Trust the leaders for air diffusion and air movement

Systemair's story is a story of innovation, intuition and breakthrough technologies. It is also a story of the women and men that have made them possible, of their lives spent for a goal that is not just of the company. As, if there is a value that is shared by all the professionals of Systemair, it is the one to believe that a better technology can provide a better life for all. The sensibility towards the environment and the constant search for production and logistics solutions of high energy efficiency are just few aspects of this value: a value that anyone working together with Systemair's professionals can feel. It is the trust of who knows of working with women and men part of an important company with an important ideal.

Systemair: Quality has always counted

If Systemair has achieved the ISO 9001 and ISO 14001 certifications it is not only due to institutional duty: the search for constant improvement of quality is an absolute must that leads every decision making and production process. The choice of the suppliers, the definition of methods, the selection of production sites, the search for the most suitable technology and material so to satisfy every goal, are inside the DNA of the international reality that has never forgotten the key values of its founder and of the men and women that have made it important. It is for such confidence that Systemair offers as standard a three year warranty on all its fan models.



Testing centre for axial fans

The axial fan technology testing centre is based in the production site of Windischbuch, Germany. The strive for continuous improvement of the fans led to need of a state of the art testing facility that now allows measurement of fan performances according to the ISO 13350, AMCA 210-99, DIN ISO 5801 and DIN 24163 standards. Jet fans and large axial fans of volume flows up and exceeding 500.000m³/h can be tested, with customers as welcomed witnesses, for the measurement of key values as: volume flow, thrust (for jet fans), vibration levels, noise levels, absorbed currents, rotation speed.



Where ideas become solutions: the new research and development centre

Inside one of the largest and modern test laboratories of Europe, fully AMCA (Air Movement and Control Association International, Inc) and ISO qualified, the researchers of the Systemair R&D Center measure volume flow levels, sound levels, efficiencies and all other important characteristics of fans, air terminals, heat recovery systems, and air curtains. Tests, results, and measurements, become products and solutions, benchmarks for the air diffusion and air movement markets.



Systemair M.R.T. Division

Systemair, world-wide leader for the manufacturing and commercialization of air diffusion components and fans, based in more than 47 countries and comprising 4700 specialists, definitely enters the field of infrastructure ventilation thanks to the acquisition of the Matthews&Yates assets.

The MRT (Metro Road and Train) division was created with the purpose of following actively this particular market so to supply ventilation systems for underground applications as, metros, road, train and hydraulic tunnels. The staff, with a specific knowledge of the peculiarities of these applications, follows each project with competence and care.

MRT division is to be the sole referent for the companies that work in underground projects. Our proposal is global as Systemair can supply ventilation systems from the very start of the project during tunnel construction and follow the supply of the final ventilation systems needed to control internal air quality and fire safety measures.

Moreover, understanding the importance of such works and the need of safety required, we provide unique solutions to our customers.

In close cooperation with them, we design, according to the enforced standards and laws, the most suitable ventilation system, not solely relying on standardized previous solutions. We will provide our experience and tools for helping you during design, control and optimization, supervising installation and verifying together the functionality of the ventilation system. Each new contract is an incentive to provide You a tailor-made solution.

For tunnel in construction we are able to provide the most suitable products for each single need following a sizing of the systems according to the enforced laws.

Each peculiarity connected with the ventilation system will be discussed and cleared so to provide a solution just for You. An example being the particular care we take in sizing sound attenuation systems, optimizing each solution according to the specific needs of each installation.

For the definitive ventilation systems, we offer consultants, construction companies and mechanical contractors, our competence and support for designing the proper ventilation system for each single

project. In case of fire, the safety of the users, is the key element and a correctly sized ventilation system is the most suitable means to control the smoke and heat produced by the fire and to save lives. Knowing the project from the early stage (construction), we are able to propose the most correct products for ambient comfort and smoke control in case of fire. As a partner, our staff will follow you through the different steps of the project, being available for supervision during installation, start-up and control of the supplied products performances (aeraulic and acoustic), up till the final commissioning in respect of the tender documents.

Systemair invests in research and development programs and owns one of the largest and modern testing labs in Europe where innovations have allowed the design of premium quality products, each singularly

tested and dedicated to this field in conformance with the most recent International Standards.

The MRT Division shares Systemair's vision: satisfying the customer, anticipating his needs supporting him along the process of making each single project an opportunity for mutual benefit and growth.

Due to the constant work and competence of its specialists Systemair can once more define itself as a leading air distribution and movement group.
Trust Systemair.



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Tunnel Drilling Ventilation



Systemair is able to provide the necessary technical support for designing the proper ventilation system using the enforced international laws and recommendations as the Italian D.P.R. 20-3-56, the Swiss SIA 196 and the French AFTES and supplying the resulting products.

Systemair Products

Axial fans manufactured in single stage or in multi-stage units realized by coupling one or more contra-rotating fans so to deliver large air volumes with high pressure heads (over 5000Pa).

The adjustable pitch angle configuration and variable impeller solidity offers a wide performance range and maximum flexibility to match precisely individual airflow and noise requirements, while considering energy efficiency, allowing for successive re-use of the fans for new projects.

Ventilation during tunnel construction is needed so to provide the external air required to dilute the pollutants produced by the machines used during the different stages of the manufacturing granting the working squads a safe environment.



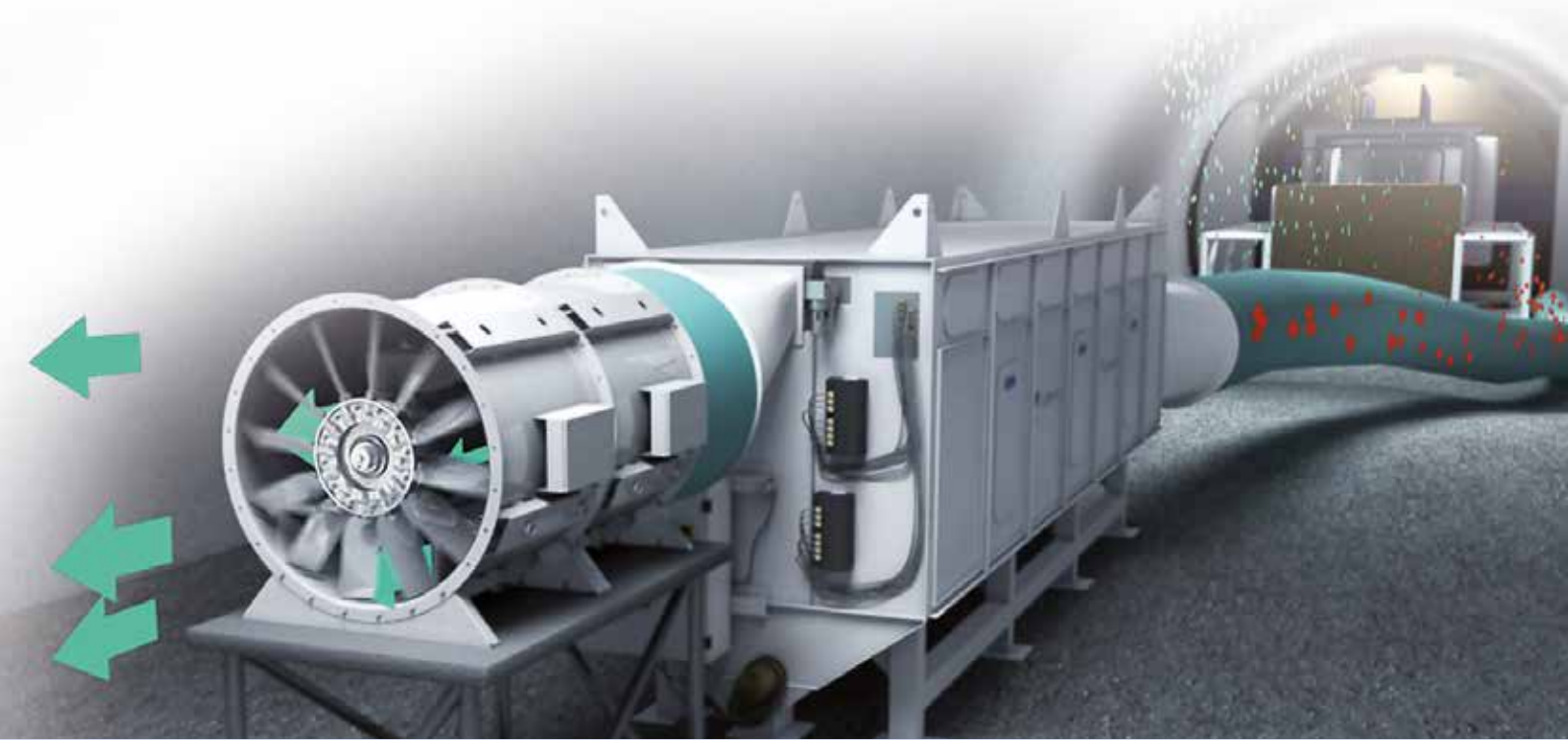
Silenced drilling application in urban context



Drilling application with flexible duct assembly



Deduster installation on TBM
(Tunnel Boring Machine)



Systemair's Key Distinctive Elements

Fans manufactured using sturdy cases, hot dip galvanized after manufacturing with spun flanges for high rigidity and premium structural strength for long lifetime service in severe conditions.

Systemair proposal is not only centered on its axial fan technology but comprises all required ancillaries and components so to provide the most suitable solution for each single project. According to the agreed configurations and design results, Systemair can propose: mounting skids, frequency converters, sound attenuators, flexible ducts and tailor-made components so to provide customers the complete ventilation system taking care of its global functionality.

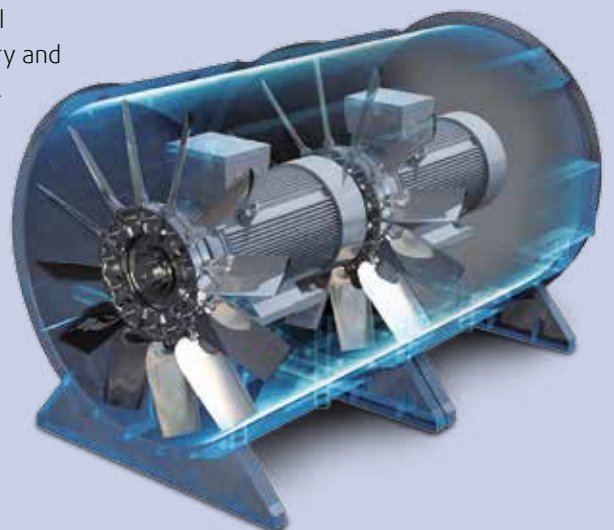
Sound Attenuators

Sound emissions can be greatly reduced by adopting the correct solutions as adding cylindrical silencers to the fan or by realizing uniquely designed splitter silencers, particularly useful in urban environment where sound impact is becoming ever so important.

Both are manufactured in heavy duty construction with significant steel sheets thicknesses to grant sturdiness and lifetime. All acoustic silencers are designed for the real life situation requirement and are manufactured to allow direct mounting of the flexible ducts or to connection pieces.

Frequency Converters

Delivered to be either installed inside electric cabinets or as stand-alone units in IP54 protection class, all pre-programmed before delivery and with control panels as standard.



Flexible Ducts

The Easy Joint flexible ducts, manufactured in smeared polyester PVC fabric, are available from 500mm to 3000mm diameter. Ducts are manufactured in stretches of length between 1m and 150m and of different weights up to 850g/m² chosen based on the maximum pressure level it will be subject in exercise. The innovative junction system allows easy installation while maintaining intact the sturdiness and reliability. Ducts can be supplied in anti-static and self-extinguishing material for tunnels in which certified anti-explosion products are required.

Design

Systemair's proposal includes the design of the proper ventilation system basing calculations on the enforced international laws and recommendations as the Italian D.P.R. 20-3-56, the Swiss SIA 196 and the French AFTES.



Silenced two-staged axial fan assembly

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Per calcoli di dimensionamento e dimensioni dei progetti ventilare sistemi aerea, si consiglia di utilizzare il software di calcolo Systemair, che calcola automaticamente le dimensioni dei componenti e la portata d'aria necessaria, in base alle caratteristiche del sistema di ventilazione e al tipo di lavoro da svolgere.

Il sistema di ventilazione è composto da:

- 1. Ducto di aspirazione (Suction duct)
- 2. Ducto di distribuzione (Distribution duct)
- 3. Ducto di aspirazione (Suction duct)
- 4. Ducto di distribuzione (Distribution duct)

Le dimensioni dei componenti sono indicate nel disegno. Le dimensioni dei componenti sono indicate nel disegno.

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Descrizione	Unità	Valore
1. Ducto di aspirazione	m	100
2. Ducto di distribuzione	m	100
3. Ducto di aspirazione	m	100
4. Ducto di distribuzione	m	100

Il sistema di ventilazione è composto da:

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Il sistema di ventilazione è composto da:

- 1. Ducto di aspirazione (Suction duct)
- 2. Ducto di distribuzione (Distribution duct)
- 3. Ducto di aspirazione (Suction duct)
- 4. Ducto di distribuzione (Distribution duct)

Le dimensioni dei componenti sono indicate nel disegno. Le dimensioni dei componenti sono indicate nel disegno.



Urban context fan assembly



Deduster system



Installation inside tunnel during construction

Systemair is able to provide for all ventilation systems design the proper material and support during: conceptual design, installation and commissioning.

Quality and Reliability

All products are CE certified and production and commercialization are performed under ISO 9001 and ISO 14001 certifications. Our quality system allows us to improve our products and our customer satisfaction. Reliability is guaranteed by severe quality control procedures without shipping any fan without having first performed running tests so to verify its functionality

Service

The long term experience and professionalism of our engineers allow to support each customer along the projects phases, following the initial design stage, up to supporting him to the commissioning of the plant; assisting him with key elements for this particular market as: pre-programming of the frequency converters, detailed installation procedures, and pre-assembling of the fan units and ancillaries so to allow direct connection to the other plant components.

Dust filters: Deduster

Systemair has increased its product range with the introduction of the newly designed DS deduster. The DS dedusters, are designed so to be able to reduce the dust content in the air in demanding applications found during all underground construction projects, being them hydraulic, rail or road tunnels, and during tunnel refurbishing. The filter efficiencies are extremely high reaching 99.9% for particle sizes between 0.2 e 2 microns for dust concentration up to 2500mg/m³. All particles of greater sizes are completely stopped and treated.

Deduster systems are ever more needed by health organization especially when silica or asbestos is present in the rock that is being treated.

For mechanical drilling of tunnels, dedusters are used to reduce the amount of dust, frequently unhealthy for the working squads. created by the construction operations. In this case the DS will be supplied on skids for ease of movement so to follow the construction progress.

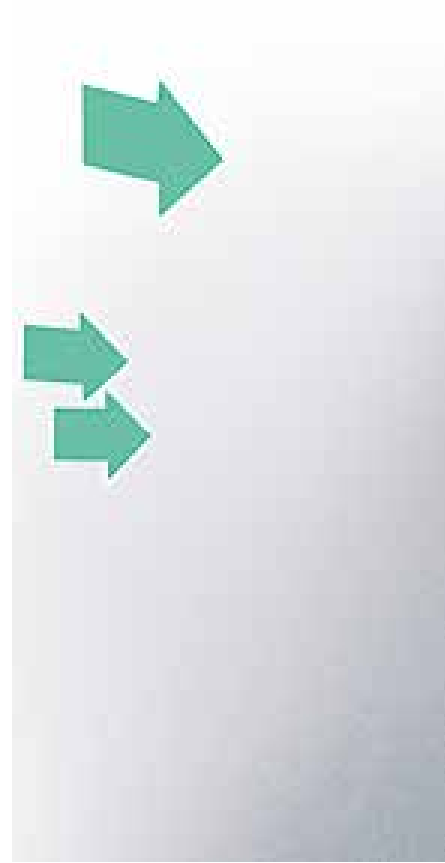
The DS deduster can also be used when TBMs (Tunnel Boring Machine) are used for the construction of long tunnels. In this application the deduster is used to capture the dust that rises from the conveyor belt that brings the drilled material towards the TBMs end. Due to the limited space available, the deduster needs to be tailor-made so to reduce to a minimum the hindrance to workers and optimize installation.

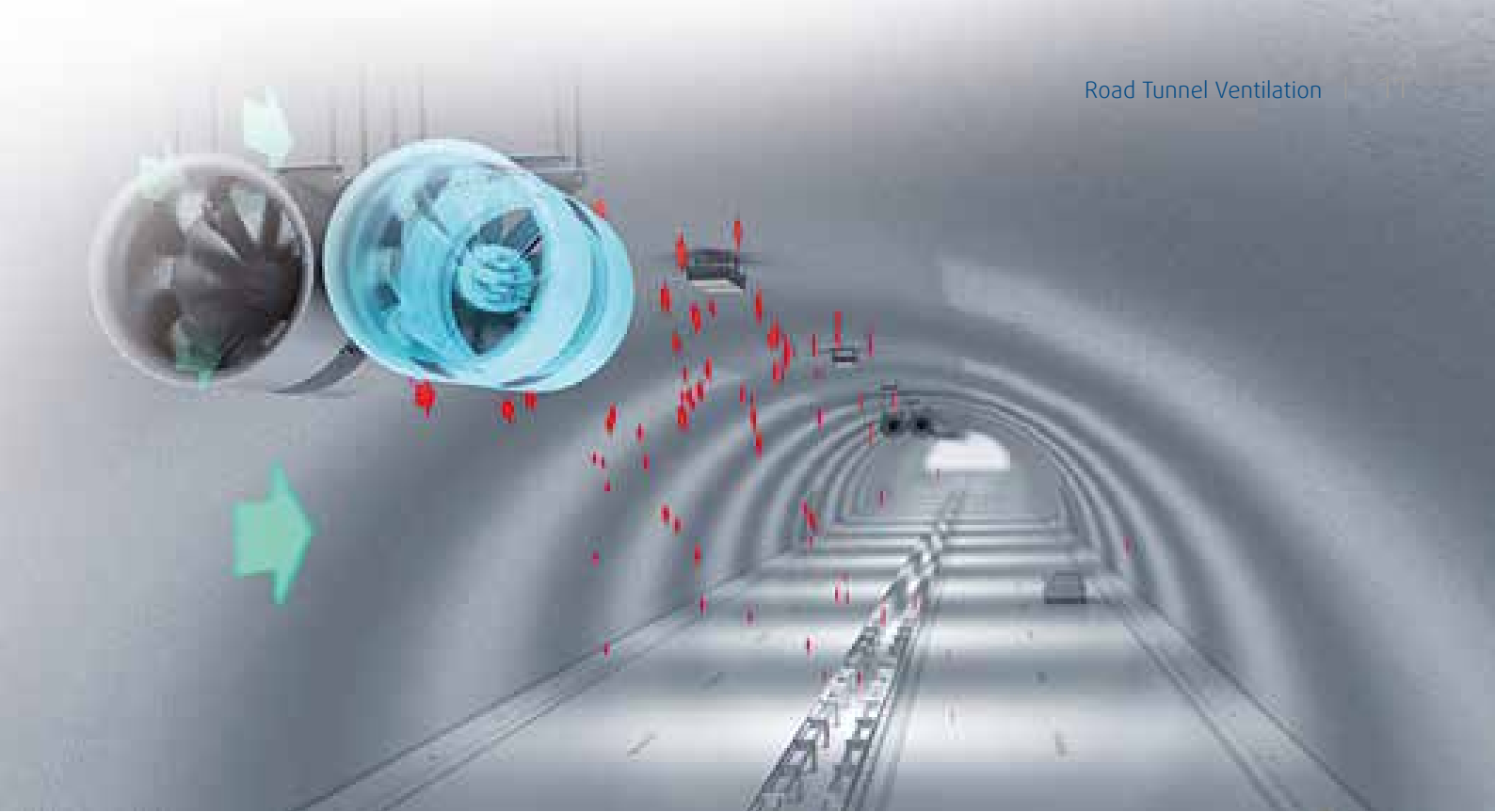
Road Tunnel Ventilation

New road tunnels will be required for the foreseeable future due to the following main reasons:

- Density of the population increasing worldwide
- Economic growth of developing countries
- Increase in prosperity leading to:
 - Increased vehicle ownership
 - Increased movement of goods by road (HGV)
 - Need to decrease journey times (goods/private)

Systemair, as market leader for tunnel ventilation systems, is able to provide technical expertise for the design of the ventilation systems, supply state of the art products and support staff for the installation, commissioning and running of the delivered systems.





Design of Road Tunnel Ventilation System

Design ventilation rates are based upon providing a sufficient supply of air to dilute the pollutant emissions from vehicles (Carbon Monoxide, Nitrogen Oxides, and particulate matter) and tunnel wear (dust), for the period of time in which the users of the tunnel may be exposed. The control of the effects of fire is also extremely important in tunnels. The ventilation system needs to be sized so to provide sufficient velocity and direction for controlling the spread of smoke in the event of a fire.

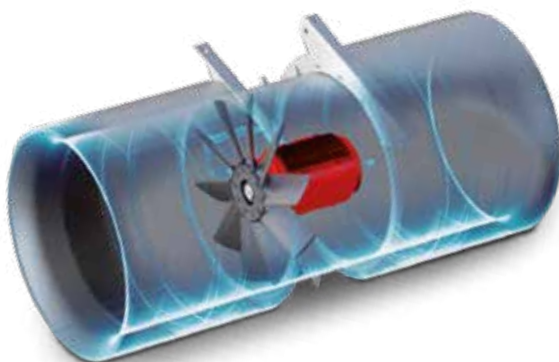
Systemair uses the latest prescriptions and recommendations coming from the official International bodies setting the standards for air quality and tunnel safety as: "PIARC" – Permanent International Association of Roads Congress, "WTC" – World Tunnel Congress, "WHO" – World Health Organization and National Guidelines – ANAS In Italy, CETU in France, RABT in Germany, etc.



Jet fan AJ1000TR



Jet fan AJ1120TR



Road Tunnel Ventilation Systems

The choice of the type of ventilation system for a road tunnel depends on different key elements such as: length, unidirectional or bidirectional traffic, gradient, cross-section, peak traffic flow rates, fire size, etc.

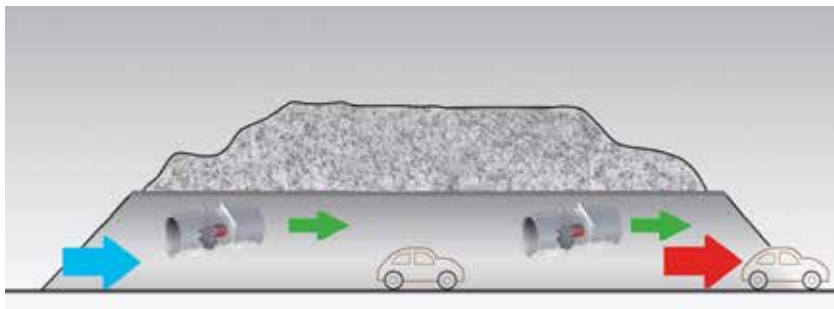
Longitudinal ventilation

Longitudinal ventilation is accomplished by using jet fans that, by accelerating a small part of the air present in the tunnel, through an exchange of momentum, are able to induce, on the overall air inside the tunnel, a movement in the willed direction.

The same is accomplished for fire smoke propagation control. Normally used for unidirectional tunnels with relatively short lengths (< 3km).



Possibility of supply of ancillaries such as: vibration transducers, support frames, dis-alignment switches



Extra size terminal box for ease of installation and cabling

Systemair Product

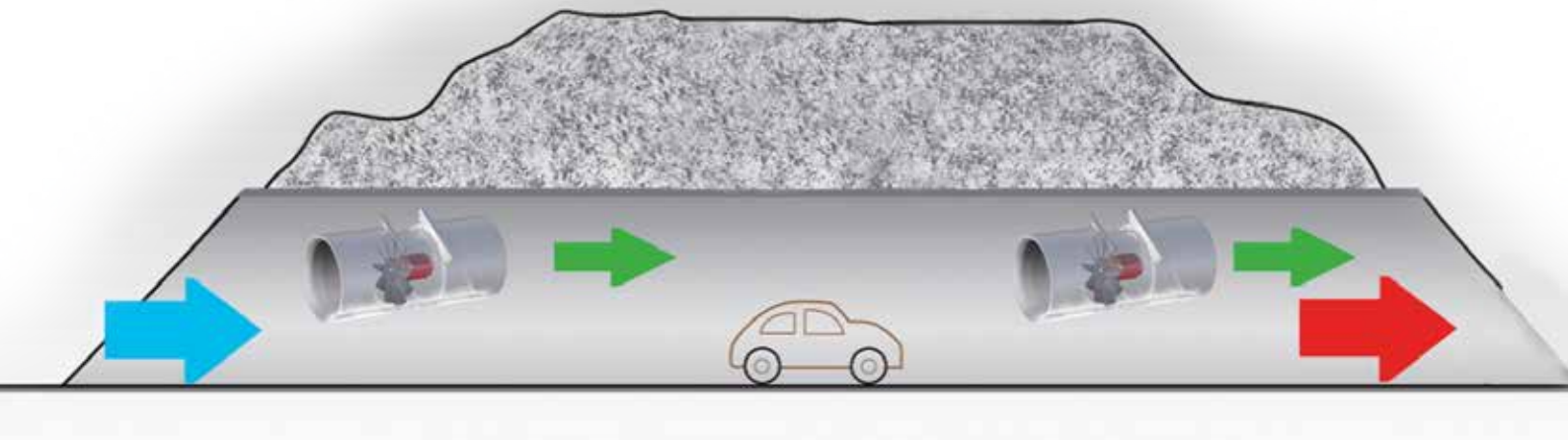
Jet Tunnel Fans from 500mm to 1600mm for thrusts up to 2100N and EN 12101-3 heat and smoke removal certification up to 400°C for 2hr operation. Fan development has been verified structurally with finite element analysis and performance tests follow ISO 13350 standard.

Key Distinctive Elements

Cases with augmented thicknesses for premium structural strength and long-lifetime service in severe conditions. All elements have been accurately designed as: the motor-external terminal box connection, the predisposition for fixing of vibration sensors and alignment switches, and the support frames designed for ease and reduction of installation times.



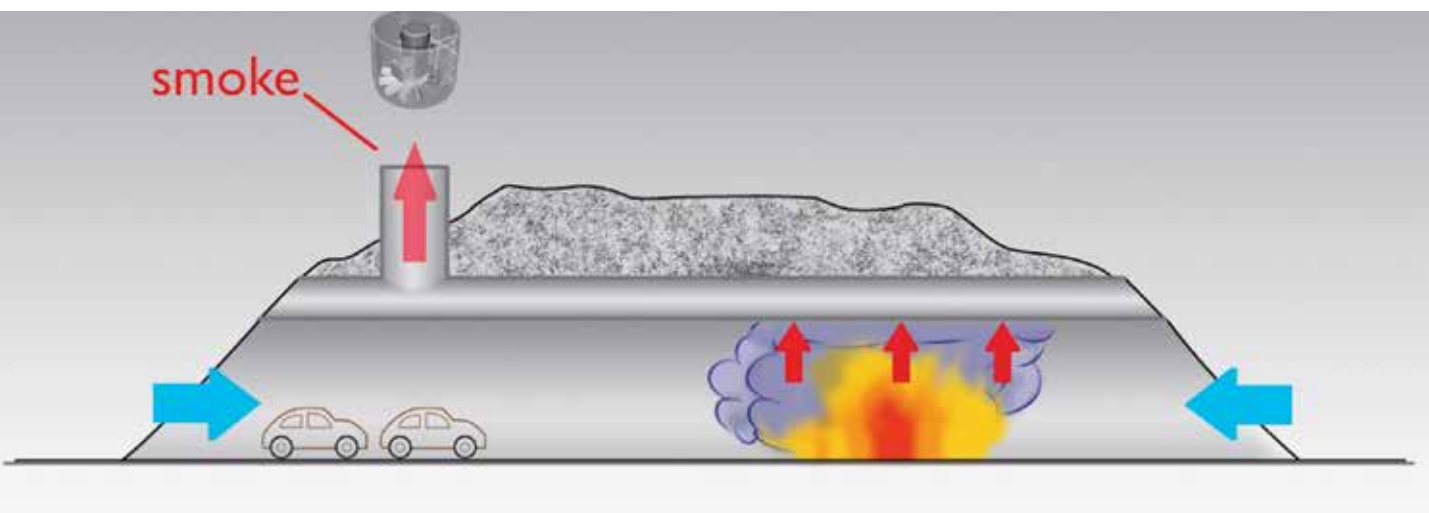
Installation example



Semi-transversal Ventilation

Semi-transversal ventilation uses air ducts to introduce inside the tunnel set flow rates of fresh air so to accomplish the dilution of the pollutants. In case of fire, the fans need to be able to reverse their

running direction so to extract the smoke flow rate and grant safe environment to the tunnel users. Normally used for bi-directional tunnels with need of augmented safety.



Road Tunnel Ventilation Systems

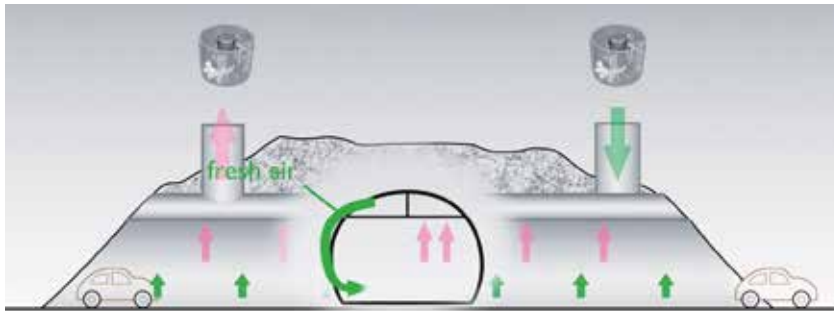
Transversal Ventilation

Transversal ventilation uses separate air ducts to introduce inside the tunnel set flow rates of fresh air and extract the flue air from the tunnel. The system grants the greatest safety and efficiency to the tunnel users but is also the most expensive solution due to the high civil work costs involved (large ventilation

rooms and large cross-sections to allow ducting). Normally used for long bi-directional tunnels with high traffic levels and high percentage of heavy good vehicles transit.



Axial fan AXR2000



Motor and external lubrication details

Systemair Product

Large axial fans, both unidirectional or truly reversible for both running direction. Volume flows up to 150m³/s and 5000Pa of pressure using contra-rotating fans in series. EN 12101-3 heat and smoke removal certification up to 400°C for 2hr operation.



Extra sized external terminal box



Sturdy tube casing construction



Silencer installation example



Multileaf damper installation example

Key Distinctive Elements

Tube casings, realized in hot-dip galvanized steel after manufacturing, for premium structural strength and long-lifetime service in severe conditions. Motors include copper lubricators for motor bearing re-greasing and are supplied for VSD control with A/C heaters and temperature sensors.

Fan development has been verified structurally with finite element analysis and performance tests follow ISO 5801, DIN 24163, AMCA 210-99 standards.

Extra size terminal box for ease of installation and cabling with IP65 protection class.

Possibility of supply of ancillaries such as: vibration transducers, inertia base frames and antivibration mounts, transition pieces and diffuser, air interception dampers, extract dampers, acoustic silencers, control systems, static frequency converters (inverters), etc.

Sound Attenuators

Sound emissions can be greatly reduced by adopting the correct solutions as adding cylindrical silencers to the fan or by realizing uniquely designed splitter silencers, particularly useful to reduce sound impact when intake or exhaust shafts are used.

Both are manufactured in heavy duty construction with significant steel sheets thicknesses to grant sturdiness and lifetime.

All acoustic silencers are designed for the real life situation requirement and are manufactured to allow direct mounting inside the allocated spaces. Splitter baffles can be mounted on rail systems so to allow the possibility of easy cleaning procedures. All materials used are classified as A1 for fire behavior according to ISO EN 13501-1 standard.

Multileaf Dampers

Being their use to intercept the ventilation room fans or for the extracting the flue air and smoke from the tunnel, multi-leaf dampers are often a key element for a fully functional ventilation system. The dampers offered are all realized for the greatest reliability having been subject to fatigue tests to simulate years of operation inside tunnels. Sizes are not an issue as, by coupling different modules together, virtually any dimension can be easily realized and manufactured. Dampers can be provided with fully electric actuators or with pneumatic and fail-safe return modules, granting great flexibility of choice to suit any need or request. Stainless steel can be employed for the manufacturing of all of the damper components and heat covers to protect the actuators from the high temperature involved with fire scenarios can be supplied if needed. Air leakage tests, blade deflection and pressure drop tests can be organized at need as well as the possibility of supplying BS 476 part 20 compliant dampers

Road Tunnel Ventilation Systems

Electro-precipitator tunnel filter systems

Environmental pollution is becoming a key element to take in due consideration when planning new road infrastructures in densely populated areas. Citizen sensibility to air quality, stirred up by medias, has greatly increased in the last years, forcing public and private organizations to take in consideration means to limit air pollution, in particular, small dust particulate such as PM_{10} and $PM_{2.5}$. We are able to provide a new concept of electro-precipitator filter system to be installed in road tunnels.

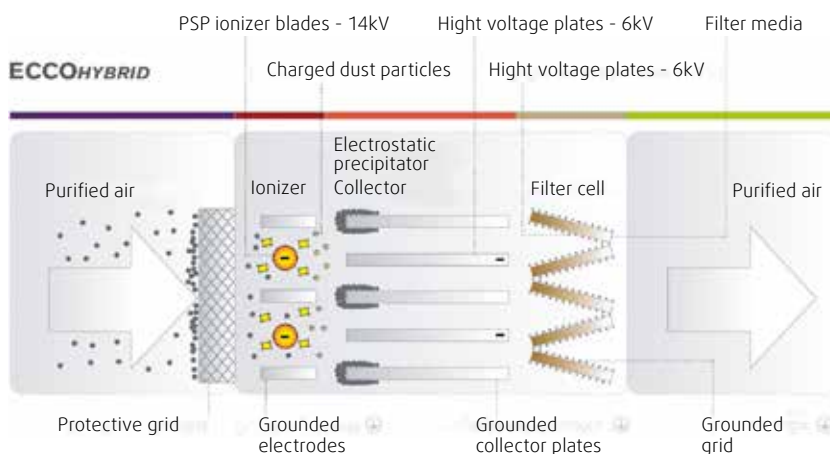
Tunnel air is forced by large axial fans to pass through an ionizing filter section, where dust particles are negatively charged before flowing through a magnetic repulsive field. The charged dust particles are, thus, pushed against a mechanic filter media where they're captured. The cleaned air is then released in the environment. The whole system is self-cleaning and fully automated so to limit men involvement.

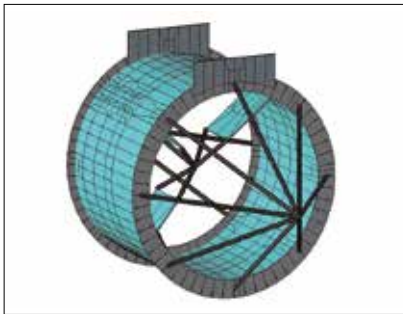


Filter collector detail

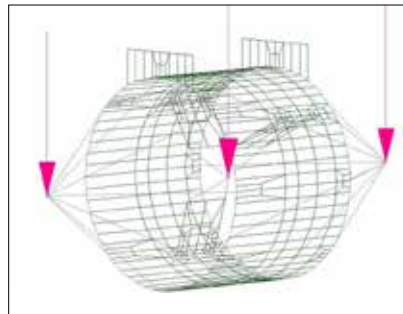


Ionizer detail

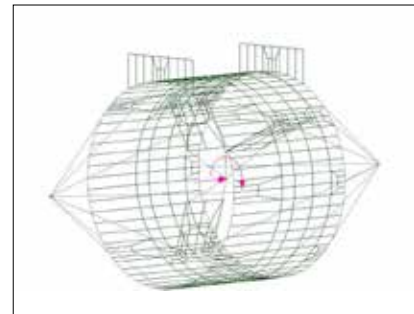




Solid model for FEM analysis



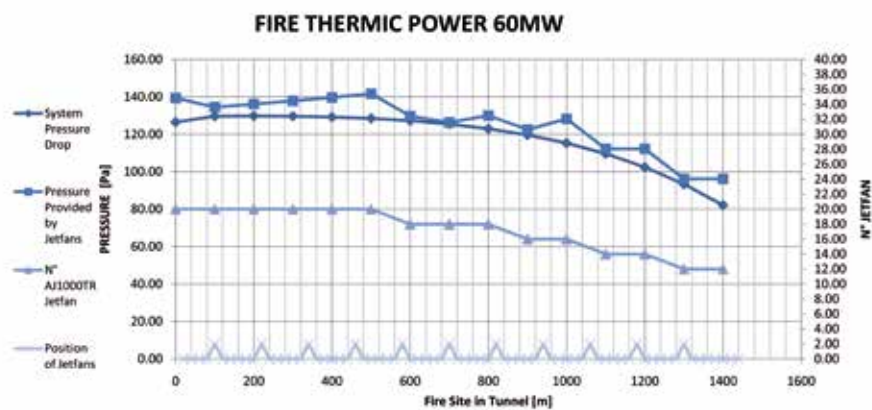
FEM vertical loads



FEM axial loads

Design

Systemair can provide assistance and realize design calculations based on PIARC, CETU and international standards



systemair rev.2

LONGITUDINAL VENTILATION PRELIMINARY DESIGN - FIRE EMERGENCY

HYPOTHESIS
The scope of the study is to size the longitudinal mechanical ventilation system for the Riva and Camilli tunnels following the indication received after the meeting in your office in Istanbul.

General Data	Riva Downhill	Riva Uphill	Camilli Uphill	Camilli Downhill
Length [m]	484	116	116	484
Height [m]	11.2	11.2	11.2	11.2
Width [m]	11.2	11.2	11.2	11.2
Height of the tunnel [m]	11.2	11.2	11.2	11.2
Height of the approach [m]	11.2	11.2	11.2	11.2
Height of the tunnel [m]	11.2	11.2	11.2	11.2

The ventilation system will be sized to be able to guarantee an air velocity over the critical velocity in all the cross section of the tunnel in accordance to the indication of NFPA 92.

Critical velocity calculation
The determination of the critical velocity, by iteration, determines the critical velocity.
The critical velocity, V_c , is the minimum steady-state velocity of the ventilation air moving toward a fire that is necessary to prevent backdrafting.
It is atmospheric temperature inside the cross-section immediately after the fire.

$$V_c = K \cdot K_f \cdot \left(\frac{g \cdot H}{T_c \cdot (T_c - T_a)} \right)^{1/4} \cdot \left(\frac{Q}{A \cdot V_c} \right)^{1/4} \cdot T_c$$

where:
 V_c : critical velocity [m/s]
 K_f : 0.85 (Friction factor factor) [m/s]
 K_g : 0.85 (Gravitational factor) [m/s]
 g : acceleration caused by gravity [m/s²]
 H : height of duct or tunnel at the fire site [m]
 Q : heat release rate of the fire [kW]
 A : area perpendicular to the flow [m²]
 T_c : average temperature of the fire gases [°C]
 T_a : temperature of the approach air [°C]

After the fire the temperature will reduce due to heat exchange with the tunnel wall and ambient air.
So, to be able to prevent the temperature reduction convective and radiative heat coefficients h_c & h_r as follows:

Design	Fire Power	Critical velocity	Friction loss
Riva Downhill	60 MW	1.7 m/s	1.7 m/s
Riva Uphill	60 MW	1.7 m/s	1.7 m/s
Camilli Uphill	60 MW	1.7 m/s	1.7 m/s
Camilli Downhill	60 MW	1.7 m/s	1.7 m/s

For a complete verification of calculation please check PIARC OS 118-2009 page 103-104.

Analysing the trend of the fire along the tunnel, it is possible to verify the minimum temperature class required by the fire.

The trends, calculated with the PIARC formula, are shown in the below graphics.

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Introducing the data

Parameter	A	B	C
Tunnel	1200 m	1200 m	1200 m
Fire Power	60 MW	60 MW	60 MW
Fire Site	1200 m	1200 m	1200 m
Fire Site	1200 m	1200 m	1200 m
Fire Site	1200 m	1200 m	1200 m

INFLUENCE OVER PRESSURE LOSSES
The pressure losses depend quadratically to the air speed and, thus, to the temperature. The dynamic pressure of the air is:

$$\frac{1}{2} \rho \cdot v^2 = \frac{1}{2} \cdot \frac{M}{A} \cdot v^2 \quad \text{with} \quad \dot{M} = \rho \cdot v \cdot A$$

Where the mass flow is assumed constant in static conditions.

TUNNEL FRICTION PRESSURE LOSS
The following formula is used to determine the friction pressure loss.

$$\Delta p_f = \lambda \cdot \left(\frac{L}{D_h} \right) \cdot \frac{\rho \cdot v^3}{2} \cdot \frac{T_a}{T_c} \quad (\text{Pa})$$

where:
 Δp_f : pressure loss in a tunnel section of L length [Pa]
 λ : friction loss coefficient (0.025) [m]
 L : length of tunnel [m]
 D_h : hydraulic tunnel diameter [m]
 T_a : wall temperature (assumed equal to ambient temperature) [°C]

INLET PRESSURE LOSS
The following formula is used to calculate the inlet pressure loss

$$\Delta p_i = \alpha \cdot \frac{\rho \cdot v^3}{2} \quad (\text{Pa})$$

where:
 α : localized pressure loss coefficient (0.5)

OUTLET PRESSURE LOSS
The following formula is used to calculate the outlet pressure loss:

$$\Delta p_o = \frac{\rho \cdot v^3}{2} \cdot \frac{T_a}{T_c} \quad (\text{Pa})$$

PRESSURE LOSS DUE TO THE FIRE
Several studies have determined that the fire has a negative effect over the tunnel's fluid dynamics due to the sublimation and excavation produced by the combustion. The effect can be calculated as sum of the Fire Obstruction Losses (Δp_{ob}) and the Smoke Buoyancy Effects (Δp_{sb}).

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Fire Obstruction Losses (Δp_{ob})
In an emergency scenario the effects of the fire must be accounted for, one effect is the backdraft caused by the fire. This can be calculated by the following formula:

$$\Delta p_{ob} = \lambda_{ob} \cdot \frac{\rho \cdot v^3}{2}$$

Where the following formula from CETU methodology is used to calculate λ_{ob} :

$$\lambda_{ob} = 1.0 \times 10^{-4} \cdot \frac{Q}{D_h^2 \cdot T_c^2 \cdot v^2}$$

Smoke Buoyancy Effects (Δp_{sb})
The buoyancy of the rising smoke plume will give some assistance to the ventilation system. This can be expressed by the following formula:

$$\Delta p_{sb} = -(\rho_c - \rho_a) \cdot g \cdot h_{eff}$$

where:
 ρ_c : density of the smoke [kg/m³]
 ρ_a : density of the air [kg/m³]
 g : gravity acceleration [m/s²]
 h_{eff} : effective height of the smoke plume [m]

CHIMNEY EFFECT
The chimney effect can be positive or negative depending on the position and direction of the air and ventilation system. The formula for the chimney effect is:

$$\Delta p_{ce} = -(\rho_c - \rho_a) \cdot g \cdot h$$

where:
 g : gravity acceleration [m/s²]
 h : height of the tunnel (positive or negative) [m]
For an uphill tube the chimney effect is positive and acting in favor of the ventilation system.
For a downhill tube the chimney effect is negative and acting against the ventilation system.

METEOROLOGICAL EFFECT
The wind speed at the tunnel entrance is a DP—0.4Pa counterpressure.

PRESSURE DROP DUE TO THE VEHICLES
The compressed vehicle inside the tunnel causes a resistance for the moving air. It is considered with the following equation:

$$\Delta p_v = \frac{C_d \cdot A_v \cdot \rho \cdot v^3}{2} \quad (\text{Pa})$$

Where n is the number of compressed vehicles and C_d , A_v , its resistance surface.
The formula has to be applied for each type of vehicle.
For the application has been considered.

Road Tunnel Ventilation Systems

Quality

Fan product range is certified according to EN 12101-3 for smoke and heat removal up to 400°C for 120 min., and has been verified structurally with finite element analysis. Performance tests follow ISO 5801, DIN 24163, AMCA 210-99 and ISO 13350 standards.

Service

Systemair supports you in every step of the project following you onsite granting supervision during installation, start-up, commissioning and running period.

Systemair is able to provide for all ventilation system design the proper material and support during: conceptual design, installation and commissioning.





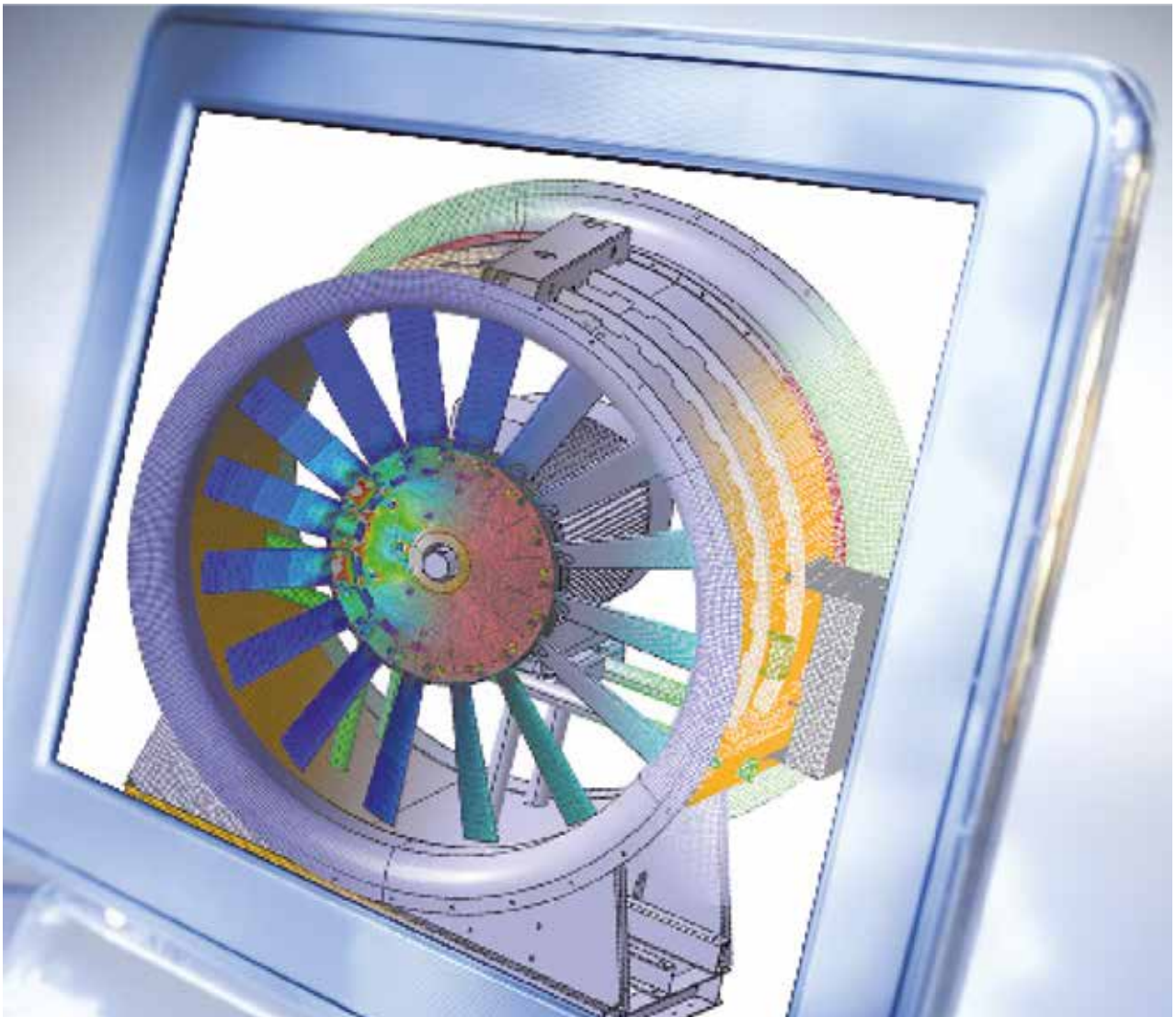
EN 13350 jet fan testing rig



Jet fan arrangement



Assembly line



Metro and Rail Ventilation

The increase of population in urban areas causes a significant increment of traffic and pollution.

To solve this problem, without hindering economic growth, people have used underground transport systems to decongest cities.

Subways and underground rail systems allow rapid transit times while transporting a large number of users.



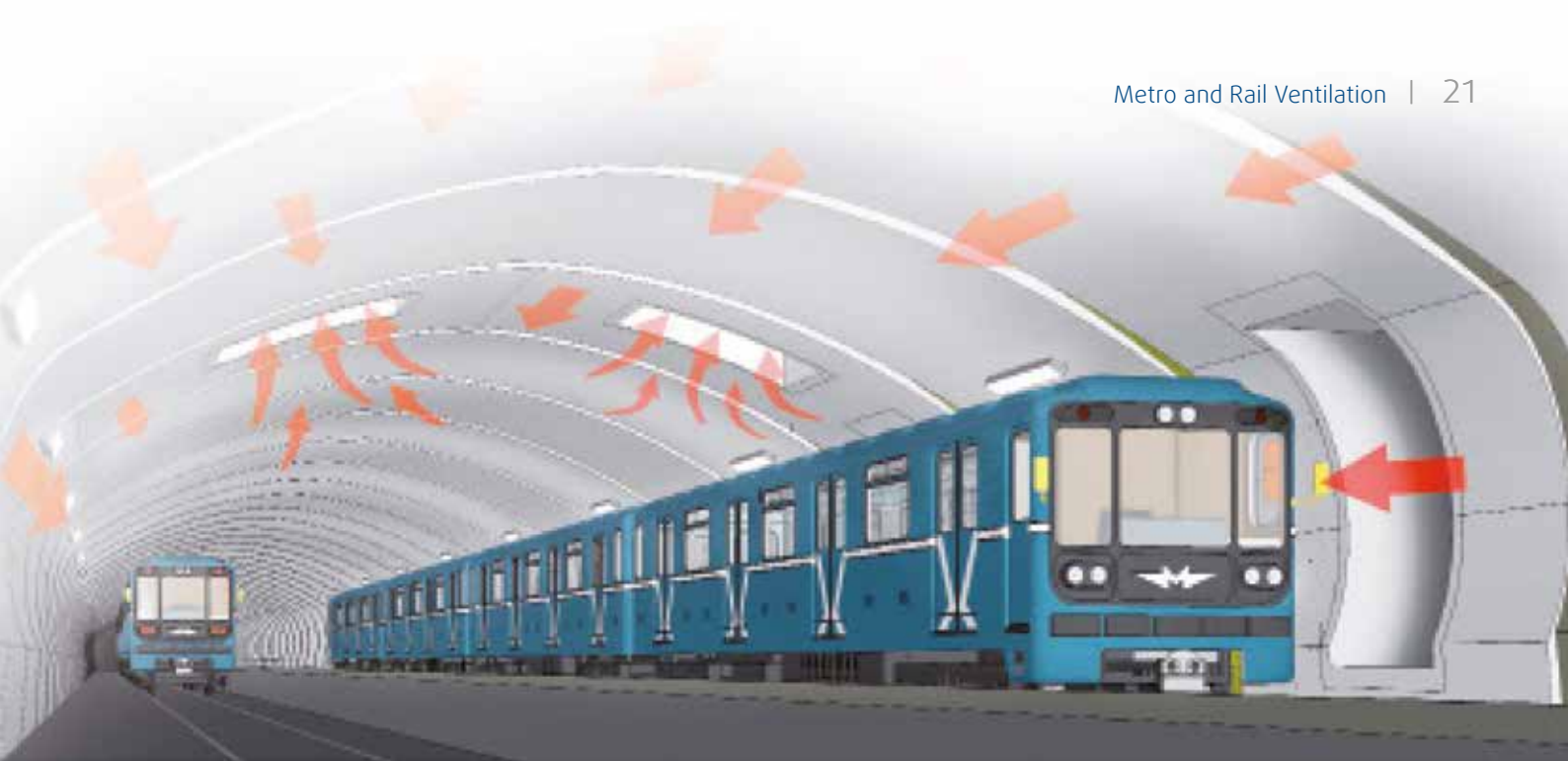
Truly reversible AXR 2000- 300kW



Details of installation of jetfans in rail tunnel



Unidirectional AXC 2000 – 160kW



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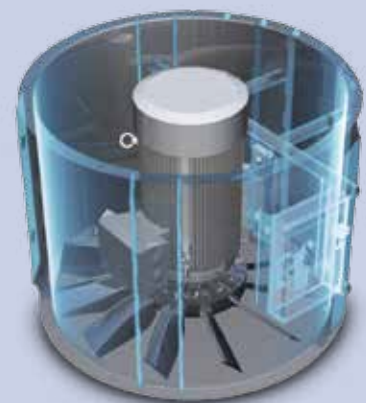
As known, closed underground environments tend to keep more constant temperature conditions than outdoor environments. This is mainly due to the lack of natural ventilation and air exchange. In metros, though, the influx of a large number of people and the presence of moving trains, generates a reduction of oxygen levels and an increase in heat and pollutant production. Mechanical ventilation is, then, required to allow the necessary air exchange and grant users of the underground train systems safe and comfortable conditions.

Ventilation systems have a second and even more important purpose, that is to grant safety in case of fire emergency. It is possible that for different reasons, a fire can start in stations or inside rail tunnels with potential serious risks for the users of a mass rapid transit. Smoke produced by the fire is the main enemy to fight off as it causes a reduction in visibility and is extremely noxious and deadly if breathed. Mechanical ventilation is designed so to prevent smoke to reach people fleeing the metro or rail system while avoiding the fatal consequences.

Understanding the importance of such plants, the MRT division of Systemair has gained in-depth knowledge of the needs and requirements for such mechanical ventilation systems and can provide a valuable support to designers and mechanical contractors to determine the most suitable solutions for their particular need.

Systemair products are chosen so to optimize the ventilation systems and calculation results can be provided for, as example, system pressure drops, or acoustic sound levels towards the platform or towards the ambient, so to confirm product selections.

The MRT division of Systemair follows customers through all the project's phases: starting from verifying the ventilation system's characteristics up to the final testing and commissioning, when needed.



Metro and Rail Ventilation

Systemair Products

The core elements of the ventilation system are the axial fans that are all certified according to the latest standards and in continuous development so to obtain the highest quality standards.

The range includes unidirectional and truly reversible fans for volume flow up to 150m³/s and high pressure levels. The possibility of varying the number of blades and hub size allows to define each fan to the specific duty requirement while optimizing power consumption and energy efficiency.

Systemair's Key Distinctive Elements

Fans manufactured using sturdy cases, hot dip galvanized after manufacturing with spun flanges for high rigidity and premium structural strength for long lifetime service in severe conditions. The impellers are all statically and dynamically balanced according to ISO 1940 standard and all rotating parts are subject to X-ray inspection according to ASTM E155 procedures so to exclude any faults in the castings.

Zyglo testing is also possible as option. Fans have been certified for smoke and heat removal according to ISO 12101-3 and development has been verified structurally with finite element analysis while performance

tests follow ISO 5801, DIN 24163, AMCA 210-99 standards.

Systemair proposal is not only

centered on its axial fan technology but comprises all required ancillaries and components so to provide a fully functional ventilation system.

According to the agreed configurations and design results the Systemair's scope of supply can include: vibration transducers, inertia base frames and antivibration mounts, transition pieces and diffusers, air interception dampers, by-pass dampers, acoustic silencers, control systems, frequency static converters (inverters), etc.

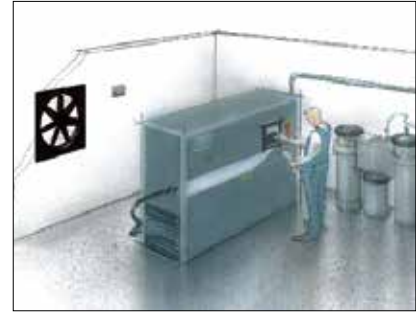




Special movable silencer for Metro application



Fan interception damper



Ventilation for technical rooms

Sound Attenuators

Sound emissions are particularly important in urban environment. The silencers offered by Systemair are optimized and designed specifically for each project granting the maximum efficiency both acoustic and aerodynamic. Silencers are manufactured in heavy duty construction with significant steel sheets thicknesses to grant sturdiness and lifetime. All acoustic attenuators are designed to allow direct mounting inside the allocated spaces and splitter baffles can be mounted on rail systems so to allow the possibility of easy cleaning procedures. All materials used are classified as A1 for fire behavior according to ISO EN 13501-1 standard. Acoustic calculations can be supplied for granting approval from final users and works supervisors of the chosen materials.

Multi-leaf Dampers

Being their use to intercept the ventilation room fans or for allowing by-pass ventilation in the rail and metro tunnels, multi-leaf dampers are often a key element for a fully functional ventilation system. The dampers offered are all realized for the greatest reliability having been subject to fatigue tests to simulate years of operation inside metro and rail tunnels with operation guaranteed for pressure levels up to 6kPa (special executions for pressure over 11kPa can be offered if needed). Often bypass dampers are asked to have large cross-section areas due to the large air flows in transit. This is not an issue as, by coupling different modules together, virtually any dimension can be easily realized and manufactured. Dampers can be provided with fully electric actuators or with pneumatic and fail-safe return modules, granting great flexibility of choice to suit any need or request. Stainless steel can be employed for the manufacturing of all of the damper components and heat covers to protect the actuators from the high temperature involved with fire scenarios can be supplied if needed. Air leakage tests, blade deflection and pressure drop tests can be organized at need as well as the possibility of supplying BS 476 part 20 compliant dampers.

Ventilation Systems for Technical Rooms

As market leader in air distribution elements, Systemair is able to complete its scope of supply including the components of for ventilation of technical rooms. This includes, transit grills, fire dampers, inline fans and extractors, and all other elements that allow Systemair to be a sole referent to allow metro and train ventilation systems come to life.



EI 120S Fire Damper

Metro and Rail Ventilation

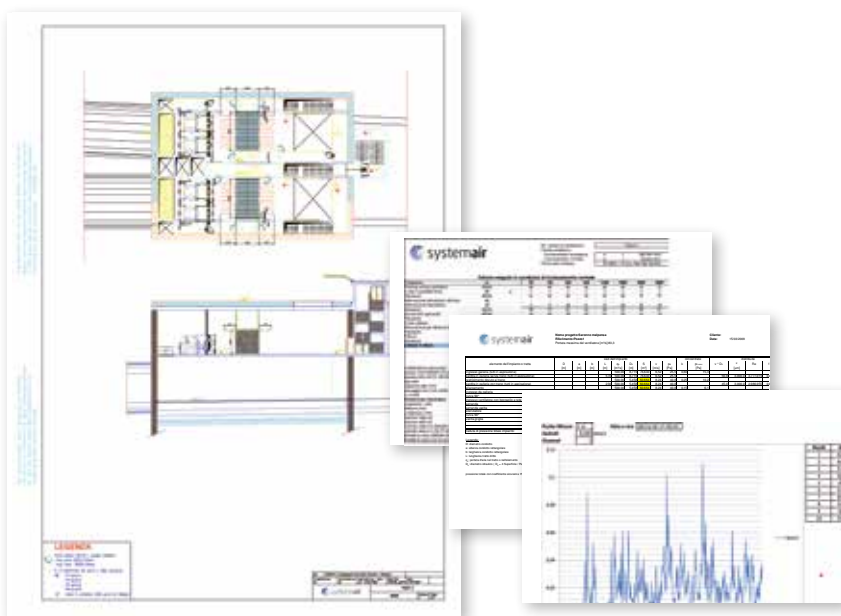
Design

Systemair can provide assistance and support so to confirm the required products and perform calculations for the validation of the system's pressure drops and for the correct sizing of the sound attenuators.

Due to the know-how gained by onsite experiences, Systemair's engineers, can provide assistance and suggestions so to determine the most proper installation solutions.

Quality

Fan product range is certified according to EN 12101-3 for smoke and heat removal up to 400°C for 2hr, and has been verified structurally with finite element analysis. Performance tests follow ISO 5801, DIN 24163, AMCA 210-99 and ISO 13350 standards.



Service



Competent engineers at your service



Onsite supervision during installation



The long-term experience and professionalism of its engineers allow Systemair to be not just a supplier but a partner for its customers. The goal for Systemair is to be a provider of solutions and this involves being an active part in definition, installation, and commissioning of the systems delivered.

Understanding the importance that the delivered components have for the well-being and safety of the tunnel users, Systemair's professionals lay their knowledge and competence in the hands of the designers and planners so to actively cooperate to define the most reliable and cost efficient equipments.

Correct installation is as vital as correct designing, thus Systemair is particularly attentive and provides competent service for supervising the installation phase of the supplied equipments. The active supervision, in addition to the I&O manuals provided for each component, allow the critical phase of installation to run as smoothly as possible, with prompt support in case of any unexpected situation that could arise. Pre-programming of frequency converters, the detail in the definition of the ancillaries and duct components, and confidence in the products, lead to a time-saving and efficient installation phase.

Start-up and commissioning is often the next critical phase that needs to be completed for the turn-over of responsibility of the systems. With the same dedication provided for the earlier steps, Systemair's professionals will support customers so to allow the equipments to work and run as smoothly as possible, granting the possibility of having live measurements of electrical and aerodynamic data. As important as a pre-sales, after-sales service is a key element for Systemair's success.



Onsite volume flow measurement during commissioning



Onsite programming of frequency converters

Systemair Worldwide



Systemair production facilities worldwide:

Skinnskatteberg, Sweden:

Head office of the Systemair group, distribution center and largest production facility with one of Europe's most advanced R&D-centers. Production of fans and accessories, compact air handling units, air curtains and heating products.

Windischbuch, Germany:

Production facility for fans and modular air handling units, specialized on engineered products (e.g. tunnel and jet fans). Distribution center.

Mülheim an der Ruhr, Germany:

Menerga-Systemair, is a leading European

producer of air handling units for swimming pool halls and comfort ventilation with extra high efficiency.

Langenfeld, Germany:

Production of air curtains.

Hässleholm, Sweden:

VEAB manufactures heating products for ventilation systems, mobile and stationary fan heaters and dehumidifiers.

Ukmerge, Lithuania:

Modern production facility for air handling units with focus on energy recovery.

Maribor, Slovenia:

Production of high temperature fans and air handling units.

Aarhus, Denmark:

Production of modular air handling units.

Dal, Eidsvoll, Norway:

Production of air handling units for the Norwegian market.

Bratislava, Slovakia:

Production and modern R+D center for air distribution products and fire and smoke dampers.



Quality:

Systemair is certified in accordance with ISO 9001; ISO 14001 and ATEX. Our research and development laboratories are one of the most modern in Europe; measurements are made in accordance with international standards like AMCA and ISO.

Save energy, lower running cost!

Our label "Green Ventilation" features products with a high energy saving potential. All products labelled with "Green Ventilation" combine energy economy with energy efficiency.



Madrid, Spain:

Production of air handling units and box fans.

Milan, Italy:

Production of chillers and heat pumps.

Waalwijk, Netherlands:

Production of air handling units, also for marine applications.

Tillières-sur-Avre, France:

Production of air conditioning products.

Istanbul, Turkey:

Systemair-HSK is Turkey's leading manufacturer of air handling units.

Bouctouche, Canada:

Production of fans and air handling units for the North American market.

Tillsonburg, Canada:

In Tillsonburg we develop, engineer, service and manufacture school classroom ventilation equipment for the American market.

Kansas City, USA:

Production of fans for the US market.

Sao Paulo, Brazil:

Production of air handling units.

Kuala Lumpur, Malaysia :

Production of fans for the Asian market.

Hyderabad, India:

Production of air distribution products.

New Delhi, India:

The factories in New Delhi and Noida manufacture grilles and diffusers.

Wujiang, China:

Production of air handling units for the Asian market.

